9-28-2018

Development of a Model for Determining Factors Affecting Safety Performance in the Saudi Arabian Construction Industry Using Structural Equation Modelling (SEM)

Majed Moosa
University of Windsor

Development of a Model for Determining Factors Affecting Safety Performance in the Saudi Arabian Construction Industry Using Structural Equation Modelling (SEM)

By

Majed Hassan Moosa

A Dissertation
Submitted to the Faculty of Graduate Studies
through the Industrial and Manufacturing Systems Engineering Graduate Program
in Partial Fulfillment of the Requirements for
the Degree of Doctor of Philosophy at the
University of Windsor

Windsor, Ontario, Canada

2018

Development of a Model for Determining Factors Affecting Safety Performance in the Saudi Arabian Construction Industry Using Structural Equation Modelling (SEM)

by

Majed H. Moosa

APPROVED BY:

____
D. Alwerfalli, External Examiner
Lawrence Technological University

____
D. Andrews
Department of Kinesiology

____
Z. Pasek
Department of Mechanical, Automotive and Materials Engineering

____
M. Wang
Department of Mechanical, Automotive and Materials Engineering

____
L. Oriet, Advisor
Department of Mechanical, Automotive and Materials Engineering

21 September 2018

DECLARATION OF CO-AUTHORSHIP / PREVIOUS PUBLICATION

I. Co-Authorship

I hereby declare that this thesis incorporates material that is result of joint research, as follows:

Chapters 2-8 of the dissertation were co-authored with my advisor, Dr. Leo Oriet. In all cases, the key ideas, primary contributions, method design, data collection, data analysis, interpretation, and writing were performed by the author, and the contribution of co-author was primarily through the supervision of the study on conducting the research methodically, refinement of ideas and editing of the manuscript.

I am aware of the University of Windsor Senate Policy on Authorship and I certify that I have properly acknowledged the contribution of other researchers to my thesis and have obtained written permission from each of the co-author(s) to include the above material(s) in my thesis.

I certify that, with the above qualification, this thesis, and the research to which it refers, is the product of my own work.

II. Previous Publication

This thesis includes four original papers that have been previously published/submitted for publication in peer reviewed journals, as follows:

Thesis Chapter	Publication title/full citation	Publication status*
Chapter [2&3]	Moosa, M. (2015). Factors causing construction accidents. In The (NOISH) 6th National Occupational Injury Research Conference (NOIRS 2015). Kingwood, WV USA.	*Published*
Chapter [2]	Moosa, M.; Oriet. L. (2016). Deaths, Accidents, and Injuries: Measuring Perceptions of Personal Safety in Saudi Arabia's Workplaces. In 29th WSO International EOSH Professional Development Symposium. Houston, TX USA.	*Published*
Chapter [4]	Moosa, M.; Oriet, L. (2017). A Conceptual Framework to Measure Safety Performance in Construction Using Leading Indicators, In 30th Annual WSO International Environmental & Occupational Safety & Health Professional Development Symposium. Las Vegas, NV USA	*Published*

Chapter [2-8]	Moosa, M., Oriet, L. (2018). Factors Affecting Safety Performance in the Construction Industry: An Empirical Study Using Structural Equation Modeling (SEM). Manuscript submitted for publication in International Journal of Occupational Safety and Ergonomics (JOSE)	Submitted

I certify that I have obtained a written permission from the copyright owner(s) to include the above published material(s) in my thesis. I certify that the above material describes work completed during my registration as a graduate student at the University of Windsor.

III. General

I declare that, to the best of my knowledge, my thesis does not infringe upon anyone's copyright nor violate any proprietary rights and that any ideas, techniques, quotations, or any other material from the work of other people included in my thesis, published or otherwise, are fully acknowledged in accordance with the standard referencing practices. Furthermore, to the extent that I have included copyrighted material that surpasses the bounds of fair dealing within the meaning of the Canada Copyright Act, I certify that I have obtained a written permission from the copyright owner(s) to include such material(s) in my thesis.

I declare that this is a true copy of my thesis, including any final revisions, as approved by my thesis committee and the Graduate Studies office, and that this thesis has not been submitted for a higher degree to any other University or Institution.

ABSTRACT

As large-scale infrastructure investments drive rapid growth, the Saudi construction industry is among the largest in the region—and, for workers, among the most dangerous industries on the planet. Using a quantitative survey measure adapted from the Ontario Leading Indicators Project (OLIP) and administered to a small (n = 276) sample of individuals who currently work in the industry, this study aimed to contribute to empirical understandings of hazards, sources of risk, and perceptions of safety in this unique context. A multivariate safety performance model was developed based on a systematic literature review and with an eye to ensuring compatibility with the structure of the adapted OLIP measure. The model's key variables were OHS Planning; OHS Policy; OHS Promotion; Communication & Awareness; OHS Training; Control, Monitoring, & Review; OHS Leadership; Safety Climate; Hazard Management; and Safety Performance.

The survey data revealed a strong consensus expressing negative views of every safety dimension and variable tested, with only tiny minorities selecting positively-valenced responses. Using the survey data as a substrate, correlation analysis found significant relationships between all individual variables. In order to test the descriptive power of the model as a whole, a structural equation modeling (SEM) technique was used in order to assess the correspondence between the relationships constituting the model and their significance relative to empirical data. This analysis found that Hazard Management, OHS Training, and OHS Promotion had no significant impact on Safety Climate, and that OHS Training, Safety Climate, and Control, Monitoring, & Review had no significant impact on Safety Performance, when evaluated in the context of the model as a whole.

This result, which is attributed to significant reciprocal relationships between individual variables balancing one another out in the multiple regression analysis, is not consistent with previous findings in the scholarly literature. It is possible that this result reflects a limitation in the model or in the underlying data, and further scholarly attention is recommended. Overall, however, the need to take urgent steps to improve the safety landscape of the Saudi construction industry, even in the absence of further empirical study of the topic, is stressed throughout the study. Attention from scholars, policymakers, and organizational leaders is indicated.

Keywords: Construction Industry, Safety Culture, Safety System, Saudi Arabia, Safety Performance Model, Structural Equation Modeling (SEM), Analysis of Moment Structures (AMOS)

DEDICATION

With all my heart, I dedicate this dissertation to my darling mother, Fatimah AL-Showkani; my aunty, Asmaa AL-Showkani who I call mom, and who looked after me all through my childhood till today; and my father, Hassan Moosa. They all had a part to play in who I have become today. I have turned to each one of them for inspiration, morale, and support spiritually, emotionally, and financially.

A special dedication to my wife, Hams, who has shown me so much love and support all through this process. I thank you for always being patient with me.

To my two amazing kids, Joanne and Lamar. Because of you, I am a stronger, better and a more fulfilled version of myself than I was before I had you. I love you both endlessly.

To my sister, brother, relatives, mentor, teachers, friends, and classmates. Your words of advice and pearls of wisdom were a great factor in the successful completion of this study.

ACKNOWLEDGEMENTS

During the final years of my study, a lot of people walked with me, guided me through every path, opened the gates of opportunities for me, and showed me which doors to open. This dissertation would not have materialized if not for the input of these individuals and organizations. I am saying a big thank you to each of these individuals, because I couldn't have done this without them.

I also wish to extend my deepest respect and appreciation to my advisor, Dr. Leo Oriet, for his unwavering support, professional advice, and mentorship throughout this project. First of all, a big thank you for everything you did! You had a lot of faith in me and you never stopped encouraging me throughout this process. The kind of help and support you provided was just what I needed to successfully complete this study. I will also like to give special thanks to Dr. David Andrews, Dr. Michael Wang, and Dr. Zbigniew Pasek for their professional guidance and support over the years.

I would like to offer thanks to the Institute for Work & Health (IWH) in Ontario for permitting me to make use of their OLIP survey for my study.

I would also like to take advantage of this opportunity to appreciate my beloved friends for always supporting me through this journey.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS/SYMBOLS

Abbreviation	Full Form
AMOS	Analysis of Moment Structures
AVE	Average Variance Extracted
CA	Internal Communication & Awareness
CFA	Confirmatory Factor Analysis
CR	Control, Monitoring & Review
CR	Composite Reliability
EFA	Exploratory Factor Analysis
HZ	Hazard Management
ILO	The International Labour Organization
IWH	The Institute for Work and Health in Ontario
KMO	Kaiser-Mayer-Olkin
KSA	The Kingdom of Saudi Arabia
LD	OHS Leadership
OHS	Occupational Health and Safety
OHSMS	Occupational Health and Safety Management System
OLIP	Ontario Leading Indicators Project
OPM	The Organizational Performance Metric
PL	OHS Planning
PO	OHS Policy
PR	OHS Promotion
SC	Safety Climate
SEM	Structural Equation Modelling
SP	Safety performance
TR	OHS Training

CHAPTER 1: INTRODUCTION

1.1. Background

On September 11, 2015, thousands of Muslims from around the world gathered at Mecca's Grand Mosque in Saudi Arabia, Islam's holiest site, as part of the annual Hajj pilgrimage. However, what was meant to be a deeply religious experience for those pilgrims, soon became traumatic. Thunder and high winds plagued a massive crane, unbalanced and unstable as it towered above the thousands of people standing near its base, gathering to pray. In one swift and devastating moment, it toppled, killing 107 people and injuring hundreds more. Despite claims that the crane was installed correctly, the construction company, Saudi Bin Laden Group, was suspended, and the safety conditions that caused the accident were placed under investigation. (Dunn & Charlton, 2015). Many critics noted that, although the company was one of the largest and most experienced in the region – and received a significant portion of government funds for the project – the accident was the result of negligence. In fact, a royal investigation found that the company was responsible for this tragedy as it "had not respected the norms of safety" at the construction site (France, 2015). Another resource claims that the incident occurred because the crane was "in a wrong position [and] in violation of the manufacturer's operating instructions" (Al Omran, 2015).

1.2. Significance

Several research studies have already been conducted in order to evaluate improvement of Saudi Arabia's construction productivity procedures. Abdallah (1995) found that measurement plays an important role in any effort to improve labour productivity and safety management in construction. This is because it provides the basis for a detailed study and analysis. Moreover, Jannadi and Al-Sudairi (1998) measured safety performance in the Saudi Arabian construction industry. They concluded that the best safety performance can be found in larger construction firms. They also found that a construction site's level of safety depends upon project size: large projects, constructed by large international firms, have much better safety records than smaller projects. This is because most international firms use their own safety standards. As noted in the literature review, dynamic multivariate models of safety performance are few and far between. A major contribution of the present study is to synthesize original data with secondary research focused on establishing correlations and descriptively characterizing perspectives and insights in safety practices, in order to codify a novel system dynamics model relating a number of diverse factors to safety performance.

Most importantly, this study is significant because it will explore many new topics at the forefront of the Kingdom of Saudi Arabia's burgeoning construction industry. These topics focus on a need for a local safety code that meets the construction industry's safety and health requirements, while simultaneously acknowledging that formal prescriptions of this nature represent a necessary but insufficient condition for the development of a safety process that delivers world-class results. This study, therefore, has been designed specifically to have significance beyond the official policy formulation process, but to be relevant for organizational decision-makers and trainers, as well, to perform safely.

1.3. Problem Statement

The construction industry is one of the most dangerous sectors worldwide due to its work environment. Unlike other industries, especially manufacturing, construction sites change according to a plethora of factors, such as contract requirements and weather conditions. The construction work environment directly and seriously impacts people's health and safety. The International Labour Organization (ILO) estimates that there are over 2.3 million fatalities per year caused by occupational accidents and work-related diseases worldwide (ILO, 2015). Moreover, the ILO reported that, in addition to these fatalities, the number of non-fatal occupational accidents that entail at least four days away from work reached over 313 million in 2010 (ILO, 2015). Therefore, it is vital that the construction industry strictly prioritize safety along with other important factors, such as a project's quality, cost, and schedule (Karahalios, 2005).

There are also many behavioural components to safety that could increase the probability of accident occurrence. Creating patterns of behaviour that are conducive to safety can be effectively accomplished by embedding desired behaviours within larger value systems. For this reason, safety is not only an issue of procedure, but also one of culture. Indeed, according to Alasamri, Chrisp, and Bowles (2012), safety culture is one of the major driving forces behind the high injury rates in the construction industry worldwide. Thus, the authors argue that "improving safety culture is necessary to reduce the number of injuries and fatalities on construction sites internationally" (p. 475). This is, perhaps, more true for Saudi Arabia and the rest of the Arab world: Saudi Arabia's major injury and fatality rates in the construction industry are probably the highest in the region compared to other gulf countries such as the United Arab Emirates (UAE) (Alasamri, Chrisp, & Bowles, 2012).

By improving our understanding of safety performance and culture in the Saudi construction industry, it should be possible to set the stage for a major change guided by industry best practices. Fortunately, scholarly literature on safety performance within this industry is rapidly growing in scope and quality. The proposed study will help prevent Saudi Arabia's construction industry tragedies by contributing to the growing body of scholarly literature on Saudi Arabia's safety performance. This study will address the problem of the demand for improved safety practices in Saudi Arabia's construction industry.

The study will examine the many complex factors that may play an important role in the growth and development of Saudi Arabia's construction industry safety culture from an industrial engineering perspective. It will investigate the factors that influence the country's safety performance with an approach involving a model based on quantitative surveys carried out by the Ontario Leading Indicators Project (OLIP), which is being conducted by the Institute for Work and Health in Ontario.

Using collected data, the factors of Saudi Arabia's safety performance will be synthesized to develop a practical model that describes the functional relationships that shape safety performance. The safety performance model will be novel and multivariate, tailored specifically to the Saudi context. It will make a topical, meaningful contribution to the growing body of literature on safety in Saudi Arabia's construction industry. Recommendations will be made to improve the country's safety performance and management, and the model will lay a foundation for future research on the topic of safety performance.

1.4. Aims and Objectives

This dissertation is designed to address the considerable need for improved safety practices in Saudi Arabia's construction industry through an investigation comprising quantitative data collection as well as mathematical modelling and data analyses. By examining quantitative data regarding accident rates and drawing connections between complex variables using a mathematical model, it aims to analyze safety performance from a systems-oriented industrial engineering perspective. The overarching aim of this study, therefore, is to improve safety performance and practices in the Saudi construction industry by way of an in-depth analysis.

Accomplishing this will require meeting the following four objectives:

- Evaluate and measure the attitudes and perceptions of current safety practices among workers in Saudi Arabian's construction industry using a quantitative survey.
- Develop a conceptual safety performance model and then refine, and evaluate it in light of the study's findings.
- To find and investigate the proposed factors that impact the safety performance of the construction industry in Saudi Arabia.
- To provide recommendations for stakeholders to achieve successful safety practices in the construction industry of Saudi Arabia.

These objectives are designed to facilitate the development of a general model based on a narrow but deep case investigation, in the interest of exploring the range of accident causation factors relevant to diagnosing and modelling organizational safety performance in the Saudi construction industry. Each strategy for data collection and analysis seeks to evaluate the contribution of factors identified in previous studies (e.g., mainly, the OLIP components) to facilitate the articulation of a multidimensional, systems-based understanding of safety performance in the Saudi Arabian construction industry. Ultimately, the study will seek to identify strategic strengths and opportunities within the construction industry's safety performance, allowing for the recommendation of specific actions, initiatives, or systems to improve Saudi Arabian construction site safety.

1.5. Research Questions

As indicated above, the proposed study is primarily concerned with evaluating safety in Saudi Arabia's construction industry and seeks to make modest contributions to the develop and engineering of improved safety processes in this important and rapidly-growing industry. Specifically, the research will be guided by three core questions:

- What is the current state of safety processes and practices in the Saudi construction industry?
- What measures can be implemented with a reasonable expectation of improving safety performance along the dimensions of safety management systems, climate, leadership, and hazards management?

- How do we capture the factors affecting safety performance in the Saudi Arabian construction industry with maximum effectiveness using the proposed Safety Performance Model?

Any serious attempt to address the fundamental problem of improving safety practices requires engagement with the broad and diverse array of factors that shape safety performance. It is because of the broad, multidimensional, and interdependent nature of this web of factors (many of which are typically segregated into distinct academic disciplines) that an industrial engineering perspective attuned to the demands of working with and modelling complex and dynamic systems —translating continuously between theory and practice, between the abstract and the pragmatic — is uniquely appropriate with respect to generating insights in this domain. Engaging directly with this process through the development of a safety performance model has the potential to provide a means by which to integrate research and test possible approaches to improving safety in this industry.

1.6. Research Steps

As suggested by the research objectives described above, this study utilizes a unique, multi-pronged research methodology. This methodology relies on the ability to obtain and integrate data to yield an empirical basis for the development of a process model describing the relationships between a broad array of factors implicated in determining organizational safety performance. A summary of the research design is shown in Figure 1.1.

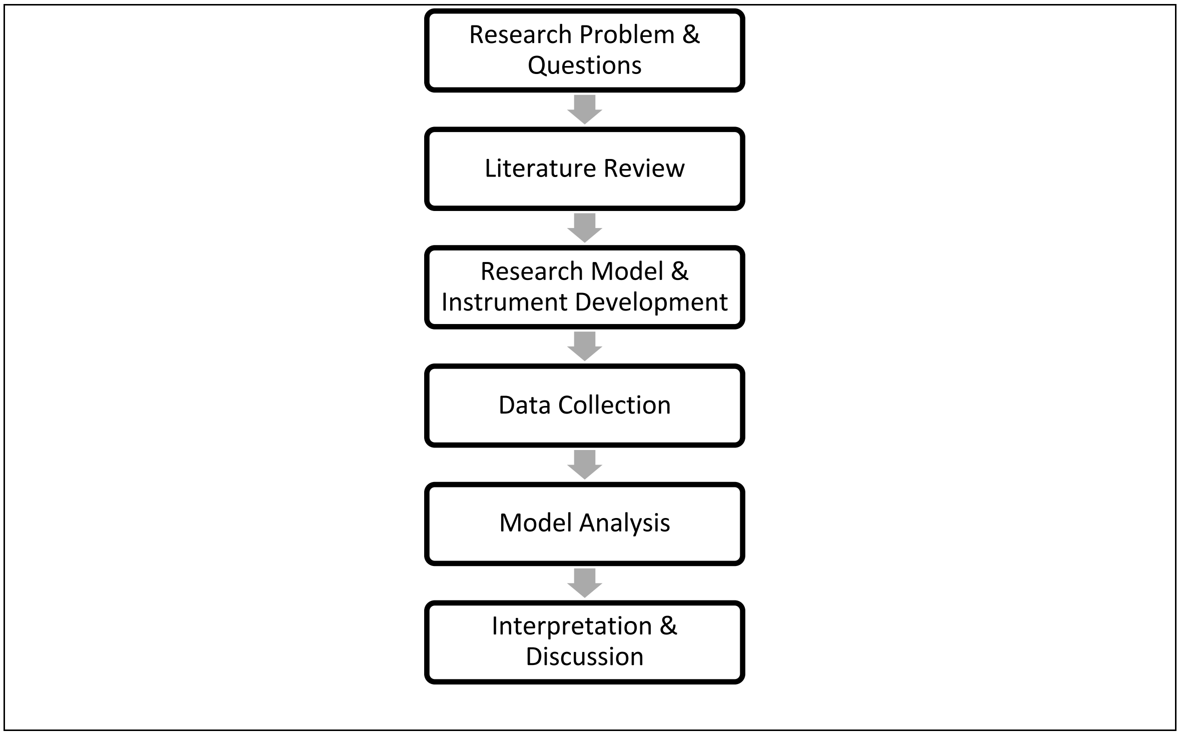

Figure 1. 1: Research Steps

CHAPTER 2: SAFETY IN THE KINGDOM OF SAUDI ARABIA

2.1. Overview

This chapter presents a description of the general safety practice in the Kingdom of Saudi Arabia (KSA) with a major focus on current safety reforms. A detailed description of safety practice, and the organizations governing safety practices and their roles are presented as a profile, since this research addresses a component of safety performance in KSA. As a starting point for the chapter, the basic information about the country such as geographic location, population, ethnic and religious composition, economic and social statuses, and its administrative structure are presented before presenting the safety profile.

2.2. The Country

2.2.1. Introduction

The kingdom of Saudi Arabia is an independent country located in the Middle East. It has a strategic location as it centres three contents, Asia, Africa and Europe (Figure 2.1). It connects the East and West through its central location on the traditional and international trade routes. The population of the KSA is estimated according to the results of population characteristics (2017) with 32,552,336 people, compared with 31,742,308 in the demographic survey (2016), with an average annual growth rate of (2.52%). The population is divided by sex by 57.48% for males and 42.52% for females in 2018 (Stats, 2017). Arabic is the official language. However, English language is widely spoken, especially in the private sector and universities. The nation is divided into 13 provinces. Riyadh is the capital city, with a population of over four million people. Other important cities are Mecca and Medina, as they are the first and second holiest cities in Islam, respectively.

Figure 2. 1: Location of the KSA

(source: http://www.maps-of-the-world.net)

2.2.2. Vision 2030

The progress of the Kingdom of Saudi Arabia is not new. The modernization has been significantly steady, with each generation building on the work of its antecedents/predecessors. Through utilization of wealth generated from the natural resources of the Kingdom, help both the economic and social activities of the nation, continuous efforts have been made to improve the lives of the people of Saudi Arabia. The different measures of human development – for example per capita income, infant mortality, life expectancy, and literacy etc. – have significantly improved in a very short period of span (MOFA, 2017). However, this new generation brings forth a new set of opportunities, threats, and challenges with this comes a new stimulus for further growth and development. In April 2016, the Saudi Crown Prince Mohammed bin Salman unveiled the Saudi Vision 2030. This is an ambitious program of advancement of the Kingdom of Saudi Arabia. The focus of Vision 2030 is to strengthen Saudi Arabia's as an investment powerhouse located in the centre of the Arab world with powerful linkages to Africa, Europe, and Asia.

This ambitious Vision 2030 package of social, political, and economic progression is erected around three pillars – an ambitious nation, a vibrant society, and a thriving economy. The focus is on building on the strengths of Saudi Arabia and to develop it into an an investment powerhouse that is situated in the centre of Arab world, thus acting as a regional hub connecting three continents. The Kingdom seeks to achieve a total of 24 specific goals within Vision 2030 through political, societal and economic development. In order to attain the proposed goals, Vision 2030 articulates 18 commitments – with detailed focus towards manufacturing, education, renewable energy, culture, e-governance, and entertainment (MOFA, 2017).

2.2.3. Economy

In order to achieve the targets of sustainability, Saudi Arabia needs to diversify beyond just oil and gas, which have been the most potent economic pillars historically. In order to diversify, additional investments are being made into different sectors for expansion. This new development poses significant challenges, but Saudi Arabia plans in place to overcome them. There has been an annual growth of 4% in the Saudi economy in the past 25 years; this has contributed to the creation of millions of new jobs. According to MOFA (2017), the Kingdom is among the top 20 economies in the world.

However, the objective is to have an even better world economic ranking by 2030, even in light of the obstacles emerging from the economic deceleration globally and the consequence of structural economic rehabilitations. In order to achieve the desired target, there is a need to devote significant resources that would aid in diversifying the economy, tap into the capabilities of economic sectors that show promise, and privatize some government services to improve quality.

In order to foster increased foreign direct investment, changes have been made to the regulations pertinent to the economic sector. The regulators and power corridors have rehabilitated their stress on small and medium-sized enterprises (SMEs). Additionally, the education system in Saudi Arabia is now increasingly focused on mapping the skills gap through training students and professionals for the challenging job market. Vision 2030 has led to an increase in the foreign investment in Saudi Arabia. KSA has been considered an appealing place for investors due to the availability of primary partnership opportunities in many industries, such as healthcare, manufacturing and many more. Employment opportunities for Saudi women have also increased because of the proposed initiatives for economic growth (MOFA, 2017). One of the leading economic initiatives undertaken by the Saudi government is the transformation of Aramco from an oil, focused organization into an industrial conglomerate. Additionally, Aramco, with its partial privatization, would help change the Kingdom's Public Investment Fund into the largest sovereign wealth fund in the world. This fund seeks to make investment into the leading technologies around the globe.

2.2.4. Sociocultural Development

Another important focus of the Vision 2030 is to foster a society where everyone will have a healthy lifestyle, enjoy a good quality of life, and expanded cultural opportunities. The role of Saudi women in the country's political, economic, and social development is also recognized in the initiatives of the Kingdom. It should be noted that women comprise more than the half of the total graduates from Saudi universities. This large number shows that the KSA has assured that they will extend efforts to invest in their citizens' capabilities and talents, which will result in strengthen their own future and contribute to the country's development, both socially and economically (MOFA, 2017). The whole development drive in Saudi Arabia is not a one-time arrangement, but rather a continuous process. The growth and development initiatives undertaken by the Saudi government are part of a long-term agenda, which is focused on going beyond replenishing sources of income that are declining. All these efforts are being made to open new avenues of economic growth and generate income, move Saudi Arabia beyond just oil, and help create a more dynamic economy that will not be just the subject to commodity price instability. Moving away a reliance on oil related products, the initiatives will help provide opportunities to the public – this will help unlock various talents, potentials, and dedication of young men and women. These efforts will result top-class governmental services that would efficiently and effectively meet the requirements of the public (MOFA, 2017).

2.3. Construction Industry in KSA

High living standards in Saudi Arabia have generated many manufacturing and building employment opportunities. The Kingdom has seen an unprecedented boom in the construction sector throughout the last two decades, which has become one of the fastest-growing in the Middle East region (Alasamri, Chrisp, & Bowles 2012). Saudi Arabia represents the largest construction market in the Middle East and one of the fastest growing construction markets in the world. Key development areas include improving infrastructure, transport, education, and real estate, all of which will require construction-related activity (MOFA, 2017). The growth of towns has accelerated as a result of a large and growing population. Sizeable and complex projects have been built, attracting consultants and contractors from all over the world. Indeed, Saudi Arabia's construction industry is at a critical stage in its development, and its growth trajectory is likely to rapidly accelerate in the near future. The industry's compound annual growth rate is expected to reach nearly 11% in the next three years; and its added value increased by nearly 10% in 2012 (PR Newswire, 2014). The Saudi Arabian General Investment Authority (SAGIA) plans to invest over $100 billion in transportation projects during the coming ten years (MOFA, 2017).

A report by BMI Research announced that the construction market in KSA is expecting to double within the next seven to eight years, from $45.33 billion in 2016, to about $96.52 billion in 2025. Sophisticated construction technologies, such as 4D Building Information Models (BIM), will be implemented and used to help Saudi Arabia's construction stakeholders, such as architects and contractors, to promote participation and productivity, and at the same time, to reduce overall costs (MOFA, 2017).

This organic growth, which is related to demographic and socioeconomic developments, is being increasingly augmented by government policies, such as a 2013 mortgage law designed to expand the country's real estate market, as well as comprehensive national initiatives designed to enhance energy and transportation infrastructures (PR Newswire, 2014). In Saudi Arabia, government policies of this kind have a long history of encouraging rapid growth in the construction industry, which has been the foremost recipient of state funding for three consecutive National Development Plans. This monetary support is not surprising, considering the fact that the Saudi construction industry "employs 15% of the total labour force" and accounts for approximately one fifth of gross domestic product (GDP) (Jannadi & Bu-Khamsin, 2002, p. 539).

The construction industry of the Kingdom of Saudi Arabia has the potential to make a major contribution to the Kingdom's construction production and business, working towards modern and innovative safety systems. Past investment projects are quickly becoming enormous investments today. Major cities, such as Riyadh and Jeddah, are now developing new malls, towers, and roads. However, perhaps the most ambitious project currently underway can be found in Rabigh, 100 km north of Jeddah. It is where the King Abdullah Economic City (KAEC) is being built, one of six economic cities unveiled by King Abdullah as part of a massive program of building work that will change the entire face of the country (Gorvett, 2008).

These new projects and opportunities are not without challenges. The growth of its construction industry includes development projects for public and private building facilities and major infrastructure. As these construction projects are completed, protection and safety management issues have been raised that draw attention to the responsibilities of maintenance contractors and building owners (Al-Hammad & Abdul-Mohsen, 1995). Many of the consultants and contractors that have recently moved to the Kingdom appear to lack a sufficient understanding of the unique social, cultural, and physical environments of Saudi Arabia. This situation, coupled with inexperienced building owners, has led to inadequate designs resulting in many changes to plans, specifications, and contract terms (Arain, Low Sui, & Assaf, 2006).

In Saudi Arabia, construction processes are typically based on several international codes. A significant major portion, however, do not follow any standard. Consequently, several problems have arisen that are related to reinforced concrete buildings and are now unavoidable. Although the number of reported collapsed buildings is minute, strength and durability problems are very common. The consequences of these issues vary from high maintenance costs to the entire collapse or utility loss constructed buildings. It is essential that the country improve its safety performance with a consideration of safety-related factors such as leadership, training and education, planning, communication, design, and hazard management. Such a performance will function to use a set of defined practice necessities that can ensure structural serviceability and safety.

Jannadi's observation that the Saudi construction industry "has had a poor reputation for coping with risks, with many projects failing to meet deadlines and cost targets" is an understatement (2008, p. 776). Consider, for example, the most basic form of construction: trenching and excavation. Jannadi's comprehensive risk assessment of Saudi's widespread, fundamental construction practices for this form identified an alarming array of potential risks, ranging from exposure and soil caving to trench failure due to rainy weather, equipment operations, material handling, public accidents, crossings of existing utilities, and more (p. 776).

2.4. Safety in KSA

Although it remains at a fairly early stage of development in many regards, over the course of the last two decades, literature exploring safety culture in Saudi Arabia has undergone impressive growth. Significant work remains to be done, however, with respect to both refining and developing this body of scholarship as well as improving actual safety practices and records within the country.

Between 2004 and 2010, more than 260,000 serious accidents occurred in the industry; over 2,000 of these accidents claimed employee‘s lives, yielding "an annual average death rate of 28.3 per 100,000 employees" (Alamsari, Chrisp, & Bowles, 2012, p. 475). While data collection and reporting methods vary substantially from country to country, their comparative analysis, as shown in Table 2.1 , revealed that out of a sample of construction industries in the United Kingdom, the United Arab Emirates, the United States, Saudi Arabia, Australia, Kuwait, Jordan, and Bahrain, Saudi Arabia has the highest rate of major injuries as well as the highest rate of fatal injuries" (Alamsari, Chrisp, & Bowles, 2012). The results show that Saudi Arabia is on top of the list with 3117 injuries and 28 fatalities out of every 100,000 employees in 2008. These numbers indicate a very serious and disturbing situation. A widespread absence of safety culture was implicated as a major driving force behind these high accident rates (p. 478).

Although the reporting system for injuries in Saudi Arabia is not effective, the Saudi Arabian General Organization for Social Insurance (GOSI) collects these data and annually provides statistics related to Saudi Arabian industries, including participants, injuries, and reasons for those injuries. Table 2.2 presents the number and percentage of work injuries distributed by economic activities in Saudi Arabia between 2006 and 2014.

Table 2. 1

Comparative Study

Country	Labour (Thousands)	No. injuries		No. deaths	Rate of major injuries / 100,000 employees/Year	Rate of fatal injuries /100,000 employees/Year	Date issued
United Kingdom	2404	Major	3286	53	254.1	3.4	2008
		Minor	6789		524.9		
Australia	926	Major	1621	55	175	5.9	2008
		Minor	13118		1416		
United Arab Emirates	1349	Serious	690*	20*	233.03*	6.7*	2008
United States Of America	13735	Major	164900	975	1200	9.7	2008
		Minor	316800		1500		
		Job transfer	207900		2300		
Kuwait	127	Serious	1257	13	1013	10.4	2008
*Jordan	374	Serious	2306	-	615.9	-	2008
*Bahrain	133	Serious	475	-	357.1	-	2008
Saudi Arabia	1248	Serious	38929	402	3117	28.19	2008
Max. Rate of Non-Fatal injuries (major)			3117 per 100,000 (Saudi Arabia)				
Max. Rate of Fatal injuries			28.19 per 100,000 (Saudi Arabia)				

Source: (Alasamri, Chrisp, & Bowles, 2012)

Figure 2.2 clearly indicates that the injury rate for the construction industry is extremely high, with an average of about 48% compared to the average injury percentages in the other industries.

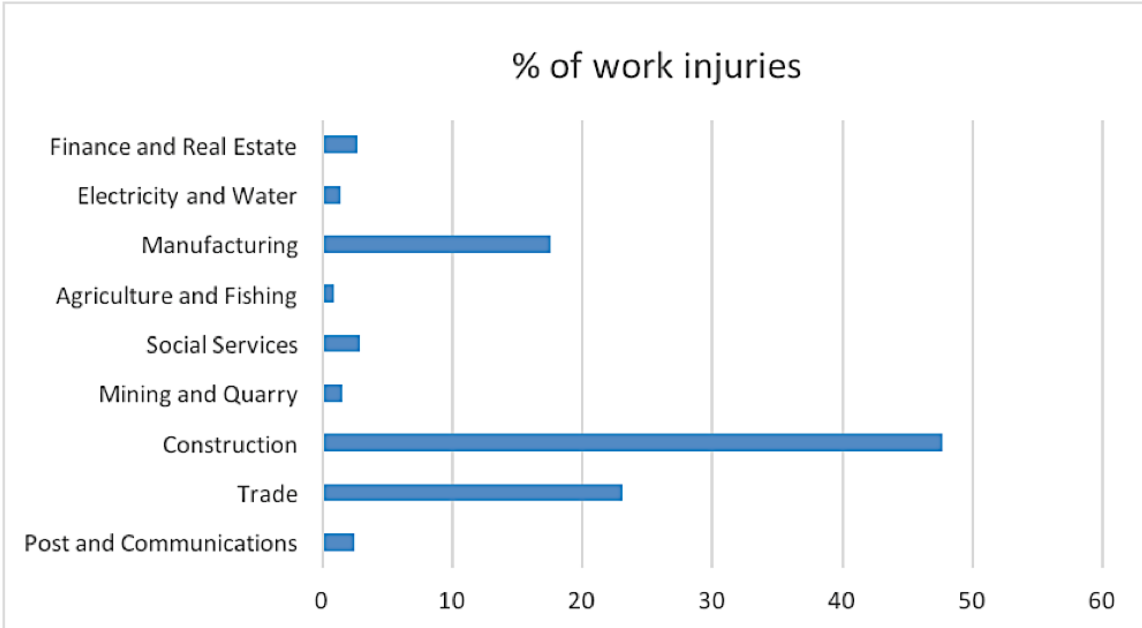

Figure 2. 2: Average (%) of work injuries by economic activities in Saudi Arabia between 2006 and 2014

A pilot study conducted by the author, which provided preliminary findings that guided the development of the present project, is also relevant here (Moosa, 2015). Using a survey, the author sought to identify the leading contributing factors to construction accidents in Saudi Arabia, as well as to gain an initial assessment of safety practices and perceptions of accident causation. As expected, the results were in line with previous scholarship on the topic, and indicated that attitudes toward safety practices — an important component of overall safety performance — were the top factor contributing to workplace accidents in this context. This strongly implies that improving the Saudi construction industry's safety performance will mean beginning with attitudes regarding safety and seeking to lay the groundwork for the development of a healthier and more robust safety culture. The following subsection offers a more detailed consideration of how this might be accomplished and where work is particularly needed.

Table 2. 2

Number and percentage of work injuries distributed by economic activities in the Kingdom of Saudi Arabia

Year / Activity	2006		2007		2008		2009		2010		2011		2012		2013		2014	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Post and Communications	2150	2.4	2 499	2.7	2014	2.2	1757	2.0	1502	2.0	1517	2.0	1243	1.89	1117	2.13	1673	4.42
Trade	25946	28.6	25042	27.3	20766	22.3	16936	19.6	16028	21.2	19385	25.6	17275	26.31	10312	19.65	12948	18.7
Construction	37427	41.2	38929	42.4	44430	47.6	43308	50.2	37527	49.7	36367	48	31048	47.29	26700	50.89	35552	51.35
Mining and Quarry	1190	1.3	1354	1.5	1410	1.5	1367	1.6	1129	1.5	985	1.3	941	1.43	906	1.73	1346	1.94
Social Services	3223	3.5	2927	3.2	2960	3.2	2885	3.3	2033	2.7	1789	2.4	1677	2.55	1511	2.88	1860	2.69
Agriculture and Fishing	867	0.9	846	0.9	848	0.9	828	1.0	746	1.0	608	0.8	500	0.76	418	0.8	539	0.78
Manufacturing	17892	19.7	17570	19.1	17741	19.0	15454	17.9	12714	16.8	11921	15.7	10103	15.39	9148	17.44	11400	16.46
Electricity and Water	1460	1.6	1274	1.4	1454	1.6	1607	1.9	1147	1.5	1074	1.4	835	1.27	651	1.24	811	1.17
Finance and Real Estate	698	0.8	1381	1.5	1662	1.8	2066	2.4	2661	3.5	2179	2.9	2034	3.1	1704	3.25	3112	4.49
Total	90859	100	91822	100	93285	100	86211	100	75487	100	75825	100	65656	100	52467	100	69241	100

2.5. Safety Administrative Structure

The Kingdom of Saudi Arabia is witnessing a great development in the economic and industrial field. This development was accompanied by the entry of many chemicals and modern machines into industrial activity, which carries many chemical, mechanical, physical and other risks.

The increase in the number of factories in the various fields of production, and the doubling of the number of workers in these factories, has exacerbated the incidence of occupational injuries and diseases, and has threatened the development of these fields.

Therefore, the importance of occupational health and safety in the Kingdom has increased to cope with this steady expansion in the Saudi industrial sector. Safety regulations aim at protecting the basic elements of production, the most important of which is the human element, and regulations were issued concerning the protection of the worker and compensation for injuries or risks of work in the Kingdom, and take all precautions that protect workers and the establishment and increase production and push Industrial and economic development. The Kingdom of Saudi Arabia has entrusted the task of protecting workers and compensating for the occupational risks of several government agencies as shown in Figure 2.3, the most important of which are:

- Ministry of Labor
- General Organization for Social Insurance
- Ministry of Health
- Ministry of Interior
- Saudi Civil Defense
- Higher Commission for Industrial Security

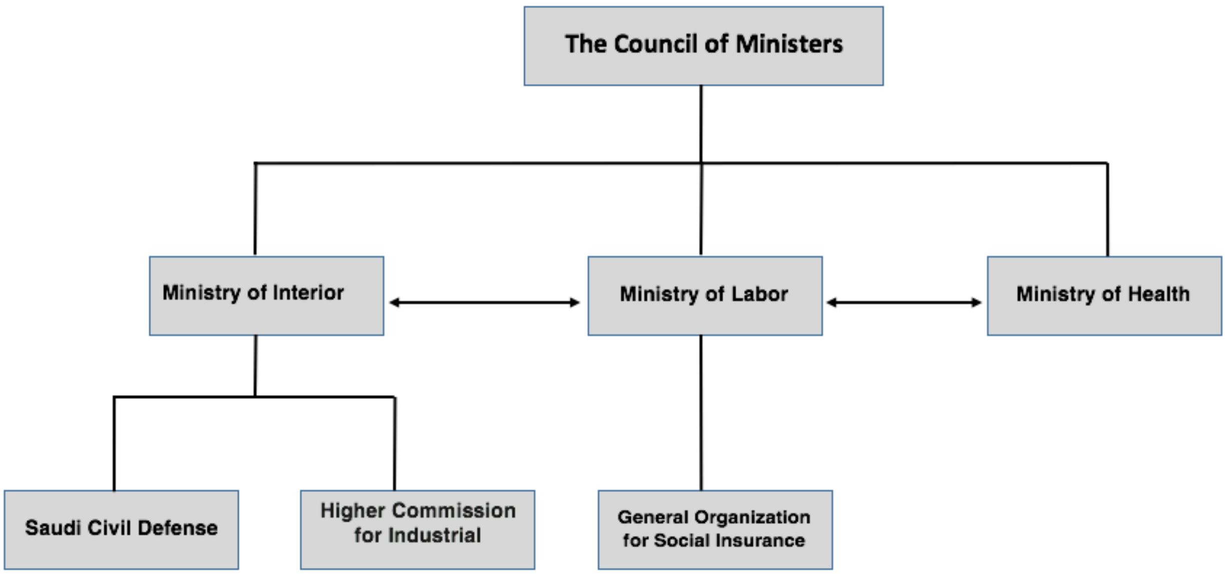

Figure 2. 3: Safety administrative structure in KSA

Ministry of Labor:

The Ministry of Labor, through labor inspectors, shall inspect the premises to ensure the application of occupational safety and health measures in industrial establishments to:

- follow up the work environment through field trips to industrial establishments.
- follow up the existence of a medical file for each worker containing the procedure of periodic medical examination and primary.
- raise awareness of the concept of occupational safety and health through field visits to establishments by occupational safety and health inspectors,

issuing pamphlets and bulletins for occupational safety and undertaking surprise field visits to facilities to ensure compliance with occupational health and safety requirements.

- ensure that employers provide occupational health and safety requirements of medical services for workers and provide personal protective measures to reduce occupational accidents in the work environment, and ;
- participate in the preparation of regulations and legislation for occupational health and safety at the level of the Kingdom with the relevant authorities.

General Organization for Social Insurance:

- Treatment and payment of compensation for occupational injuries through the Occupational Hazards Branch.
- Participate in the preparation of regulations and legislation for occupational health and safety at the level of the Kingdom.
- Develop and update the occupational diseases table in accordance with international regulations and legislation in this field.
- Follow up the availability of occupational health and safety requirements in establishments through field visits.
- Spread the culture of safety and awareness of the importance of applying safety requirements within industrial establishments to reduce the incidence of degrading injuries, through special means and media, holding conferences and symposia and participating in special events.

- Prepare the annual statistical book of occupational injuries in the Kingdom.
- Prepare brochures and brochures to raise awareness of occupational hazards.
- Attract and qualify medical and engineering personnel specialized in the field of occupational health and safety.
- Conduct field studies on the damage of some chemicals and some modern equipment and devices.
- Make environmental measurements necessary to ensure a healthy and healthy work environment.

Ministry of Health:

The Ministry of Health implements the occupational safety and health programs in its health facilities through the implementation of the medical waste program, the radiation protection program and the infection control program. The Ministry participates with the relevant authorities (Ministry of Labor and General Organization for Social Insurance) in the development and follow-up of occupational health and safety programs and occupational medicine.

Ministry of Interior:

Ministry of Interior is responsible for both the Saudi Civil Defence and Higher Commission for Industrial Security:

The Saudi Civil Defence:

The Saudi Civil Defence is a set of measures and actions necessary to protect the population, and public and private property from the dangers of fire, disasters, wars, various accidents, relief of the affected people, safety of transport, communications and work flow in public facilities, and protection of national sources of wealth in times of peace and war. For its safety participation, the major responsibility is the organization of rules and means of industrial safety and security.

Higher Commission for Industrial Security:

In view of the importance of petroleum, industrial and service facilities in the Kingdom of Saudi Arabia, the Kingdom considered the need to establish a supreme body for industrial security to develop appropriate policies and plans to protect these facilities in the areas of security, safety and fire prevention to ensure continuity of work and production under all circumstances. It is governed by the Ministry of Interior. The most important responsibilities of the High Commission for Industrial Security:

- Implement the decisions of the Board of Commission;
- Coordinate between petroleum, industrial, service and security establishments to activate the requirements of security protection, industrial safety and protection from fire;
- Conduct comprehensive field surveys of all facilities under the supervision of the Commission to implement the instructions and requirements of security, safety, fire protection and follow-up implementation;
- Set the technical, engineering, regulatory and procedural instructions for the requirements of safety, safety and fire protection in all establishments subject to the Authority's supervision and updating them permanently;

- Supervise and follow up on the establishment of departments for industrial security work in all facilities;
- Organize seminars, exhibitions and conferences aimed at developing and improving various areas of industrial security and qualifying employees to keep abreast of modern techniques and theories and to identify the dangers and environmental and industrial effects inside and outside;
- Develop contingency and evacuation plans that are commensurate with the circumstances and specificity of each facility and follow up the conduct of phantom experiments to ensure their suitability;
- Participate in the committees concerned with the establishment of security and safety precautions for facilities and facilities not under the supervision of the High Commission for Industrial Security, and
- Provide information base on all types and quantities of chemical, radioactive materials, and their places of existence to ensure the safety and transportation of these materials.

2.6. Safety Reform

The matter of occupational safety and health in the Kingdom faces several challenges. The current strategy of the Ministry of Labor aims at creating a unified national OSH system to promote awareness, reduce accidents and work injuries, maintain capacity and resources, improve legislation and regulations, apply inspection and accident registration systems, and investigate occupational safety and health.

The multiple roles and responsibilities in the area of occupational safety and health lead to the overstrain of the private sector, wasting time and wasting national resources. Developing the field of safety helps reduce the costs of work injury and helps in creating an attractive environment for all employees. However, there is a lack of statistics, but what exists is helping to walk on the right path to develop the field of occupational safety and health. There are few, but effective, government initiatives to develop the field of occupational health and safety, the most important of which are:

- The Council of Ministers' initiative;
- The National Strategic Program for Occupational Safety and Health; and
- The Occupational safety and health initiative in industrial activities.

2.6.1 The Council of Ministers of KSA:

On October 17th, 2016, the Cabinet of KSA approved a number of financial and procedural arrangements relating to security and safety projects in the country, including:

1 – Verification of the Government agencies, when executing their projects, their compliance with instructions and regulations of the safety and security set forth in the concerned regulations and instructions and to commit themselves to the following (spa.gov.sa, 2016):

- Never pay any current or final dues except after a certificate by the consultant office affirming the commitment to the instructions of security and safety is presented;

- Never start new projects or those already bidden but not yet started, and no down payment to be disbursed unless the project's security and safety plan is submitted after having been approved by the supervising consultant or government entity owning of the project, or both;
- For the non-closed projects, or those being all-or-partly visited by the public, such as appendices, alterations, repairs or projects related to roads and transportation, the process of payment for them requires a certificate showing that the contractor is committed to the regulations of security and safety or the plan of security and safety approved by Civil Defense.

2 - The Ministry of Municipal and Rural Affairs has to review the classification's system of contractors and its executive regulation as well as the main standards in force, and study whether to add a clause requiring the contractor to be committed to the requirements and systems of security and safety as a prime criterion in the classification of contractors and fixing their classification degrees.

2.6.2. Occupational Safety and Health 2020

The national Strategic Program for Occupational Safety and Health 2020 is one of the programs of the Ministry of Labor and Social Development in the National Transition Program 2020, and one of the programs that contribute to realizing the vision of the Kingdom 2030, in terms of finding suitable and quality employment opportunities for national cadres. This initiative aims to establish occupational health and safety regulations and laws in the workplace, which is a key factor in attracting and stabilizing the workforce to enhance productivity. Indeed, it has positive effects on the private sector and the economy in general, such as:

- Raise awareness of the importance of occupational health and safety and promote a culture of prevention;
- Enhance knowledge and capacity building for occupational health and safety;
- Develop occupational health and safety regulations and legislation; and
- Strengthen and carry out effective inspections and report injuries in the workplace.

2.6.3. occupational safety and health initiative in industrial activities

The Ministry of Labor and Social Development launched the "Occupational Safety and Health in the Industrial Activities" initiative as an applied model of the National Program for Occupational Safety and Health, one of the programs included in the National Transition 2020 Program (Aleqt, 2018).

The Ministry, in cooperation with the Job Creation and Unemployment Authority, has built a strategic partnership with several occupational safety and health bodies in the industrial activities, namely the Human Resources Development Fund (HEDAF), the Ministry of Energy, Industry and Mineral Resources Agency representing Industrial Affairs, the General Organization for Social Insurance, and the National Industrial Council of Saudi Chambers. This initiative is important in building an attractive work environment for the cadres, and contribute to enhancing the efficiency and effectiveness of work on the bases and standards of occupational safety and health of the global industrial establishments. The initiative is at the forefront of a range of strategic initiatives aimed at rehabilitating the work environment in the industrial sector by creating quality jobs for young men and women. It will also help generate more related jobs in occupational safety and health (Aleqt, 2018).

CHAPTER 3: LITERATURE REVIEW

3.1. Introduction

The role that safety perception plays in understanding and predicting safety performance is well known. In relation to safety performance and causes of accidents, several theories and models have been created as core concepts in the field of safety. The objective of the present study is to discover the factors that influence the responses of workers to safety performance in the construction industry, and in addition, further develop structural models to understand the roles played by Occupational Health and Safety Management System (OHSMS) and leadership, safety climate, hazard detection and control, and safety performance. This chapter presents a literature review of previous research and theory in relation to the topic of this study.

3.2. Theoretical Considerations: The Concept of Safety

There are many definitions of safety. However, the most comprehensive definition of safety is “a state in which hazards and conditions leading to physical, psychological or material harm are controlled in order to preserve the health and well-being of individuals and the community” (Maurice et al, 1998). In order to fully consider safety in general, and its performance and culture, and safety systems, it is also necessary to consider the very thing these structures are designed to prevent: accidents. Ultimately, the fundamental and implicit claim underlying any discussion of safety culture, safety systems, or any practice designed to promote safe behaviours, is simply that the frequency with which accidents occur will be reduced, accidents will be averted, and accidents will not be caused. Thus, theories of safety are inextricably connected to human error and theories of accident causation (Abdelhamid & Everett 2000; ILO, 2015). Accordingly, one may ask why accidents happen and what their root causes are.

Interestingly, much like the cultural dimension of safety, models for understanding accident causation are socially constructed; because of this, individuals with different professional or cultural backgrounds commonly outline very different chains of cause and effect leading to the same accident (Gherardi, Nicolini, & Odella, 1998, pp. 206–8). Engineers, for example, might present a narrative in which a lack of organizational control combined with economic and time constraints degrade respect for safety regulations, thus increasing the likelihood of human error and leading to an accident. Comparatively, site managers might describe a less linear chain in which a number of individual failings intersect and coalesce by chance, creating a situation from which an accident arises (pp. 206-8).

In applied settings such as those that are industrial, formalized accident causation models are often used, including the deterministic domino theory (analogous to the engineer's narrative presented above) and multiple causation models (analogous to the site manager's narrative). In turn, human error models are comprised of human factor models, behavioural narratives, and the Ferrel Theory (it holds that accidents have multiple causes, but that human error tends to play a decisive role) (Abdelhamid & Everett, 2000, pp. 53-54). Perhaps the most widely accepted model for understanding accident causation, however, is known as the sociotechnical approach. It holds that "safety performance is influenced by internal factors (e.g. safety culture) or external factors (e.g. regulatory and governmental issues)" (Katsakiori, Sakellaropoulos, & Manatakis 2008, pp. 1007-8). This sophisticated but complex approach takes an exceptionally wide view, attempting to account for a diverse range of actors and risk factors interacting between and across a wide range of scales. Consider, for example, the recent study by Khosravi et al. (2015) assembling the factors that influence unsafe behaviours and accidents on construction sites by way of a meta-analytic review: the authors identify primary causal categories spanning scales from the societal to the personal characteristics of individual workers. However, there is an important degree of tension between theory, practice, and the collection and analysis of empirical data. Theories of accident causation unavoidably inform research designs exploring the root causes of accidents; in turn, these empirical data are often used not only to inform new regulatory approaches, but also to refine theoretical models (Hinze, Pederson & Fredley, 1998).

3.3. Theories of Accident Causation

3.3.1. Domino Theory

During the early twentieth century, Herbert Heinrich, an accident prevention and industrial safety official, conducted a study of 75,000 reported industrial accidents (Goetsch 2014). As Raouf (2011) explains, Heinrich found that:

- 88% of industrial accidents were a result of fellow workers' unsafe acts;
- 10% of industrial accidents were a result of a dangerous environment; and
- 2% of industrial accidents could not have been avoided.

Heinrich's study formed the basis of his domino theory of accident causation. While his research is now outdated, several theories of accident causation that are accepted today have roots in his work, in particular his domino theory and ten axioms of industrial safety. Heinrich's ten axioms of safety were:

1. Injuries are caused by a succession of factors, and one of those factors is the accident itself;
2. An accident can only be caused by an individual's hazardous action or a mechanical or physical threat;
3. The majority of actions occur due to the hazardous behaviours of individuals;
4. Hazardous actions or conditions do not always instantly cause injuries or accidents;
5. The reasons for an individual's hazardous actions can provide direction when choosing remedial actions;
6. The severity of accidents is a result of chance and the causes of such incidents are, to a great extent, avoidable;
7. The most effective strategies to avoid accidents correspond with the most effective strategies to improve quality and productivity;
8. Safety should be management's responsibility as management will inspire best results;

9. To prevent industrial accidents, supervisors are critical; and

10. While accidents result in direct costs such as hospital expenses, they also result in hidden or indirect expenses.

Heinrich noted that to prevent accidents, it was necessary that decision makers understand his ten points. He stated that accident prevention strategies that used all ten would be the most effective (Goetsch 2014).

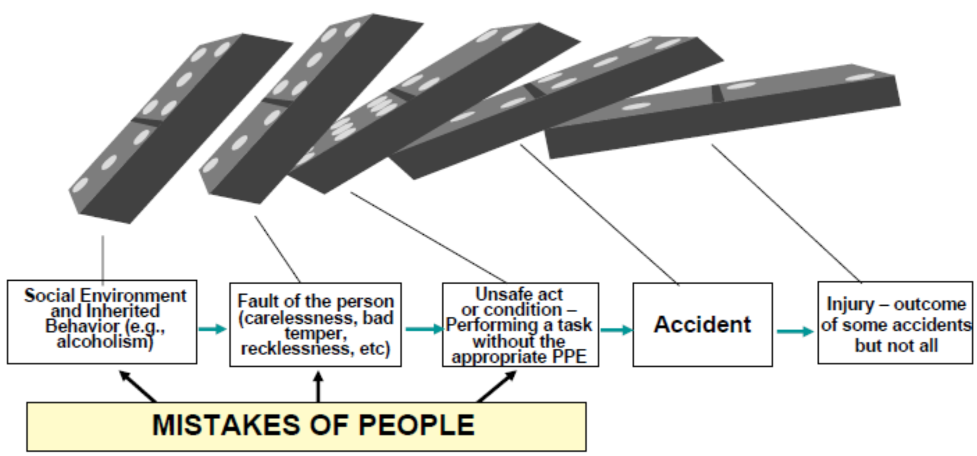

Figure 3. 1: Domino Theory of Accident Causation

His domino theory of accident causation worked in a fashion similar to that of dominoes standing in a row; as one falls over, it topples additional dominoes until they have all collapsed, as shown in Figure 3.1. He stated that five factors precede accidents (Raouf, 2011):

1. Ancestry and social surroundings (undesirable personality traits that result in hazardous behaviour are inherited or are a result of one's social surroundings);

2. Fault (people behave in hazardous manners and unsafe environments exist as a result of undesirable personality traits);
3. Dangerous behaviour/physical or mechanical hazards (hazardous behaviour and physical and mechanical dangers are direct sources of accidents);
4. Coincidence (most injurious accidents are a result of workers falling or moving objects hitting them); and
5. Injury (most accidents result in cuts and fractures).

The two main points of the domino theory are that injuries are a result of existing factors and that removing the main causes of an accident (such as a hazardous behaviour or environment) will counter the existing factors, thereby thwarting workplace injuries (Goetsch 2014). The conceptual model designed for the study (Figure 4.1), discussed in a later chapter, addresses these five factors in its consideration of the impact safety climate, leadership, and hazard detection and training have on accident causation and prevention. If one factor in the model is negatively impacted (for example, if inadequate safety training occurs), then it is plausible that related variables will be impacted, thus causing a succession of safety failures, ultimately leading to poor safety performance and/or a workplace accident.

3.3.2. Human Factor Theory

Accidents are often caused by a chain of events involving human failure. Humans often err as an overload, an inappropriate response or activity. An overload is a lack of balance between a worker's carrying capacity and load. An individual's carrying capacity is determined by his or her natural abilities, fatigue, state of mind, training, and physical condition. The load an individual may carry is the tasks he or she is responsible for, in addition environmental issues (distractions, etc.), internal issues (emotions, etc.), and situational issues (risks, etc.) The individual works in a state that is a result of their alertness and motivational levels (Goetsch 2014).

The way in which a person experiencing these factors will act in a particular situation will either contribute to either create or thwart workplace mishaps. If a worker notices a condition that is dangerous but chooses not to fix it, for example, he or she has not reacted in a suitable manner. Unsuitable reactions lead to workplace deaths and injuries. However, workstation incompatibility can also contribute to accidents. If a worker is not compatible with the reach, size, force, or other factor of his or her workstation, an accident may result (Lenne et al. 2014). Figure 3.2 depicts the human factor theory.

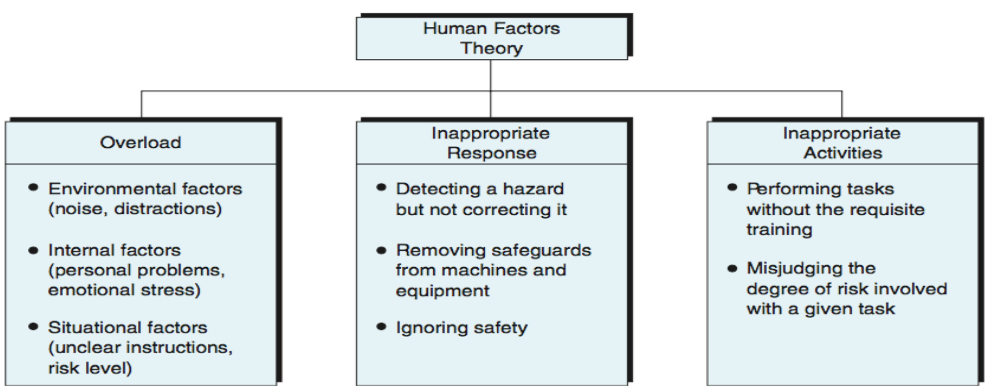

Figure 3. 2: Human Factors Theory

Human error may also be caused by unsuitable behaviour. If a worker begins a task he/she does not have the proper knowledge to complete, then he/she has acted unsuitably and is likely to make errors. Unsuitable behaviour and human errors can result in workplace accidents and injuries (Goetsch, 2014). Human errors are reflected in the proposed conceptual model of this study in variables such as training, hazard detection, and performance. For example, if a worker does not have proper training and fails to adequately detect and control hazards, he or she has failed to act suitably and is likely to cause workplace accidents.

3.3.3. Accident/Incident Theory

The human factors theory is the basis of the accident/incident theory. Posited by Dan Petersen, it is also known as the Petersen accident/incident theory. As Hosseinian (2012) explains, Petersen incorporated the decision to err, ergonomic traps, and systems failures with the human factors theory. All three aspects lead to human error. A worker may either consciously or unconsciously decide to make an error. Factors such as peer pressure, deadlines, and budget can lead a worker to act hazardously. He or she may also fall into an “it won’t happen to me” frame of mind.

A key aspect of the accident/incident theory is the systems failure component. It demonstrates that there can be a causal relationship between safety and decisions or behaviour of management. Additionally, it demonstrates that management can affect accident prevention and the workplace’s overall health and safety concepts. Peterson posits that systems can fail if:

- thorough safety policies are not established by management;

- safety authority and responsibility are not well defined;
- safety procedures, such as inspection and rectification, are neglected or disregarded;
- orientation is not suitably provided to workers; and
- safety training is not suitably provided to workers (Goetsch 2014).

Figure 4.1, discussed in a later chapter, addresses potential human accident causation through variables such as planning, policies, leadership, and training.

3.3.4. System Theory

A system can be defined as a body of related components that interact on a regular basis and form a cohesive whole. Accordingly, the systems theory posits potential accidents as being impacted by a system comprising of a person (a host), a machine (an agency), and a setting (a place). These three factors determine an accident's probability of occurring. If the interaction pattern of the three factors is altered, the likelihood that an accident will occur will grow or decline. If a competent worker who typically operates a machine is temporarily replaced by a less skilled worker, for example, the likelihood that an accident will occur will increase. The changes that affect the probability of an accident are decidedly more complex in most environments, however. Companies may require a team of experts to analyze workplace injury probabilities (Goetsch, 2014). Figure 3.3 depicts the system theory.

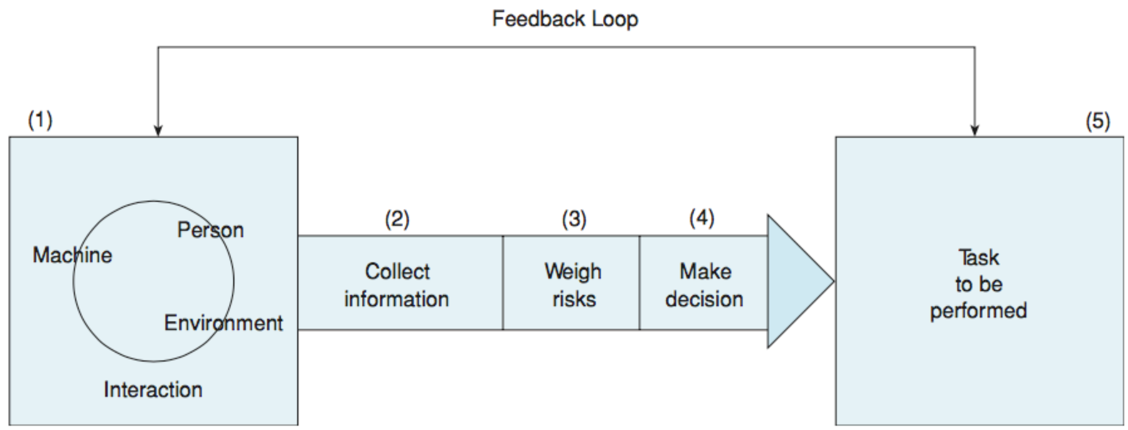

Figure 3. 3: Systems Theory

The key aspects of the systems theory are machine/person/environment, tasks, risks, information, and decisions. Each aspect impacts the probability of a workplace accident and constantly fluctuates. Every time a worker conducts a task, the likelihood that an accident will occur changes. Information collection and decision making are required each time the worker decides whether or not to complete the task. He or she must observe and consider the situation and decide whether or not to complete the task based on that information (Lenne et al., 2014). If a machine operator is behind schedule, for example, and her machine's safety device is broken, she must decide whether to fix it and fall further behind schedule or to ignore it and continue working. If she assesses the situation correctly and acts appropriately, accidents will be less likely to occur, but if she fails to correctly assess the situation or to act appropriately as a result of stress and distraction, accidents will be more likely to occur. The system theory therefore posits that five factors need to be contemplated before a decision can be considered and arrived at:

- The requirements of the task;
- The limitations and capabilities of the worker(s);
- The potential benefit of attempting the task successfully;

- The potential loss of attempting the task unsuccessfully; and
- The potential loss of refusing to attempt the task (Goetsch, 2014).

When considered, workers will gain perspective before making a decision about completing a task. They will be especially critical when workers are experiencing distractions, noise, pressure, or other negative influences, as such stressors can negatively impact a worker’s decision to act appropriately.

Figure 4.1, in the following chapter works as a system of interrelated factors and is based on the occupational health and safety management system. Variables such safety planning and policies both interact with each other and other variables, such as safety climate and leadership. As one variable changes, the probability of poor safety performance and/or a workplace injury also changes. For example, if a company fails to have a strong safety policy in place, then it is plausible that its safety climate will suffer, as will the company’s safety performance.

3.3.5. Combination Theory

Theories of accident causation and the reality of accidents often differ to an extent. Some theories may accurately explain the causes of accidents while others may fail to do so. Indeed, the causes of accidents are usually complex and can rarely be explained by a single theory. The combination theory thus considers multiple models when explaining workplace accidents. Health and safety workers must consider multiple theories when considering accident causation and prevention. Nonetheless, the consideration should be careful and they should not all simply be applied at once (Goetsch 2014).

In chapter 4, Figure 4.1 takes multiple theories of accident causation into account, as discussed in this section. For example, it is plausible that a human factor, such as leadership's failure to properly train workers, will create a domino effect, impacting additional human factors such as errors when detecting and controlling hazards. This will in turn impact overall safety performance, as the factors are part of a system.

3.3.6. Behavioural Theory

Also known as behaviour-based safety (BBS), the behavioural theory applies behavioural psychology to workplace health and safety, but it has received criticism. E. Scott Geller of Safety Performance Solutions, Inc., is a defender of the theory. He states that in behavioural theory:

- Intervention should concentrate on the behaviour of workers;
- Noting external factors will foster an understanding of and improvements in workers' safety-related behaviours;
- The direct behaviour of workers, the catalysts and incidents prior to workers' suitable behaviour, workers' inspiration to behave suitably, and encouragements and rewards for workers' suitable behaviour should be considered;
- Workers can be motivated to behave suitably by focusing on the positive results of appropriate behaviour;
- The scientific method can be used to improve behavioural intervention endeavours;

- Theory can be used to combine information instead of restricting potentialities; and
- Concerted efforts to impact behaviour should be done while considering workers' emotions and attitudes (Geller, 2005).

The theory constructively applies typical behavioural theory to occupational safety. It is pertinent in situations where particular human behaviours are needed and others must be avoided. Rewards and incentives encourage suitable, safe behaviours and discourage unsuitable or hazardous behaviours (Hosseinian, 2012).

Those who apply behavioural theory to workplace health and safety use an "ABC" model to comprehend human behavior, prevent hazardous or unsuitable behavior, and develop appropriate interventions when the behaviour is undesirable (unsafe). The ABC model is taught by behaviour-based consultants and safety trainers and consultants and used as a model to comprehend and consider worker behavior, or to create ways to improve behaviour. "A" stands for activators or events that occur prior to behaviour ("B") and the consequences ("C") produced by, or following the behaviour. The activators, direct behaviour and the consequences inspire behaviour (Goetsch, 2014).

Bruce Fern and Lori Alzamora added to the ABC model to create ABCO. Hazardous behaviour results in a long-term outcome ("O"). An antecedent such as an accident, for example, could occur in a workplace. A sign would then be erected in the workplace reminding workers to use safety goggles, resulting in the suitable behaviour of wearing eye goggles and the consequence that workplace injuries are avoided. The outcome of this would be that workers would be safe and uninjured, able to work and live as normal. Outcomes are key to behavioural therapy as they provide workers with an incentive to behave suitably (Goetsch, 2014).

Figure 4.1 from a later chapter follows the ABCO model of the behavioural theory. For example, it is plausible that a lack of safety promotion by leadership ("A") would cause a poor safety climate ("B"), resulting in a poor safety performance ("C"), and ultimately, a workplace accident ("O").

3.3.7. Management Failures and Accident Causation

Accidents also primarily occur when management fails to foster a healthy and safe workplace. Management's level of responsibility depends on the level of management itself (Goetsch, 2014). Supervisory management is responsible for the active, everyday promotion of health and safety in the workplace. Supervisors are key to ensuring that the workplace is suitable for employees. Health and safety workers need hands-on assistance supervisors. They must work together to ensure that the workplace is suitable. Supervisors are responsible for ensuring their workers are safe, while health and safety workers are responsible for ensuring that the supervisors do so (Goetsch, 2014).

When considering health and safety, supervisors must:

- provide new hires with proper safety orientation;
- provide new and existing workers with suitable and continual safety training;
- supervise workers and carry out workplace safety rules and regulations;
- help health and safety workers investigate workplace accidents;
- help health and safety workers report accidents;
- stay abreast of all safety challenges; and

- lead employees by example.

Management's failure to encourage and enforce a safe and healthy workplace is often a considerable accident causation factor. Management must seriously expect employees to act appropriately, include health and safety expectations in job descriptions, oversee procedures, and lead by example; provide new and existing workers with suitable and ongoing safety training and orientation; periodically review workers' health and safety behaviours; and reward and encourage employees who behave suitably.

When management fails to foster a safe and healthy work environment, tools may be used improperly, housekeeping may be unsuitable, safety requirements may not be developed, or safety rules and regulations may not be enforced. Such failures may be a result of improper communication of safety expectations, inadequate safety training, or improper supervision (Lenne et al., 2014).

However, management may succeed in developing and enforcing suitable health and safety policies, expectations, procedures, and supervision but may still fail to foster a safe work environment. This is often a result of factors such as stress and emotion. Such a failure is arguably the most concerning of management failures as it undermines all of the successful health and safety measures that are in place. If management disregards existing health and safety measures or encourages their disregard during particular situations, employees will fail to follow health and safety measures on a consistent basis (Goetsch, 2014).

Management's impact on accident causation is reflected Figure 4.1, shown in a later chapter, at multiple levels. For example, in the leadership cluster, management must uphold adequate safety policies to promote a positive safety climate in the workplace. It is plausible that, as a result of these actions, adequate safety performance will occur and accidents will be avoided. However, if management fails to uphold adequate safety policies, it is plausible that they will be undermined and a poor safety climate and performance will result.

3.4. Safety Performance

A number of studies have examined safety performance in Saudi Arabia specifically. In 2012, Alasamri, Chrisp, and Bowles created a visual representation of the studies and the approaches that were taken; Table 3.1 summarizes them. As Alasamri, Chrisp, and Bowles (2012) discuss, an early study completed by Jannadi and Sudairi (1995) took a traditional approach using “lagging indicators” – that is, post-injury indicators (for example, compensation expenses) to examine Saudi safety performance. Indeed, one such lagging indicator, injury rate, has been used to discover companies’ safety rates through a calculation of the total workplace injuries per 1,000,000 hours worked by employees. The conclusion was that the mean rate of injuries for more sizeable companies was more favourable than that of smaller companies, as the rate was comparatively low. However, this approach was critiqued by Mohamed in 2002 and by Choudry et al. in 2007. They stated that it was a poor tool for measuring safety performance, as it only considered companies’ historical events and depended upon data reliability and availability. It did not consider companies’ present day safety activities.

Saudi safety performance was later investigated by Alamoudi (1997), Jannadi and Assaf (1998), and Alasmari (2010). They used “leading indicators" – that is, early warnings, including safety climate (Mohamed, 2002), safety culture (Cooper, 2000) and hazard identification checklists (Choudhry et al., 2007). The leading indicator safety climate was also used by Alamoudi (1997) and Alasmari (2010) as a tool to measure individual leaders' safety perceptions. One study found a poor level of safety performance while another found a safety performance range of poor to good. Alasamri, Chrisp, and Bowles (2012) explain that in 1998, Jannadi and Assaf made use of a checklist for hazard identifications to measure safety performance. They found a safety level ranging from fair to good. Such "leading indicator" approaches are beneficial in that companies' present day safety activities can be seen, as well as their safety management success. In comparison, Baig (2001) and Alutaibi (1996) made use of both traditional and modern approaches to measure safety performance (Alasamri, Chrisp, Bowles, 2012). As shown in Table 3.1, the various approaches have resulted in a wide range of levels of safety performance found in Saudi Arabia's construction industry.

Table 3. 1

Safety Performance Studies

Author & Year	company Size									
	Construction firms participated	Small			Medium			Large		
		Safety assessment methods			Safety assessment methods			Safety assessment methods		
		Mean Injury frequency rate	Mean Attitude score	Mean Checklist score	Mean Injury frequency rate	Mean Attitude score	Mean Checklist score	Mean Injury frequency rate	Mean Attitude score	Mean Checklist score
Jannadi & Al-Sudairi (1995)	16	43	---	---	19	---	---	11	---	---
Al-Utaibi (1996)	45	35.78	---	66.78% and rated "fair"	29.74	---	68.05% and rated "fair"	10.06	---	88.62% and rated "very good"
Al-Amoudi (1997)	122	---	16 % and rated poor	---	---	37% (poor)	---	---	45% (poor)	---
Jannadi and Assaf (1998)	14 sites	---	---	65.21 % and rated "fair"	---	---	---	---	84.55 % and rated "very good"	---
Baig (2001)	28	89.43		0.47 on a scale of 1 and rated (poor)	34.83		0.61 on a scale of 1 and rated "fair"	13.79		0.8 on a scale of 1 and rated "very good"
Alasmari (2010)	38	---	45.36 %, rated "poor"		---			---	75.23%, and rated "good"	

Source: (Alasamri, Chrisp, & Bowles, 2012)

3.5. Safety Culture

To begin improving Saudi Arabian safety practices, it is necessary to specifically consider the concept of safety culture, and what the term means in practice. James Reason is arguably a seminal researcher in the field, and his work has significantly influenced scholarly discourses surrounding safety culture. In 1995, he authored a widely-referenced and much-discussed article notable for its exploration of how human factors can contribute to adverse events even in highly regulated, systematic contexts such as healthcare, and more broadly, how those factors can serve as contributors to "the breakdown of complex, well-defended technologies" with reference to generic and commonly-used accepted models of accident causation (p. 80). In it, the presence of a poor organizational safety culture is identified as a major latent failure leading to accident causation; in this practical usage, routine behaviours by employees are cited as an example (e.g. "the technicians routinely ignored alarms and did not survey patients, the after-loader, or the treatment room after high dose rate procedures") (p. 84).

How the concept is defined theoretically rather than practically is a rather more difficult question to answer, and literature is rife with debates and examples of occasionally conflicting (or not obviously congruent) views. Reason (1998), for instance, described a basic conceptual division: should safety culture be envisioned as "something an organization *is*" or as "something that an organization *has*" (p. 294; emphasis in original)?[1]

Although these visions may be competing in the sense that they complicate scholarly discourses when implicitly assumed by researchers, they are not incompatible. Ultimately, Reason offers a tentative endorsement of Uttal's (1983) more integrative definition:

[1] Examples of the former conceptualization include “the beliefs, attitudes, and values [of organizational stakeholders] regarding the pursuit of safety,” while those of the latter include “the structures, practices, controls, and policies designed to enhance safety”; Reason argues that while both components are essential features of safety culture, per Hofstede, “the latter is easier to manipulate than the former”

“Shared values (what is important) and beliefs (how things work) that interact with an organization's structures and control systems to produce behavioural norms (the way we do things around here)”.

In a 2000 article, Reason (2000a) offers an even more common-sense means of conceptually approaching the idea of safety culture and its significance for organizational performance:

“A safe culture is an informed culture, one that knows continually where the edge is without necessarily having to fall over it. The edge lies between relative safety and unacceptable danger. In many industries, proximity to the edge is the zone of greatest peril and greatest profit. Navigating this area requires considerable skill on the part of system managers and operators. Since such individuals come and go, however, only a safe culture can provide any degree of lasting protection” (p. 3).

Thus, as Alasamri et al. (2012) discuss, safety culture as a concept is not necessarily unitary in nature, and multiple — sometimes competing — models have been developed to describe it. The “reciprocal safety culture model” for example, views safety culture as emerging from an interaction between individuals, the environments and situations in which they are embedded, and the behaviours individuals exhibit, either in the performance of their professional duties or alone (pp. 475–76). Cooper (2000), who ascribes to a version of the reciprocal model, describes safety culture as little more than a subset of the broader organizational culture. In turn, Guldenmund (2000) distinguishes between academic (e.g. sociological, psychological, and anthropological) perspectives on safety culture and those that are more action oriented, which is to say, designed with application and practice, rather than merely theory, in mind (p. 216). A number of other researchers distinguish between safety culture and safety climate in a way that corresponds to the more familiar distinction between organizational culture and organizational climate (Choudhry, Fang, & Mohamed, 2007a; Cooper, 2000). They state that, while this distinction presents no intuitive difficulty, describing it in an empirically rigorous fashion is somewhat more difficult. Some suggest that the relevant distinction is primarily methodological, while others view the relationship between climate and culture as hierarchical, with climate preceding culture in a logical sense (Guldenmund, 2000, pp. 220-223). Payne et al. (2009), for instance, define safety climate as a product of "employee perceptions of the policies, procedures, and practices concerning safety" in a given organization (p. 736). Similarly, Griffin and Curcuruto (2016) define safety climate as "a collective construct derived from individuals' shared perceptions of the various ways that safety is valued in the workplace" (p. 191).

These definitions are both in line with that described by more seminal research on the topic, including Zohar (2003).[2] This is not to say, however, that the concept is universally accepted or even consistently operationalized. In a review of the term's usage in literature, speaking to the construction industry specifically, Schwatka, Hecker and Holdenhar (2016) report that, while researchers commonly defined safety climate as

[2] In a retrospective article published in 2010, Zohar argues that safety climate research had been validated by a wealth of empirical data "as a robust leading indicator or predictor of safety outcomes across industries and countries"; for this reason, he calls upon safety climate scholars to proceed to the "next phase of scientific inquiry," in which empirical data might be increasingly used to test the relationships between safety climate and "antecedents, moderators, and mediators, as well as with other established constructs" (p. 1517).

"perception-based" in its character, the "object of those perceptions" often varied substantially from study to study:

"Within the wide range of indicators used to measure safety climate, safety policies, procedures, and practices were the most common, followed by general management's commitment to safety. The most frequently used indicators should and do reflect that prevention of work-related ill health and injury depends on both organizational and employee actions" (p. 537).[3]

Beus, Munoz, Arthur, and Payne (2013) also emphasize the critical importance of consistent and rigorous operationalization of this term. Despite the fact that safety climate is typically viewed as a multilevel construct (e.g. salient variations may exist when climate is considered at the organizational level vs. the work-group level, etc.), the authors note that most research studies fail to incorporate this perspective into their design or analysis (p. 537).

Thus, the study advocates for a conceptualization of safety climate as a "fuzzy composition construct" in the sense that, while it "appears to be conceptually similar at individual and aggregate levels," it can in fact "differ meaningfully in functionality" from one construct level to another.

Generally speaking, there is a way in which this lack of clarity is indicative of fundamental questions relating to human behaviour in a psychological sense; as Blair

[3] It is worth noting that the review found that the fact that "safety climate has been promised as a useful feature of research and practice activities to prevent work-related ill health and injury," this sentiment is in spite of significant conceptual and methodological limitations characterizing existing research on the topic (Schwatka, Hecker and Holdenhar, 2016)

(2003) points out, “people are neither deterministically controlled by their environments nor entirely self determining, instead existing in a state of reciprocal determinism whereby they and their environments influence one another” (p. 18). Similarly, abstract concepts that are clearly manifested in social and intragroup interactions are notoriously difficult to pin down as well, Guldenmund (2010) notes that the concept of culture itself is somewhat “intangible” and “fuzzy.” As a result, safety researchers often fall prey to the temptation to deprive this concept of its “depth and subtlety,” thereby infusing cultural characteristics with “normative overtones” (p. 1466). At the same time, however, it is also important to keep in mind that research aims and researcher perspectives can strongly influence which conceptualization of safety culture is utilized. Discussions of safety culture implicitly informed by person-centred models of accident causation are likely to rely on very different error-management philosophies than those coming from a systems-oriented approach of accident causation, for instance (Reason 2000b, p. 768). In other words, discussions of safety culture may also be informed by unstated assumptions inherent in the use of related theoretical models.

Fortunately, despite these conceptual difficulties and disagreements concerning perspective, for practical purposes, there is some degree of common ground. Safety culture is almost always characterized as having some of the following qualities: it is shared by a group of people, it is multifaceted, and it relates to practices in behaviours not in a procedural sense, but in a more fundamental way related to attitudes, values, and worldviews (Guldenmund, 2000, pp. 223-24). Thus, Blair asserted that “the concept of safety culture must be practically defined to be of value” (2003, p. 18). This value, of course, is not merely abstract, but also concrete, often measurable and quantifiable, and companies and contractors alike can observe the benefits of improving safety culture and safety climate (Choudhry, Fang, & Lingard, 2009; Karahalios, 2005). Achieving these kinds of results, however, requires an understanding of safety culture that is not quite as diffuse, but which is functional and actionable instead. A closely related issue is the fact that actually evaluating and characterizing a safety culture requires methodologies that are designed to target its relevant features and salient indicators; some scholars suggest, for example, that questionnaires are particularly poorly suited to measuring safety climate (Guldenmund, 2007). To complicate matters further, the methodological criteria used by scholars seeking to evaluate occupational safety intervention research have not yet reached general acceptance by the scholarly community; instead, this remains an area of active research. Thus, it is not always possible to rigorously discriminate between cases in which safety interventions improved safety overall, and situations in which new safety interventions actually make matters worse (Shannon, Robson, & Guastello, 1998).

One way to approach this problem is by attempting to identify empirically defined factors expected to be conducive to a positive safety climate, and to then use statistical analysis to correlate these factors with actual safety outcomes. The results are not always strictly intuitive. For example, research has shown that perceived safety performance is inversely correlated with “inappropriate safety procedure and work practices” (Guldenmund, 2007, p. 890). This finding illustrates an important point that lies close to the core of the concept of safety culture in most theoretical models: safety culture has pronounced attitudinal dimensions and cannot easily be deconstructed into strictly behavioural narratives (Choudhry, Fang, & Mohamed, 2007b).

3.6. Safety System

Given its diffuse and conceptually fraught definitions and theorized modes of action, it should come as no surprise that safety culture is not sufficient with respect to ensuring that workers ultimately behave in safe ways. For this reason, formalized procedural systems also play an important role in improving organizational safety profiles. As a matter of fact, the presence and quality of safety systems constitutes one of the dimensions of safety climate most commonly assessed by formal scales in the industry sector (Flin, Mearns, O'Connor, & Brynded, 2000, p. 177; Salman, 2004). It should be noted that Flin, Mearns, O'Connor, Brynded, and Salman all state that safety systems are preceded as a dimension of measurement by management and followed by risk, in order of most common to least common.

Ideally, safety systems are clear and logical, based on evidence without damaging organizational productivity. Even so, such systems are only as good as their implementation. In Saudi Arabia, this implementation arguably leaves much to be desired. According to Al-Darrab, Guiza, Karuvatt, and Ali (2013), for example, while individual safety systems are "plentiful" in Saudi Arabia, they are typically implemented in a way that is "generally unproductive" because the systems have not been well integrated with relevant procedural structures (p. 336). Insofar as adherence to safety systems is strongly influenced and informed by safety culture (which, in turn, is shaped not only by organizational factors but also by cultural ones), the astonishing growth of the Saudi construction industry can actually form a barrier to the widespread adoption and effective implementation of safety systems – especially because industry growth has had the effect of “tracking construction professionals from all over the world” (Jannadi & Bu-Khamsin, 2002, p. 539)

In light of the discussion presented above, it should not be surprising that this can generally lead to compromised safety. The probability that a well-developed and well-integrated safety system will exist is strongly associated with the presence of incentives to develop such a system. It is for this reason, perhaps, that safety levels in construction sites in Saudi Arabia often vary between larger and smaller sites, with small sites scoring lower on safety scales than their larger counterparts (Jannadi & Assaf, 1998). Another difficulty is presented by the fact that safety systems are often standardized. While this certainly supports empirical evaluations of their effectiveness, it can also lead to the development of systems that are rigid and difficult to adapt to unique or unusual work environments or circumstances (Mahmoudi, Ghasemi, Mohammadfam, & Soleimani, 2014). The fact that data collection practices for safety assessments are also often quite standardized (at least within studies) incentivizes the development and implementation of similar standard safety systems. Managers may view these as more likely to receive a high safety rating by evaluators, who often use walkthroughs and safety checklists as a primary tool when making their evaluations (Noweir et al., 2013).

The challenges faced by high-risk process industries, such as chemical manufacturers, nuclear power plants, and hospitals provided an important impetus to the development of more robust safety systems and led to a novel paradigm known as the high reliability organization (HRO) (Hofmann, Jacobs, & Landy 1995). High reliability organizations are by definition complex and involved in operations with the potential to do "great physical harm to themselves and their environments" in the case of errors or process failures. Thus, in order to function, these organizations are heavily reliant on robust safety systems designed to ensure excellent operational consistency with multiple reviews and safety checks (Roberts 1990, p. 160). Singer et al. (2003) offer another definition: high reliability organizations are those which manage to "perform successfully" despite facing "high intrinsic hazards" because they invest heavily in and commit to treating safety in a highly systematic way (p. 112). Likewise, experience with disproportionately few adverse events, cannot be applied to other industries struggling with safety performance, and cannot be used as a template for improving understandings of how "safe and reliable performance can be achieved under trying conditions" (Sutcliffe 2011, p. 133; Weick, Sutcliffe, & Obstfeld 2008). This is achieved through developing an organizational capacity to "focus attention on emergent problems and deploy the right set of resources" to address the issues. Accomplishing this dynamic is not easily achieved — particularly when firms are not accustomed to HRO principles and operating strategies:

"HROs behave in ways that sometimes seem counterintuitive —they do not try to hide failures, but rather celebrate them as windows into the health of the system; they seek out problems; they avoid focusing on just one aspect of work and are able to see how all the parts of work fit together; they expect unexpected events and develop the capability to manage them, and they defer decision making to local frontline experts who are empowered to solve problems" (Christianson, Sutcliffe, Miller, & Iwashyna, 2011, p. 1).

The HRO paradigm has been applied to contexts ranging from electrical grid maintenance to wildland firefighting; it has even been utilized in construction contexts as complex as building the International Space Station (Leveson, Dulac, Marais, & Carroll, 2009). However, serious attempts by scholars to explore the application of these principles to the construction industry, as more traditionally defined, have only begun to gain momentum over the course of the last several years. Mitropoulos and Cupido (2009), for instance, offer an initial exploration of the safety management strategies used by high-performance framing crews, which include relatively standard tactics like "controlling the production pressure, matching skills with task demands, and carefully preparing and coordinating high demand tasks," but its scope is preliminary at best. Importing the HRO paradigm into the Saudi construction context will require substantial research into its safety practices, performance, and the variables that contribute to these elements.

3.7. Characterizing Safety Practice and Performance

3.7.1. Safety Indicators

As Grabowski et al. (2007) observe, it is relatively common following serious accidents to engage in a counterfactual exercise involving identifying "prior indicators, missed signals, and dismissed alerts" which might have been used to avert the event (p. 1013). The accident becomes a data point from which it is possible to conduct further study; costs, risks, and rates soon become measurable. Measuring prevention, by contrast, whether in construction safety, medicine, or counterterrorism, is a notoriously difficult task frequently likened to proving a negative: how does one measure events which, by definition, did not occur (Van Dongen 2011; Classon & Metzger 2003)? Reason (2000) identifies the fact that "safety is defined and measured more by its absence than its presence" as a paradox representing one of the central challenges safety researchers must contend with. Typically, this is achieved indirectly, by inference from changing trends and statistical associations. Thinking about prevention in a proactive manner, however, arguably pushes the envelope somewhat farther, so to speak. This becomes especially relevant in workplace contexts where accidents occur infrequently enough that it is difficult to track trends rigorously over useful time intervals. In such contexts, employers may have very little internal data to use when they seek to develop, audit, or improve their safety programs, as the consequences of safety failures are not frequently actualized. This does not necessarily mean that these employers become content with the status quo, however; for economic or ethical reasons, or even simply due to changing operational and/or competitive landscapes, employers may wish to continue to "build safety" through the use of "early warning indicators" aimed at preventing major accidents (Olen, Utne, & Herrera 2011, p. 148). Reiman and Pietikainen (2012) offer a useful summary of the usage of this term in the safety context:

"An indicator can be considered any measure — quantitative or qualitative — that seeks to produce information on an issue of interest. Safety indicators can play a key role in providing information of organizational performance, motivating people to work on safety, and increasing organizational potential for safety [...] Currently, the same lead indicators are used — explicitly or implicitly — for both [monitoring and driving system safety]" (p. 1993).

Although these comparatively high-performing safety contexts arguably provide the major impetus for research into the development of such early warning indicators, the utility of such indicators with respect to improving safety practices in settings characterized by more mixed safety performance records seems obvious. The development of such indicators certainly has the potential to. In order to be useful and effective, however, research designed to pinpoint and characterize such indicators requires a sound theoretical foundation — which is to say, one that seeks to account for "basic concepts, main perspectives, and past developments" in the field (Reiman and Pietikainen, 2012).

The Ontario Leading Indicators Project (OLIP), carried out by the Canadian Institute for Work and Health (IWH) in Ontario, offers a particularly useful model for approaching the measurement of important components of workplace safety from an early-warning, prevention-oriented perspective (Amick & Saunders, 2013). The project, which sought to develop a "short, easy-to-use measure" of the expected performance of workplace safety processes and practices, was launched in 2008 as a joint effort between the IWH, several health and safety associations, and expert consultants (p. 3). In its first two years, the project succeeded in producing a simple, eight-item survey; after encouraging results from factor analyses and reliability tests, the survey was expanded into the Organizational Performance Metric (OPM), which consisted of a scale composed of "eight questions, each with five response categories from 1–5" (Amick & Saunders, 2013). Based on tests of the new scale, the OPM was developed into the larger, more comprehensive, and more broadly-applicable OLIP, which had been completed by more than 1,500 firms by 2013, providing a rich dataset for future research (pp. 4–5).[4]

[4] According to the authors, the OLIP survey "contains 17 measures within five tools: the OPM, the NIOSH safety climate tool; the Organizational Policies and Practices tool; the Occupational Health and Safety Management tool; and the Joint Health and Safety Committee Index".

Notably, the OLIP is explicitly oriented to relatively well-developed, highly-regulated contexts in which "many workplaces have too few injuries to distinguish real trends from random occurrences," and seeking to confront and account for this basic methodological difficulty arguably directly informs the strength of the OLIP's "leading indicator" approach. This, as a result, seeks to identify generalizable organizational indicators predictive of elevated safety risks so that problems might be identified "before they occur" and "preventative steps can be taken to avert harm" (p. 1). The approach, therefore, is not dissimilar to benchmarking and is action-oriented. The ambition is to provide a basis for offering case-specific, evidence-based guidelines enabling employers to utilize organizational resources to the greatest possible effect when seeking to improve or maintain safety performance. Particularly, the OLIP adopts an interdisciplinary and multimodal perspective, looking for diverse influences, including "safety culture, safety climate, the operation of joint labour-management health and safety committees, organizational policies and practices," and OHS systems, for instance (Amick & Saunders, 2013)

Perhaps unsurprisingly, the reliability (and therefore applicability) of the OLIP is primarily constrained by empirical limitations and the still-developing state of safety management literature. According to the issue report by Amick and Saunders (2013), comparatively little empirical data are available that could be reliably used to show which indicators should be used in what contexts — which is clearly a critical concern, given the tool's basic purpose. The authors describe a series of fundamental challenges impeding the development and deployment of leading indicators in a systematic way, which includes (among other things) methodological questions (e.g., whether policies and practices should be measured "through self-assessment or external audit"), analytic uncertainties (e.g. how significant changes in indicator scores should be interpreted), issues relating to application (e.g. how measures can actually be employed to improve accident prevention) and context (e.g. to what extent the model, or even specific indicators, should be modified and tailored to "specific workplace contexts"), and, more generally, issues related to a lack of conceptual clarity, not only with respect to the leading indicator project itself but observable in and between various domains of safety management literature as well (Amick & Saunders, 2013). For the purposes of the present research, the most relevant (and perhaps concerning) of these relates to the uncertain context-dependence of the model. It underscores the difficulties surrounding potential issues relating to validity and reliability when importing tools from one cultural, organizational, or regulatory context to another. However, it emphasizes the need for multimodal safety research in developing regions outside the cultural West, as well as for cross-border studies. Nonetheless, OLIP's relatively robust theoretical grounding, its ongoing development, and its reliability measures make it, at minimum, an attractive guiding model for the development of future leading indicator questionnaires, even if aimed at other contexts, provided that researchers keep in mind that the validity of any derivative models would need to be demonstrated rather than assumed.

To be clear, the OLIP's early-warning, leading-indicator approach does not represent an unprecedented or theoretically novel development in literature — indeed, it is substantively reliant on previous empirical and theoretical work on the topic — but is instead notable primarily for factors such as the scale at which it has been tested or its balance of brevity and reliability. In Reiman and Pietikainen (2012), a proposed theoretical model aimed at defining and integrating a three-category taxonomy for performance indicators, which are divided into the groups outcome, monitor, and drive indicators, can be seen. Like Olen et al. (2011), Reiman and Pietikainen (2012) view safety as "more than the negation of risk," but rather as something to be actively pursued, and therefore safety indicators that are capable not only of measuring negatives, but also of positively measuring safety as "the presence of something" rather than the absence of risk or accidents, should be developed (pp. 1993-94). Thus, the theoretical model the authors advance emphasizes the importance of maintaining "a continuous focus on lagging indicators of past outcomes" such as deficiencies and incidents and leading indicators based on conditions and functions capable of predicting future performance (p. 1999).

The first group (outcome indicators) consists of lag (rather than lead) indicators for the simple reason that "outcomes always follow something" and are, by definition, consequences "arising from multiple other situational and contextual factors," while the latter two categories, which seek to identify or create certain conditions expected to precipitate performance outcomes, represent lead indicators as more traditionally conceptualized (Reiman and Pietikainen, 2012, pp. 1993-94). Drive indicators primarily serve to "direct the sociotechnical activity" in a given organization by "monitoring certain safety-related activities," whereas monitor indicators are designed to facilitate the observation of safety-relevant organizational dynamics, such as the "practices, abilities, skills, and motivation of personnel," which underpin the "organizational potential for safety" performance (Reiman and Pietikainen, 2012). Through the use of these categorical divisions, the authors hope to enable analytic approaches that discriminate between prediction and influence—a distinction which is not always rigorously made in safety research and practice:

“Often some indicator is chosen as being critical to organizational performance, and then the personnel and the management focus their efforts on optimizing that indicator. Sometimes the same indicator is used afterwards in monitoring organizational performance” (p. 1999).

This is problematic as indicators are, by their very definition, a means of gaining insight into the more complex, but often independent, phenomena that underlie them. Indeed, it would be "erroneous" to focus on these measures in their own right rather than to attempt to examine the effects of a given intervention, as represented by unbiased indicators that were not "explicitly raised as a topic of concern" prior to the intervention (Reiman and Pietikainen, 2012). To illustrate this, the authors offer the useful example of management walkarounds. If these are used as a drive-indicator metric in a hospital setting, then increasing the frequency of walkarounds alone following an intervention would not be sufficient to show improved safety performance. Instead, it would be necessary to consider the *effects* of increased walkarounds "by looking at the characteristics of the hospital that walkarounds are intended to increase" such as the "safety commitment of personnel,” for instance intervention (Reiman and Pietikainen, 2012). In other words, it is critical to keep in mind that safety management is concerned with "managing the sociotechnical system" itself, and not with simply "managing and optimizing certain indicators" (Reiman and Pietikainen, 2012).

While categorizing indicators along these dimensions (leading vs. lagging, predictive vs. influential) in the context of safety management is not precisely unheard of in the academic literature, it is also true that the scientific evidence base for making these distinctions rigorously and consistently is somewhat lacking. Payne et al. (2009), for instance, make a compelling theoretical case that safety climate can plausibly be considered both a leading and lagging indicator of "safety events" such as accidents or injuries, depending on context and specific usage.[5] Despite this, the authors' review of the research literature found that researchers almost invariably adopted one meaning or the other, and rarely (if ever) integrated both within a single research study. For instance, when conceptualized as a leading indicator, safety climate is typically invoked in research projects utilizing prospective designs, wherein this climactic data are "correlated with accidents/injuries that occur in the future"; when constructed as a lagging indicator, by contrast, studies tend to invoke "retrospective designs [...] in which safety climate data are correlated with prior accidents/injuries" (p. 735). With reference to the Reiman and Pietikainen (2012) study described above, it should be noted that safety climate is rarely described as a monitoring indicator. When it is conceptualized as a leading indicator at all, it is typically as a drive indicator; otherwise, safety climate is generally treated as an outcome indicator. Thus, the treatment of safety climate by prospective studies typically involves a model in which safety climate influences safety-related behaviours, which in

[5] For the purposes of this argument, the authors define “safety climate” as “employee perceptions of the policies, procedures, and practices concerning safety” in a given organization, where “policies” are conceptualized as describing “organizational goals and means for goal attainment,” “procedures” are viewed as providing primarily “tactical guidelines for actions related to these goals and means,” and “practices” are “the implementation of policies and procedures by managers *within each work group*” (p. 735; emphasis added). For a more detailed discussion of safety climate and the various ways in which it has been conceptualized and operationalized for different research studies, see the subsection on safety culture above.

turn increase the probability of accidents and/or injuries (climate → behaviour → accidents/injuries), whereas retrospective studies tend to view figures relating to accidents and injuries as leading to and defining a given safety climate (accidents/injuries → climate) (Payne et al. 2009, pp. 736-37). Integrating both usages would produce a more cyclical model in which safety climate is located at a critical nexus that reciprocally informs safety outcomes (Figure 3.4).

Overall, Payne's review (2009) finds that prospective designs (and, consequently, their associated conceptualization of safety climate as a leading indicator) are markedly less common in the academic literature than retrospective designs constructing safety climate as a lagging indicator (p. 738). The authors conclude with a call for future studies aimed at examining "both retrospective and prospective accident/injury data" when exploring safety climate — which is to say, treating safety climate as both a leading and lagging indicator within a single study rather than between them.

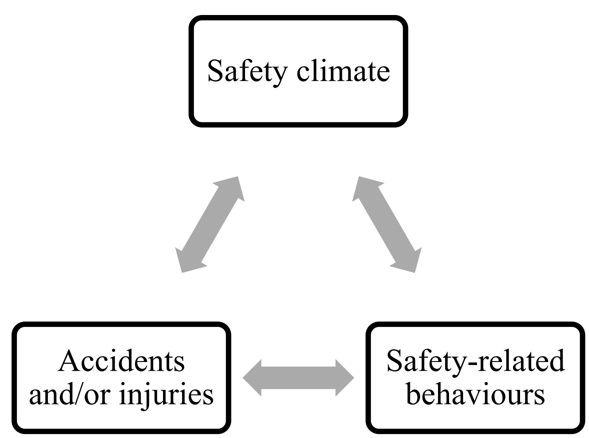

Figure 3. 4: Graphical representation of safety climate as a leading and lagging indicator

3.8. Opportunities for Improvement

Due to lack of proper designs and methods to ensure safety on Saudi construction sites, it is important to achieve a holistic approach to construction management in which health and safety systems and safety culture are considered important aspects of production planning from the beginning of a project. Comprehensive safety roles should have a foundation in advanced linear responsibility flow charts that involve the responsibilities of site managers, subagents, project engineers, general foremen, work foremen, charge hands, tradesmen, and labourers (Rowlinson, 2004).

Saudi Arabia's traditional methods of safety management have focused on techniques that are related to the identification of work hazards, the minimization of risks associated with these hazards, the development of safety management systems, safety procedures, and safety standards, and the improvement of physical working conditions, such as improved designs of plants, machines, and standards. However, unlike past investigations and analyses, contemporary research focuses on shaping a favourable safety culture for construction. This current focus involves the assembly of individual and group beliefs, attitudes, norms, and social and technical practices that minimize the risks that workers and the public face due to unsafe acts and conditions in construction environments (Fang, Choudhry & Hinze, 2006).

Jannadi and Bu-Khamsin (2002) utilized a survey-based methodology combined with formal interviews in order to explore factors influencing the safety performance of industrial contractors in Saudi Arabia.[6] This study used standardized checkoff sheets,

---

[6] See Jannadi & Al-Sudairi (1995) for further insight into the basis for this study regarding the exploration of safety management in Saudi Arabia's construction industry.

rating forms, and questionnaires. Its findings revealed that construction safety in Saudi Arabia is strongly influenced by factors such as “management involvement, personal protective equipment, emergency/disaster planning, ionization radiation … [and] fire prevention” (p. 546). The findings are in line with those of other studies that indicate safety performance in the Saudi construction industry is a multidimensional and multifaceted process, informed by factors operating at a range of scales. Jannadi and Bu-Khamsin’s 2002 work led to a useful empirical basis for a follow-up study regarding risk assessment in the Saudi construction industry (2003). It yielded industry-specific risk assessor model (RAM) designs to help contractors and industry professionals “allocate safety precautions in a more efficient manner” (p. 492).

RAM is just one example of a number of tools developed by Saudi researchers attempting to improve the country’s construction safety profile throughout the last two decades. Mohamed created an innovative “scorecard approach” (2003) to benchmark organizational safety culture in the construction industry in Saudi Arabia. It attempts to integrate safety practices across the four major domains of “management, operation(s), customer(s), and learning” in order to generate a holistic but industry-specific model to evaluate performance measures and goals, as well as to identify requirements and areas for improvement.

Risk assessments such as Jannadi and Bu-Khamsin’s RAM designs constitute an important first step towards improving existing safety profiles (2003, p. 492). First, Saudi construction industry activities can improve. In turn, Saudi Arabia and other locations around the world will have the opportunity to improve construction productivity. In many cases, as Al-Saleh (1995) points out, given the size of the Saudi construction industry, “any improvement, even a fraction of a percent in construction productivity, would produce millions or billions in savings for the country” (p. 173). The need for improved safety practices in the Saudi construction industry, whether those improvements are derived from cultural changes or procedural ones, is exceedingly clear.

CHAPTER 4: RESEARCH METHODOLOGY

4.1. Introduction

This chapter exhibits the conceptual framework and hypothesized relationships emerging from the proposed framework. In order to have a better insight into the safety performance of the construction industry in Saudi Arabia, the present study proposes a general conceptual model that synthesizes previous research findings. The proposed model includes ten components to examine their influences on the safety practices of the construction industry in Saudi Arabia. These components include Safety performance (SP); OHS Leadership (LD); Safety Climate (SC); Hazard Management (HZ), OHS Planning (PL); OHS Policy (PO); OHS Promotion (PR); OHS Training (TR); Internal communication & Awareness (CA); and Control, Monitoring & Review (CR).

4.2.Conceptual Model

Systematically interrogating the safety practices commonly observed in the Saudi construction industry in order to issue evidence-based recommendations for improving those practices and the models that underlie them, requires the development of a conceptual model describing safety performance at a fairly early stage. The conceptual model described here draws upon a number of sources within the safety and systems engineering literatures in order to present an intuitive, but nonetheless evidence-based representation, of the essential connections and relationships structuring safety performance in this unique context. It is hoped that this model will ultimately be used to facilitate not only the dynamic measurement of safety system performance, but to report those finding as well. To this end, the model described below has been developed to meet the following key criteria. It is:

- grounded in existing scholarly knowledge (theoretical and empirical) regarding safety system performance and culture;
- conceptually congruent with the methodological approach used in this study, notably including its primary data collection instruments and their associated indicators (e.g. OLIP, OPM);
- oriented toward facilitating theory-practice discourses in order to foster innovative solutions aimed at improving safety performance in multiple contexts; and
- actionable in the sense that it offers a clear and intuitive representation of the system of relationships underlying safety performance, providing structured guidance to safety investigations, aiding in the interpretation of their results and the synthesis of multimodal research data describing multiple safety-relevant processes and characteristics.

The model has also been developed to carefully address the three research questions that guide the proposed study. The relationships between *Occupational Health and Safety Management System (OHSMS) variables, safety leadership, safety climate, hazard detection and control, and safety performance* will serve as a system to investigate which factors are negatively impacting, or being negatively impacted by, safety performance in Saudi Arabia's construction industry. Such factors will assist in the identification of measures that may be implemented and/or improved, along the dimensions of culture, behaviours, and policy, to improve the safety performance of the industry. This model consists of six exogenous (independent) constructs and four endogenous (dependent) constructs.

The independent constructs in the conceptual model are shown as follows:

- Occupational health and safety planning (PL): It is the first step to prevent injuries and accidents. Safety planning is a proactive measure which consists of several steps to reduce workplaces dangers.
- Occupational health and safety policy (PO): is defined as "a statement of principles and general rules that serve as guides for action (CCOHS, 2018).
- Occupational health and safety promotion (PR): is defined as "the process applied to develop and maintain the basic conditions for safety at a local, national and international level by individuals, communities, governments and others, including businesses and non-governmental organizations" (Maurice et al., 1998)
- Occupational health and safety communication and awareness (CA): is defined as the "company's formal and informal verbal, written or unwritten policies, plans, standards, and procedures", which are used to increase the safety awareness at the organization.
- Occupational health and safety training (TR): is defined as the "organized activity aimed at imparting information and/or instructions to improve the recipient's performance or to help him or her attain a required level of knowledge or skill" (Business dictionary, n.d.)
- Occupational health and safety control, monitoring and review (CR): is defined as "A systematic action conducted to detect changes affecting a safety

system with the specific objective of identifying that acceptable or tolerable safety can be met" ("SKYbrary Aviation Safety", 2017)

The independent constructs in the conceptual model are:

- Occupational health and safety leadership (LD): defined as the process by which leaders and workers interact, and through which leaders, such as management and supervisors, use their influence to achieve safety goals,
- Safety climate (SC): is defined as the social perceptions, shared behaviour, and surroundings concerning safety in a workplace.
- Hazard management (HZ): is defined as the process of defining, recognizing, assessing, and addressing safety risks at the workplace.
- Safety performance (SP) is defined as " the actions or behaviours that individuals exhibit in almost all jobs to promote the health and safety of workers, clients, the public, and the environment." (Burke et al., 2002).

This model, as shown in Figure 4.1, is designed to highlight the way in which the Occupational Health and Safety Management System (OHSMS) serves as a basis to predict safety performance through three factors: safety leadership, safety climate, and hazard management. Safety leadership is the process by which leaders and workers interact, and through which leaders, such as management and supervisors, use their influence to achieve safety goals. Safety climate is the social perceptions, shared behaviour, and surroundings concerning safety in a workplace. Hazard management refers to the process of defining, recognizing, assessing, and addressing safety risks. The model uses the OHSMS as a basis to predict safety performance through these three factors by offering a simplified view of the complex reciprocal relationships between the effects of each of the functional components of a well-designed OHSMS. These components are in two groups: those directly under the purview of the OHS leadership, and those oriented toward workers themselves. Notably, the model regards the relationships between safety leadership, safety climate, and hazard detection and control, respectively, as bidirectional in character; these three variables form a distinct cluster that ultimately determines safety performance as an enacted phenomenon.

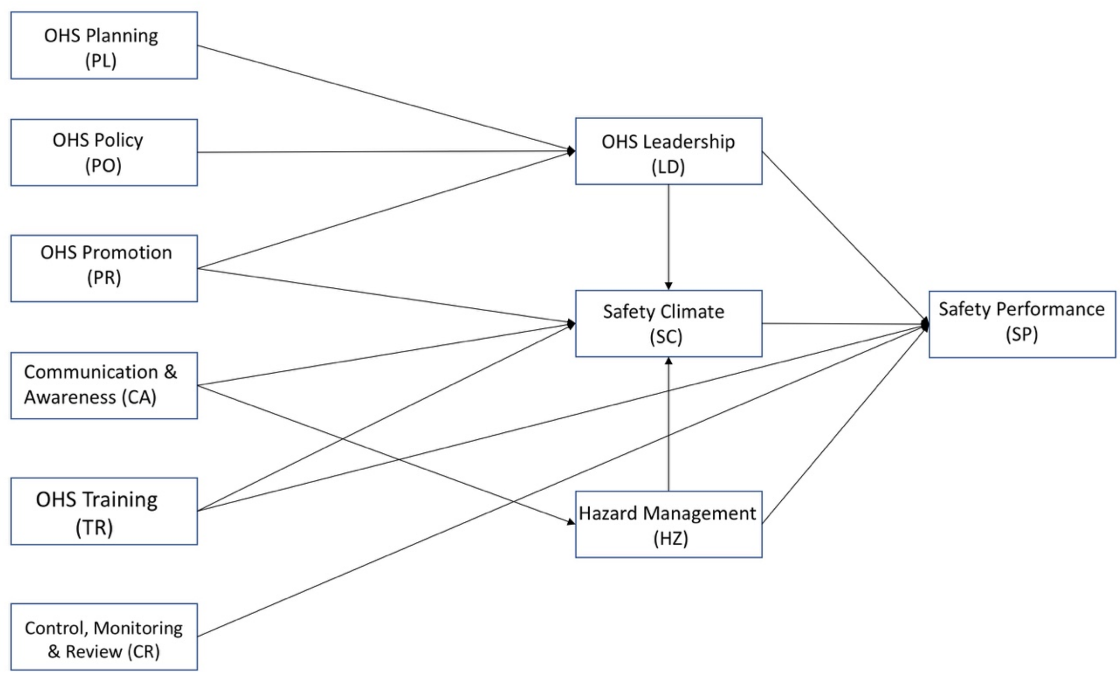

Figure 4. 1: Conceptual Safety Performance Model

Note. Safety performance (SP); OHS Leadership (LD); Safety Climate (SC); Hazard Management (HZ); OHS Planning (PL); OHS Policy (PO); OHS Promotion (PR); OHS Training (TR); Internal communication & Awareness (CA); Control, Monitoring & Review (CR)

The structure of this cluster builds on the suggestion by Payne et al. (2009) that the competing conceptualizations of safety climate as either a leading or lagging indicator in a linear causal chain are not necessarily mutually exclusive, but instead can be integrated in the form of a more cyclical model. This can be done, as above, by framing the notion of safety climate as one component of a critical nexus involving actual behaviours (e.g. safety performance) and outcomes (pp. 736-37). However, where Payne utilizes accidents/injuries as the major outcome variable, this model instead focuses on the preventative activity of successfully identifying and substantively addressing actual hazards. This adaptation was made to better accommodate integration with the primary data collection instrument use here, a survey based on the OLIP, which places a strong (and near-exclusive) emphasis on leading indicators. For the purposes of adding a normative element to the model, however, it emphasizes that this three-component safety performance cluster cumulatively serves as an enabling factor for organizational performance more broadly.

Several safety models have been proposed in the literature. According to Alasamri, Chrisp, and Bowles (2012), Choudry et al. created a reciprocal safety culture model in 2007 based on Cooper's 2000 adaptation of Bandura's 1986 safety model. Choudry et al. (2007) asserted that safety culture is a result of interactions between organizations, jobs, and people. Their model was an adaptation for use in the construction industry, demonstrating reciprocal relationships between leadership (organization), workers (people) and safety tasks, such as holding safety meetings or inspecting work sites (jobs). Similarly, the study's conceptual model is divided into two groups (leadership and workers) and identifies a cluster of three similar factors (leadership, hazard detection and control, and safety climate). It demonstrates safety performance, not just safety culture, as a result of interactions between people, jobs, and organizations, adapted for the construction industry.

Alasamri, Chrisp, and Bowles (2012) discuss a similar model that was developed in 2000 by Ho and Zeta, who compared safety culture to a four-legged table. Each factor, such as communication, impacts others, such as safety climate and hazard detection and control. Alasamri, Chrisp, and Bowles go on to discuss a model developed in 2009 by Ismail et al. to measure safety culture in Saudi Arabia. The model was divided into three groups: psychological (beliefs and values), safety officers and supervisors (leadership), and behavioural and situational (safety climate). These factors are reflected in the study's conceptual model, which demonstrates the interactions and relationships between these factors and safety performance.

Clearly, the study's conceptual model represents a generalization based on common OHSMS structures, and applying it to specific cases requires a considered approach that recognizes this fact. For instance, the degree to which health and safety leadership is involved in OHS planning, policy, and promotion, respectively, is likely to vary to some degree from organization to organization; these types of variations are directly relevant to the present research, and this model is designed to enable the researcher to account for them in an explicit and systematic way (Ginsburg et al., 2010; Akpan, 2011). Similarly, it is important to keep in mind that, as with any conceptual model, clarity is prioritized over comprehensiveness; thus, some measure of simplification is unavoidable. In this case, simplification means highlighting the dominant interconnections between key variables and omitting plausible but indirect relationships. For instance, literature is clear that internal awareness of safety considerations and practices, and the ability to communicate effectively about these topics with key stakeholders, is a major determinant of safety climate and a significant contributor to early and effective hazard detection and control, and these relationships are graphically represented in the model (Flin, Mearns, O'Connor, & Bryden, 2000; Lauver & Trank, 2012; Severin, 2014). It is plausible that the awareness and communication component of the OHSMS could conceivably shape other components of the OHSMS (e.g. promotion, monitoring) in a horizontal fashion, just as it is plausible that awareness and communication could be associated with stronger organizational safety performance. Because these relationships are more indirect (and generally less well-established in literature), however, they have been omitted from the model. In other words, the model described above is designed to highlight relationships that are clear, definable, and direct—but it should not be interpreted as an exhaustive or definitive statement of all possible relationships.

It is worth emphasizing once again that this basic structure is designed to emphasize a conceptualization of safety as necessarily and unavoidably *enacted*. In other words, the peripheral clusters are ultimately academic abstractions—until, that is, they are made manifest in the form of safety-relevant behaviours. The relationships between key variables are represented using directional arrows symbolising the general direction of casual flows *as conceptualized from the perspective of safety system management.* In other words, this directionality is not purely descriptive, but is informed by normative considerations as well.

Furthermore, the relationship between OHSMS and safety performance in general is not direct, but is instead mediated by (and in some sense mutually constitutive with) the safety leadership, safety climate and hazard management. By formulating its constituent variables in terms of their formal, intended functions, the model avoids making assumptions about their actual execution. In this way, the model retains its descriptive utility even (and perhaps especially) when the execution is suboptimal, and actual outcomes fall short of these intended objectives. Note once again that despite the process-oriented nature of this model, these relationships are not strictly causal in character; they describe conceptual as well as functional homologies, and express coincidence rather than rigidly designating or seeking to assign cause.

Indeed, following Olen et al. (2011) and Reiman and Pietikainen (2012), this model is based on a conceptualization of safety as "the presence of something" rather than defining it in the negative (i.e. as the absence of accidents) (pp. 1993-94). Although the model is designed for its congruence with the OLIP, following Payne et al. (2009) it resists the temptation to treat leading and lagging indicators as rigid, mutually-exclusive categories — a decision made not only in light of the central importance attributed to safety climate by this discussion, but also the lack of terminological clarity (and even conceptual controversy) regarding which category it should belong to. While conceptual models of this nature are pre-eminently concerned with providing structure (and typically achieve this through simplification), it is equally important to resist the temptation to be too reductive by failing to leave sufficient room for causal ambiguities. Thus, the indicators and variables ar graphically linked to one another to highlight their conceptual and functional overlaps and close associations, without rigidly classifying these variables as leading or lagging, cause or effect; these qualities will be assigned during the analysis of the OLIP data.

As indicated above, however, none of this is to suggest that this model represents a perfect or complete model of safety performance. Indeed, the system of processes it describes represents and explicit and self-conscious simplification of relationships which are not only complex in the extreme, but which are also subject to active and on-going research. That said, what this model *does* offer is a succinct and intuitive means of bringing the key dimensions of safety system performance as described by the current (admittedly imperfect and still developing) state of scholarly knowledge in relation to one another. These tasks are not easy ones; however, it is hoped that this model will not only provide support to safety managers and organizations interested in improving their safety performance records, but also make a modest contribution to the exciting scholarly discourses aimed at unpacking these relationships and dynamics with ever-greater detail and precision.

4.3. Research Hypotheses

A set of hypotheses (H1 to H14) linking the constructs of the research model was proposed, as shown in Figure 4.1. The safety performance model consists of ten factors connecting 13 basics hypothesized relationships. These hypotheses are the direct connection between the all constructs. These hypotheses state the relationships between exogenous factors (independent): OHS Planning (PL); OHS Policy (PO); OHS Promotion (PR); OHS Training (TR); Internal Communication & Awareness (CA); Control, Monitoring & Review (CR), and the endogenous factors: Safety Performance (SP); OHS Leadership (LD); Safety Climate (SC); Hazard Management (HZ). These hypotheses are:

H1: Safety Planning has a significant impact on Leadership

H2: Safety Policy has a significant impact on Leadership

H3: Safety Promotion has a significant impact on Leadership

H4: Safety Promotion has a significant impact on Safety Climate

H5: Internal Communication & Awareness has a significant impact on Safety Climate

H6: Internal communication & Awareness has a significant impact on Hazard Management

H7: Safety Training has a significant impact on Safety Climate

H8: Safety Training has a significant impact on Safety Performance

H9: Control, Monitoring & Review has a significant impact on Safety Performance

H10: Safety Leadership has a significant impact on Safety Climate

H11: Safety Leadership has a significant impact on Safety Performance

H12: Hazard Management has a significant impact on Safety Climate

H13: Hazard Management has a significant impact on Safety Performance

H14: Safety Climate has a significant impact on Safety Performance

4.4. Model Analysis

The use of structural equation modelling (SEM), exploratory factor analysis (EFA), and confirmatory factor analysis (CFA) analyzes and validates research models, such as the model that was developed for the proposed study. Initially, EFA and CFA were used to find and prove the structure of a model that is robust. SEM is then used to investigate and refine the relationships in the model (Alshehri, 2012). To achieve the study objectives, structural equation modelling (SEM) was developed based on the guidelines suggested by Hair et al. (2014). Figure 4.2 shows the steps suggested by the authors to test and validate both the measurement and structural (path) models. To this end, the following analysis techniques were used to analyze and validate the proposed study's model.

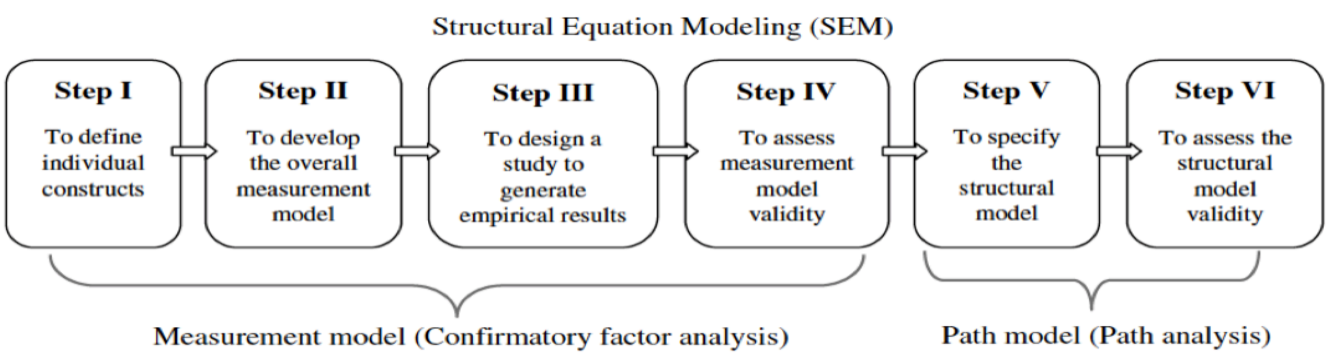

Figure 4. 2: Structural Equation Modelling (SEM) Steps

EFA is an ordered simplification of measures that are interrelated. It has been used for the purpose of investigating potential underlying factor structures of a set of variables that have been observed without causing a preconceived structure to be imposed on the results (Child, 1990). Moreover, EFA may be used to investigate data to decide on the nature or number of aspects that account for variables' covariation when a researcher is missing enough evidence to form a hypothesis concerning the number of aspects that are beneath this or her data. As a result, exploratory factor analysis is usually considered a way to generate theories rather than test them (Stevens, 2002). It is helpful when examining variables' relationships and investigating test scales' construct validity. Most factor analysis studies in the past have been investigatory (Gorsuch 1983; Kim & Mueller, 1978). Furthermore, exploratory factor analysis is driven more by data than by hypotheses or theory (Brown 2006), unlike CFA.

CFA is the extent that a model that has been hypothesized "fits" or shows data (Byrne, 2001). Researchers use it to examine the relationships between a set of unobserved, or latent, continuous variables and a set of observed variables (Baker 2004). It is also used to discover the goodness of fit between a researcher's model and the collected data (Weitzner et al., 1997). That is, confirmatory factor analysis is often used for the purpose of analyzing variables that are latent. It has been used to analyze information systems constructs (Chin & Todd, 1995).

Once a research model has been proven reliable and valid through EFA and CFA, the structure of the model needs to be tested. Doing so includes testing the theoretical hypothesis being examined and the latent constructs' relationships. This can be done using the structural equation modeling (SEM).

4.5. Structural Equation Modeling (SEM)

4.5.1. What is SEM?

Structural Equation Modeling (SEM) is a statistical methodology with a basis in latent variable theory (Kline, 2005). SEM with Confirmatory Factor and Path Analysis, “a versatile multivariate approach to the measurement of latent variables and the structural relationships among the study variables” (Wan, 2002), is employed to define whether the exogenous (independent) variables and endogenous (dependent) variables are causally related to each other.

SEM is not one technique, but a procedural family that has a variety of key aspects in common. SEM provides a hypothesis testing basis; it estimates path coefficients of linear relationships’ fundamental links in variables that have and have not been observed (Byrne, 2001). The technique has been recommended for use in the behavioural sciences (Gefen, Straub, and Boudrea, 2000). It has been posited as a favourable choice for analyzing non-experimental data and describes the relationships of variables through a visual diagram (Kline, 2005). It has been defined a statistical way to use non-experimental data to test causal relationships (Blunch, 2008) and as a multivariate way to test models that propose their variables have causal relationships (Bollen, 1989). It has two main parts: a structural model (or path model) and a measurement model. It is used for testing models that are theoretical (Hair et al., 2006).

Structural equation models usually consist of two different model types. The first is a model of measurement that represents a theory and specifies the way in which variables that are being measured meet to represent factors that are latent. In other words, it is implied by the model that the factors are represented by variables. It represents the relationships between each latent construct with its observable items (i.e. survey questions) within the expanded model. The measurement model has been considered as a CFA model. The second is a structural model. It represents a theory that specifies the way in which the model's constructs are related to each other (Alshehri, 2012). The structural model represents the relationships between all latent variables with all measurement models (CFAs) within the model. Figure 4.3 depicts these concepts.

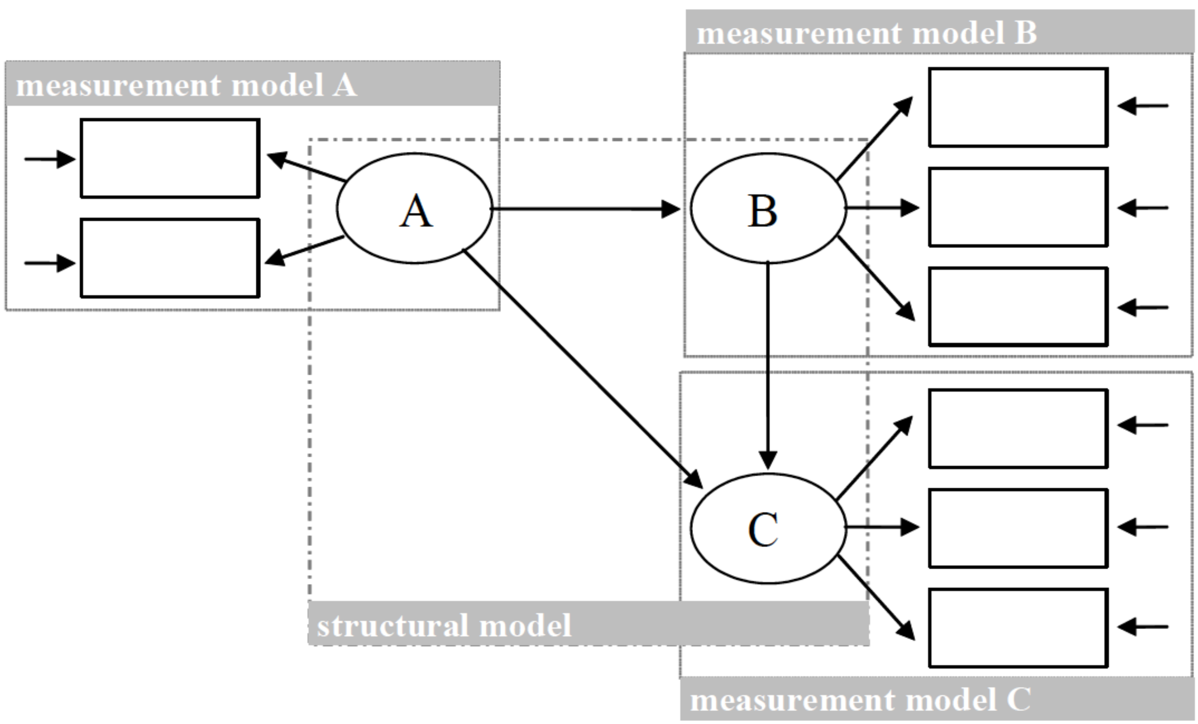

Figure 4. 3: An Expanded Model of SEM (Nachtigall et al., 2003)

What differentiates the second model from the first is the movement of emphasis. It moves from latent constructs' and measured variables' relationships to the size and nature of constructs' relationships (Hair et al., 2006). Generally, the technique provides the ability to examine the structure of the model at once. It maximizes and tests the consistency between the actual data and the theoretical model (Kline, 2005).

It has been posited that this modelling technique provides four benefits that other multivariate techniques (Byrne, 2001). First, it explicitly estimates parameters of error variance. Second, when used for data analysis, it can use observed and unobserved (latent) variables. Third, it has a number of useful features, such as the ability to model relationships that are multivariate and to estimate interval and/or point effects that are indirect. Finally, the technique uses a data analysis approach that is confirmatory instead of exploratory (Alshehri, 2012).

The validity of a construct has been defined as the amount an operational measure correlates with a theoretical concept. It assures researchers that the instrument being used for research is successfully measuring its intended factor (Gable 1993; Netemeyer et al., 2003; Turocy, 2002). Factor analysis is usually considered in regards to construct validity and an analytic tool that can be used to measure it (Turocy, 2002). It empirically investigates relationships between items and discovers clusters of items with enough similar variation to validate their existence as a measured construct (Gable, 1993).

4.5.2. Preparation and Sample Size Data

(SEM) is utilized for complex models and helps assess the measures and proposed structural relationships. In a situation when the sample size for the study is not large enough, according to Kline (2011), the probability of the technical problems in the analysis may increase, plus certain estimates in SEM, such as standard errors, may be incorrect. Several studies have focused on the identification of appropriate sample size for a study and have tried to propose a minimum sample size (e.g. Hoyle, 1999; 2012; MacCallum et al., 1996). However, there is no number that can be phrased as 'large enough' (Jackson, 2003).

Generally, the proposed sample size for perceptual study is greater than at least 200 (Roscoe, 1975). In the literature, sample sizes commonly run between 200 and 400. Some authors even suggest that SEM analyses based upon samples of less than 200 should not be accepted for publication (Barrett, 2007). However, Iacobucci (2010) argued that 200 is surely simplistic. She assumed that if the measurements have good reliabilities, each of the contructs has indicators from 3 to 4, and the structural path model is not very complex, a sample size between 50 and 100 may be enough. According to Loehlin (1992), the minimum sample size should be at least 100 cases, however a more preferred figure would be 200. Similarly, Hoyle (1995) also suggested that the sample size for a study should be in between 100 and 200. Schumacker and Lomax (2004), in their content analysis, identified that a sample size of 250 to 500 has been utilized in numerous research studies.

Others recommend that calculating sample size should build upon the number of variables used in an analysis (e.g. Bentler and Chou, 1987) or desired level of power (MacCallum et al., 2000). Models with more parameters to be estimated require larger samples. In SEM, the most common method to determine the sample size is the ratio of cases per parameter (Kline, 2011). Bentler and Chou (1987) recommended that the cases per parameter estimate can be as low as 5 but 10 is more appropriate. Jackson (2003) suggested that cases per parameter estimate of 20 to be ideal. However, Bagozzi and Yi (2012) argued this was conservative advice. They found that acceptable models have been obtained with ratios near 3:1, even close to 2:1 on certain occasions (Bagozzi and Yi, 2012). MacCallum et al. (1996) presented tables for minimum sample size requirements with selected levels of model degrees of freedom. They indicated that if the model has high degrees of freedom, adequately powerful tests of fit can be carried out with moderate sample size. For example, a minimum sample size of 142 can achieve power of 0.80 for the test of close fit when the degrees of freedom is 90, but the minimum sample size needs to be 231 when the degrees of freedom is 45.

4.5.3. SEM Program

This study utilized the AMOS (Analysis of Moment Structures), as the main software program to fit the structural equation modeling (SEM), along with the IBM SPSS. Since the development of the first SEM program named LISREL in 1974, there has been a continuous surge in the advancement and improvment of alternative SEM computer software (Byrne, 2012). Eight computer programs are specifically constructed for SEM and these appear to be the main options. These are AMOS (Analysis of Moment Structures), LISREL (Linear Structural Relationships), CALIS (Covariance Analysis and Linear Structural equations), Mplus, Mx (Matrix), RAMONA (Reticular Action Model or Near Approximation), EQS (Equations), and SEPATH (Structural Equation Modeling and Path Analysis) (Byrne, 2012; Kline, 2011). Apart from the core analytic features, each of the programs have their own special features. Kline (2011) provided a descriptive review of these eight SEM computer programs. Tabachnick and Fidell (2007) compared EQS, LISREL, AMOS, and CALIS in detail and listed all their features.

Byrne (2012) conducted a comprehensive comparative review of four of the most widely-used analytical tools for SEM that included AMOS, Mplus, EQS, and LISREL. IBM SPSS AMOS is a program with an easy-to-use graphical interface for visual SEM (Arbuckle, 2011). It provides a clear representation of models and publication-quality path diagrams. It has become the first choice for those who prefer working graphically. AMOS allows researchers to assess the proposed hypothesized relationships between the variables in the study based on the covariance in the sample data, and provide results for model fit, indicating whether the data fits the proposed model or not. Based on the goodness of fit indices, it is established whether the speculated relationships of the variables are reflected in the estimated parameters. In the current research study, AMOS 24.0 was chosen to estimate and evaluate the hypothesized models.

CHAPTER 5: DATA COLLECTION PROCEDURES

5.1. Introduction

As is made clear by the review presented in the preceding chapter, safety performance, while quantifiable when appropriately operationalized, is informed by and indeed emerges from an array of factors interacting in a highly complex and often reciprocal fashion. Relevant contributors range from the readily-definable (e.g. the duration of safety training, investments in security and safety reviews, the formal content of safety systems, the familiarity of workers with the provisions of those systems, etc.) to the highly variable and nebulous (e.g. the ethnic and national origins of workers, the organizational micro-cultures of contractors, psychosocial interactions, and the presence and nature of the safety culture surrounding a particular context, etc.). The proposed dissertation is framed, in part, by the idea that such a complex research context requires a research design capable of accounting for and negotiating between these multiple components of safety performance, at least partially.

To this end, a research approach comprising quantitative data gathered through the distribution of questionnaires was utilized. The aim was to facilitate the integration of data speaking to the two major components of safety performance: safety culture and safety management systems components. This approach, which is justified and characterized in greater detail in the following subsections, relies on the ability to obtain and integrate data in order to yield a basis for the development of a process model describing the relationships between a broad array of factors implicated in determining organizational safety performance. The data it provides, in turn, facilitated the analysis of favourable safety practices observed by construction companies operating in Saudi Arabia.

5.2. Quantitative Research

The basic rationale for the use of a quantitative research technique is to gather a broad level of information and to determine the relationships between complex variables. It emphasizes an objective measurement of data collected through surveys, questionnaires, or polls, or by manipulating data that already exists with computational techniques. It is often used to relate data across various groups of people or to find an explanation for a specific phenomenon. (Hopkins, 2000). It places an emphasis on detailed, focused reasoning and maintaining an objective stance. As Creswell (2014) explains, the variables studied can be measured so that data that are numbered may be analyzed through statistical procedures. (p. 4). Most recently, quantitative approaches to safety performance have involved complex studies with multiple variables (p. 12).

The main benefit of surveying to collect primary data is the versatility of the approach. It does not require that there be a visual or other objective perception of information sought by the researcher (Cooper & Schindler, 2003). Quantitative surveys present researchers with numeric descriptions of opinions, attitudes, or trends through studying a sample of a population. The goal of questionnaire research is to make a generalization about a population using the study's data (Creswell, 2014).

For Johnson, Onwuegbuzie, and Turner (2007), quantitative research is "one of the three major" paradigms in modern scientific research (p. 112). The value of the research approach has achieved interdisciplinary recognition. According to Sale, Lohfeld, and Brazil (2002), quantitative research is located within the positivist paradigm: its goal is to “measure and analyze causal relationships between variables within a value-free model” (pp. 43-44). Quantitative methods are very common in construction research as well as in the safety management literature. A recent systematic review by Zou, Sunindijo, and Dainty (2014) found that, of nearly 90 papers reviewed, more than 4 in 10 utilized exclusively quantitative designs (p. 316).

5.3. Population and Sample

5.3.1. Population.

Population refers to the total number of subjects, objects or members that could serve as a potential respondent in a study as they accommodate to a set of specifications (Polit & Hungler, 1999). The population for this study consisted of individuals who work in the construction industry in Saudi Arabia, and mainly in the cities of Jeddah and Jazan. This selection was because the rules and regulations in the kingdom govern by the central government in the capital city and apply to all other cities. According to the 2016 census of construction, there are 732,839 workers in the field of construction in both cities (GOSI, 2017).

5.3.2. Potential respondents.

Structural Equation Modeling is a large sample technique, as discussed in details in the previous chapter. Bigger is always better. The minimum sample size generally should be no less than 200. In consideration of the cost of the survey, and the desire for a large sample size, in addition to calculating the appropriate sample size, a survey sample of approximately 400 was planned. For some administrative reasons, it was difficult to obtain a list of construction companies with their contact details, such as names and addresses. Therefore, the method of snowball sampling was utilized. This method helps to collect respondents' information through friends, engineers, etc. Social platforms, and Google were utilized as well.

With respect to sample size, there are four different inter-related requirements of a study that can affect the identification significance of relationships, interactions and differences (Peers, 1996). Apart from the rationale for the study and total population, three conditions needed to be specified to establish a suitable sample size, including the precision level, the confidence or risk level, and the degree of variability in the attributes being measured.

The range within which the true value of a population is estimated to be is normally referred to as the precision level, sometimes called sampling error or margin of error. The range for level of precision is often stated as a percentage. For the present study, it was considered to be 5% ($e = 0.05$).

To get a confidence interval, margin of error or sampling error multiplied with two. Hence, the confidence interval in this study was estimated to be 10%, which in interdisciplinary research is generally acceptable for categorical data. The confidence level is also referred to as "Alpha Level" or "The Probability of Type 1 Error" or the level of significance. According to Ary, Jacobs and Razavieh (1996), in most engineering studies the alpha level used to determine sample size is either .05 or .01. For research studies similar to the present study, alpha is mostly considered to be .05. Significant effort was made to include an adequate and valid sample to test population characteristics of the work environment and insight of their role in safety performance, in order to make the findings of the study reliable and generalizable. Finding a difference where there is no actual difference or the chances of alpha error due to inappropriate sample size, was eliminated/minimized. The present study is based on categorical data. Hence, Cochran's formula (1977) was utilized to compute the proposed sample size, as follows:

$$n_0 = \frac{z^2 \times p \times (1-p)}{d^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{[5.1]}$$

Where:

z= z-value is 1.96 for a 95% confidence level

p= population proportion (expressed as decimal) assumed to be 0.5. This number indicates maximum variability to get a conservative size.

d= Margin of Error at 5% (0.05)

A) The first step is to calculate the sample size for infinite populations, through plugging the all values into the previous equation

$$n_o = (1.96)^2 * 0.5*(1-0.5) / (0.05)^2$$

$$n_o = 3.8416 * 0.25 / 0.0025 = 384.16$$

B) After calculating sample size, the total (estimated) population should be corrected, as following:

The Population for 2017 in areas of Jeddah and Jazan was 732,839

$$n_{o\ Adjusted} = \frac{n_o}{1+\left[\frac{(n_0-1)}{population}\right]} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{[5.2]}$$

$$n_{o\ Adjusted} = \frac{384.16}{1+\left[\frac{(384.16-1)}{732,839}\right]} = 383.95 \cong 384$$

5.4. Questionnaire Design

5.4.1. The questionnaires.

The research instrument that was used for this project was a questionnaire. Its inquiries were designed to study current safety practices of Saudi Arabia's construction industry, and to determine the main tensions that arise between contactors, managers and workers. This assisted in ranking and determining the importance of each of these problems, including the assessment and evaluation of safety planning, safety policy, safety promotion, internal communication and awareness, safety training, safety leadership, safety climate, hazard management, and safety performance.

This particular survey was structured to encourage relevant organizations to participate. This encouragement was done by including a cover letter with each survey that was distributed. Moreover, it should be noted that Arabic is considered the official language of Saudi Arabia; however, English is heavily used as the country's technical language. It is also the language that is most widely spoken by the leading and dominant expatriate constituent of the construction industry's workforce. Therefore, the questionnaires were produced in both English and Arabic languages to suit the needs of Saudi Arabia's construction community. They were distributed by both personal visits and email to over 100 organizations within the Saudi Arabian construction industry, and mainly in the areas of Jeddah and Jazan. The names and addresses of the organizations were be randomly selected from construction companies at both cities.

In the interest of producing generalizable findings by way of a theoretically-grounded instrument with a validity and reliability that has been empirically demonstrated, the survey was adapted from the Ontario Leading Indicators Project (OLIP), the indicators of which served as the major variables during the modelling portion of the present research project. The first five items of the survey involved characterizing the responding organization in basic terms, including name, firm size (as measured by number of employees), their work durations, their roles within the company, and whether they had health and safety representatives or committees. The items were meant to provide a reference point for understanding the complexity of the firm's operations, the scale relevant to the organizational safety culture and climate, and the number of functional (i.e. workgroup) divisions that might impact how that culture is transmitted (Gallo & Christensen, 2011; Ginsburg et al., 2010; Biggs, Dinsdag, Kirk, & Cipolla, 2010). Next, items 6–9 prompted the respondent to assess basic safety practices at the firm (e.g. "Unsafe working conditions are identified and improved promptly," "Equipment is well-maintained," etc.) using a symmetric 5-point ordered Likert scale, with responses ranging from "Never = 1" to "Always = 5" (Severin, 2014). For individual items, this scale should be viewed as ordinal, but the sums of scales across many items can be treated as intervals for the purposes of statistical analysis (Norman, 2010, pp. 626–30). In this context, symmetry indicates that there were equal numbers of positively and negatively valenced responses arranged in a bipolar fashion around a neutral value (here, "half of the time = 3").

This scale formed the basis for the bulk of the survey. Items 10–15 relate to top-down influences on safety culture, such as the extent to which upper management is actively involved in the safety program, the extent of investment in this program, and the authority and scope with which the safety committee has been vested (Severin, 2014, p. 5). Although it may be cursory, this set of items forms the basis for a critical safety indicator. A wealth of studies indicates that managerial support for and involvement in a given safety regime can have far-reaching consequences for the safety culture of a given organization (Dejoy, 2005; Vinodkumar & Bhasi, 2010). Items 16–22 focused on organizational health and safety performance (e.g. "Employees are always involved in decisions affecting their health and safety"), respectively. The former is meant to provide insight into organizational openness and the likelihood that healthy safety-oriented discourses can occur (thereby encouraging the development of a robust safety culture), and is therefore focused on developing leading indicators, while the latter seeks to gauge key components of the firm's actual safety performance directly, and therefore emphasizes monitoring indicators. Items 23-32 are related to hazard management. This section is not part of OLIP. However, it was provided from the Institute for Work and Health, as a recommendation. The remaining item groups addressed the occupational health and safety management system policy (33–35), organizational promotion of OHS activities (36–39), the quality and availability of OHS training (40–44), internal communication and awareness (45–47), planning of prevention activities (48–51), emergency planning (52–55), the control, monitoring, and review of health and safety-oriented activities (56–63), and safety climate (64–70) (Severin 2014, pp. 7-12).

The survey then moved away from Likert-scale responses in order to characterize specific structural aspects of the organization's safety performance. The penultimate section utilized a symmetric 3-point Likert scale consisting of the response categories

"Yes," "No," and "Don't know" in order to assess lagging indicators by inquiring about health and safety performance over the course of the past five years (e.g. asking if the company experienced any fatalities over this period). This section did not provide data that contributes to the development or evaluation of indicators, leading or otherwise, at this juncture, although it did provide some useful context for the interpretation of results ("Measures", 2014).

5.4.2. Questionnaire Testing and Pilot Study

5.4.2.1. Pre-testing.

Pre-testing a research instrument entails a critical examination of the understanding of each questions and its meaning as understood by a respondent (Kumar, 2011). It is the administration of the data collection instrument with a small set of respondents from the population for the full scale survey. If problems occur in the pre-test, it is likely that similar problems will arise during full-scale administration. The purpose of pre-testing is to identify problems with the data collection instrument and find possible solutions.

The aim is to identify if there are problems in understanding the way a question had been worded, the appropriateness of the meaning it communicates, and to establish whether the interpretation is different to what you were trying to convey (Kumar, 2011). A pre-test should be carried out under actual field conditions on a group of people similar to the study population (Kumar, 2011).

In this study, the questionnaire was pre-tested through several steps. Although the questionnaire had been used previously in several studies, it was modified slightly in this study to fit the current research aims, in addition to translation into Arabic; therefore, it needed to be tested again. The questionnaire was sent to 10 Engineering professors and PhD candidates in Canada and the US, who have some knowledge of safety, and who speak Arabic as their mother tongue. They were asked to review and answer both versions of the questionnaire (Arabic and English), and provide feedback on the adequacy, simplicity and clarity of the instrument. Their feedback was valuable, and several changes were made according to their recommendations, such as wording. The questionnaire was thoroughly evaluated for questions accuracy, simplicity and short sentences which would improve response rate. Ambiguous words and sentence structure were rephrased, and some were eliminated. To avoid respondents bias, each word in the questionnaire was checked completely. Finally, the questionnaire was tested through an online survey website.

5.4.2.2. Pilot Study.

A pilot study was conducted to pre-test the research instrument. The questionnaire was distributed to 100 online construction workers in Jeddah city, one of the fastest growing cities in terms of construction projects in the country. The users who had at least a year of construction experience were selected by using a snowball sampling method for this pilot study. The respondents were asked to evaluate and comment on the questions. A total of 55 responses were received. In general, the respondents felt the questions were clear and easy to understand.

The main aim of this pretest was to check the reliability of the instrument. Based on the 55 responses, the reliability was measured to indicate the extent to which the questionnaire was precise. The reliability test Cronbach Alpha was attempted, and it showed that the results exceeded 0.7 for all the constructs which proves good reliability. The questionnaire items were all adapted from previous literature which already assures content validity. It was further given to a panel of eight engineering and academic experts to establish the content validity. The instrument was evaluated and orally attested by the panel members showing, that the questions fully reflected the concepts to be measured.

5.4.3. Language translation.

The official language of Saudi Arabia is Arabic, and therefore, having an Arabic version for the survey was essential. The original questionnaire was developed in English, and the researchers had to translate it into Arabic. Sekaran (2003) emphasises that it is important to choose a questionnaire that is plain and easy to understand. In this study, the researchers assured that these questionnaire gets the maximum quality and accuracy. The original version of these questionnaire were sent to the Centre of English Language at Jazan University in Saudi Arabia. It was then translated and reviewed by university professors who major in linguistic and Arabic-English translation, and their mother tongues were Arabic.

5.5. Sampling Procedural Overview

5.5.1. Agreement stage.

1. Comprehensive information about the survey was provided to over 100 randomly selected companies by both emails, and visits to the companies' main offices. This was the first point of contact. The information was provided with a letter of information in Arabic (Saudi Arabia's official language) and English (the most language used the most in Saudi Arabia's construction industry). The letter of information

explained the study’s aims and purpose, questions and topics of discussion, scope, languages, and use. It also provided companies and participants with information about their anonymity, the data’s confidentiality, and their ability to withdraw from the study without consequence. Respondents were made aware of the points in the study at which they may no longer be able to withdraw their data. The companies were provided with the researchers and the research ethics coordinator’s contact information in case they had any questions or wished to see the survey’s results once the study was complete. The letter of information specified that the consent must be agreed to digitally by the participants before they proceed with the survey. Companies were allowed read and consider the letter and their participation until July 20, 2017. Companies and participants were under no obligation to consent and would not suffer any consequences if they choose not to participate.

2. The researcher sent, or presented on a tablet, a link to a digital copy of the survey to the construction company along with the letter of information. This was the second point of contact. The survey and letter of information provided were in both Arabic (Saudi Arabia’s official language) and English (the most language used the most in Saudi Arabia’s construction industry). If the participant changed his/her mind and no longer wished to participate, he/she was able to withdraw from the survey without consequence.

3. The company distributed the survey to its current employees for their voluntary participation by August 10, 2017. This was the third point of contact. The survey was distributed to the employees in digital formats in both Arabic (Saudi Arabia’s official language) and English (the most language used the most in Saudi Arabia’s construction

industry). Employees were under no obligation to participate or to share that they are participating. Once the company distributed the link to its employees or ask them for participating in the study by anyway, this would consider as implied acceptance.

5.5.2. Consent stage.

4. Volunteers interested in participating in the survey read comprehensive information about the survey with a letter of consent. It was the first screen of the online copy of the survey. The letter of consent explained the study's aims and purpose, questions and topics of discussion, scope, languages, and use. It also provided participants with information about their anonymity, the data's confidentiality, and their ability to withdraw from the study without consequence. It indicated the approximate completion time as well (15 to 20 minutes). Participants were made aware of the points in the study after which they were no longer able to withdraw their data. They were also provided with the researcher's and the research ethics coordinator's contact information in case they had any questions or wished to see the survey's results once the study was complete. The letter of consent specified that it must be agreed to on the digital copy before the participants could proceed with the survey. Volunteers might read and consider the letter and their participation until August 10, 2017.

5. Participants clicked "I Accept" at the bottom of a digital copy of the letter of consent. They had until August 10, 2017 to click "I Accept" and proceed with the survey. If participants did not consent online, they were unable to proceed to the next page of the survey. Participants were under no obligation to consent and were not suffer any

consequences if they choose not to participate. Participants had the option to print a copy of the consent form if they wished.

6. Participants began the survey. It asked each volunteer about safety performance, climate, and culture at his or her workplace. “Safety climate” refers to what they and their coworkers think of the way the company they work for approaches safety. “Safety culture” refers to the attitudes, beliefs, and perceptions that they and their coworkers have towards workplace safety. Volunteers provided both short answer and selected responses. The selected responses asked them to rate how often safety activities or attitudes occur by using a five-point scale from “never,” or 0, to “always,” or 5. If questions did not apply to the participant, the participant could indicate so. Participants were not asked for any personal information and their IP address was not collected. They remained completely anonymous. Participants had until September 10, 2017 to complete the survey online.

7. Participants could consider whether or not to click “Submit” when the survey was complete. There was no time limit for respondents to click “Submit”. If they chose not to click “Submit” they could close the survey and would not suffer any consequences for their decision to no longer participate. If they changed their mind, they could re-open the survey online and begin the online survey process again, beginning with the letter of consent. They had until September10, 2017 to submit the online survey, at which point the survey would no longer be collected and would close.

8. The researcher received the survey answers online, through Fluidsurvey online software. If a participant completed the survey online but did not click “Submit”, the

participant's survey was destroyed, and the information was not used. The survey answers were kept confidential and were stored in secure locations that may only be accessed by the researcher and his advisor.

9. The researcher compiled and analyzed the data, formed a model, and used the model and the survey's interpreted results to compose a scholarly dissertation. The participants remain anonymous and were not disclosed in the dissertation.

10. The online data collection was closed on September 12, 2017. The dissertation and/or the compiled, analyzed results were available to any participants who asked to see in either hardcopy or digital form and in either Arabic or English.

5.6. Ethical Consideration

Ethical consideration is a significant aspect of any research project. For this study, several steps were taken to ensure that standards of ethical research practice were met. Therefore, this research was granted ethical approval by the University of Windsor Research Ethics Board (REB) on April 11th, 2017 (REB number:33858).

CHAPTER 6: PRIMARY DATA ANALYSIS

6.1. Introduction

This chapter starts with presenting the analysis and findings of the quantitative data collected from the questionnaires. Descriptive data analysis including frequencies and percentages, were chosen as an appropriate way to analyze the descriptive questionnaire data. The details and results of the analysis of the measurement scales utilized in the questionnaire to test the constructs proposed in the conceptual model were then presented. Each of the ten measurement scales, representing each of the model constructs, was assessed to determine its overall reliability. Additionally, Factor Analysis (FA) was conducted on each scale to study and confirm the validity of the factor structures that represent each individual model construct.

6.2. Data Management

This section addresses a set of issues related to data management and screening that are resolved after data are collected, but before the main data analysis is run. Data screening entails a process of establishing that the data was clean of any anomalies and are ready for further statistical analyses. According to Levy (2006), the screening of data is essential for four particular reasons:

- To establish the accuracy of the data collected;
- To assess any extreme cases or outliers and propose a solution to fix the outliers;

- To treat missing data values; and
- To manage the response set issues.

According to Hair et al. (2006), the key problems of data screening that include missing data, outliers, and normality, are discussed in detail in the following sections.

6.2.1. Missing data.

According to Kang (2013), missing values refer to the data values that have been missed for a particular variable of interest during the process of data collection, and hence are not stored. The issue of missing data is fairly common and almost all research can have a significant impact due to the missing values on the conclusions of the study that can be drawn from the data that has missing data. Since all standard statistical techniques presume complete data for all the variables in the study, missing data is a significant problem. As this is also the case with AMOS, some tests require complete data without missing values. According to Kline (2011), standard errors and test statistics, bias in parameter estimates, and inefficient use of data may result because of the use of inappropriate methods for handling missing data. Hence, an essential step before an analysis is conducted, it is extremely important that the analysis procedure is adequately defined, and proper treatment is completed for missing data, such as missing sections or incomplete answers (Hair et al., 2006).

AMOS 24 software was chosen to analyze the data. However, this version cannot estimate structural models, parameters, or fit to the data if data are missing from the data set (Arbuckle, 1996). Therefore, decisions needed to be made regarding either the replacement of missing values with estimated values, or the deletion of cases from further analysis. For the purpose of the current study, any questionnaires returned by the respondents having any missing answers pertinent to the safety performance model were discarded. Missing data in the dataset are usually problematic in computing fit measures. Since the method of snowball sampling was utilized, it was difficult to calculate the response rate. A total of 329 questionnaires were received. Of this number, 53 questionnaires were considered unusable because they had excessive missing response items, which made them unusable. The remaining 276 questionnaires were completed and used in the analysis.

6.2.2. Outliers screening.

Multivariate outlier detection is important for the statistical analysis of multivariate data. According to Hair et al (2006), outliers in a dataset refers to variables/items whose values are significantly different from other data values. Tabachnick and Fidell (2013) describes that a univariate outlier is a case with an extreme value on one variable or in case of multivariate outliers, such a strange combination of scores on two or more variables that it alters the statistical results. Several methods are used to identify outliers in multivariate datasets including Cook's Distance (Di).

In this study, Cook's Distance method was utilized. Dennis Cook (1977) introduced a distance measure for commonly used estimates to study the influence of a data point when performing least squares regression analysis. In the ordinary least squares analysis, Cook's distance points with a large are considered to merit closer examination in the analysis. The Cook's distance, Di, was calculated using the following formula:

$$D_i = \frac{\sum_{j1=}^{n}\left(Y\hat{}_i - Y\hat{}_j(i)\right)^2}{pMSE} \text{ .... [5.3]}$$

Where,

- $Y\hat{}_i \text{ is the jth fitted response value}$
- $Y\hat{}_j(i)$ is the jth fitted response value without observation i
- p is the number of coefficients in the regression model
- MSE is the mean squared error

A new variable was created to provides Cook's Distance for each case. If a case has a Cook's distance of greater than 1, then it may be an influential case that warrants exclusion from the analysis (Tabachnick & Fidell, 2013). Table 6.1 shows the output. The results show that the maximum value of Cook's distance is 0.308 which is very low from 1. This suggests that there were no problematic outliers in this study sample.

Table 6. 1

Descriptive statistics for Cook's distance

	N	Minimum	Maximum	Mean	Std. Deviation
Cook's Distance	276	.000	.308	.007	.027

6.2.3. Normality investigation.

From collection of data to evaluation of results, the application of different statistical methods in different phases of the research study was strongly necessitated. Majority of the researchers utilize the different statistical analyses provided by the computer technology, it is well known that some do not establish the assumption for parametric tests, especially the "normality assumption". However, testing this assumption is crucial for reliability of test results.

A number of different data analysis techniques rely on the assumption that the data were sampled from a normal distribution or that data were normally distributed. A number of different techniques are available to assess if the data collected are distributed normally. In general, the assumption of normality can be established through graphical depiction of the data or other test methods. Although, the use of graphical methods provides information about the shape of the distribution, it does not assure that the distribution is actually normal, furthermore, the graphical methods also fail to establish if the difference in the normal distribution and the sample distribution is significant (Oztuna et al., 2006).

Multivariate normality is established when all variables under consideration in the study are normally distributed with respect to all other variables in the proposed study. Multivariate normal distributions take the form of symmetric three-dimensional bells where, the X axis is the value of a given variable, the Y axis is the count for each value of the X variable, and the Z axis is the value of any other variable under consideration. Multivariate normality is assumed in the (SEM) and certain other procedures. It is important to note that the statistical methods for testing normality are sensitive to the sample size (Field, 2005). Hence, it is suggested to assess the histogram along with the skewness and kurtosis statistics to ascertain the univariate normality.

In this study, skewness and kurtosis values were utilized. Skewness is mostly irrelevant on Likert scales. However, Kurtosis is meaningful because it is an indication of sufficient variance. Kurtosis is more flexible. Scholars like Sposito (1983) recommend up to 3, and Kline recommends up to 10 (2011). For the accepted range of skewness, Hair et al, (2006) recommends values between (-2.58 and + 2.58). As it can be seen from Table 6.2, all values of the variables were within the accepted range of both skewness and kurtosis.

Table 6. 2

Skewness and Kurtosis Statistics for all variables

Constructs	N Statistic	Mean Statistic	Std. Deviation Statistic	Skewness	Kurtosis
Safety Performance (SP)	276	1.9431	.87064	1.555	2.140
OHS Leadership (LD)	276	1.9094	.86681	1.626	2.644
Safety Climate (SC)	276	2.0610	.87928	1.438	1.806
Hazard Management (HZ)	276	1.9734	.83599	1.540	2.393
OHS Planning (PL)	276	1.9993	.90115	1.344	1.540
OHS Policy (PO)	276	2.0048	.97399	1.381	1.441
OHS Promotion (PR)	276	1.9266	.89813	1.427	1.908
OHS Training (TR)	276	1.9703	.89937	1.417	1.847
Internal Communication & Awareness CA	276	1.9710	.93979	1.387	1.691
Control, Monitoring & Review (CR)	276	1.9674	.84040	1.546	2.518
Valid N (listwise)	276				

6.3. Descriptive Statistics

A total of 329 questionnaires were received. Of this number, 53 questionnaires were considered unusable because they had excessive missing response items, which made them unusable. The remaining 276 questionnaires were completed and used in the analysis. Since the method of snowball sampling was utilized, it was difficult to calculate the response rate.

6.3.1. Company size.

Respondents were asked to provide information about the size of their company. As shown in Table 6.3, about half (48.2%) of the respondents came from medium size companies with 50 to 499 employees, while 29.3% came from small size companies of less than 50 employees. About 22% of the respondents were working at large companies of over 500 employees.

6.3.2. Work experience at the company.

As shown in Table 6.3, the majority of workers (about 44%) had work experience for more than five years, while 42% of the respondents had work experience between one and five years. Finally, only 14% of the respondents had work experience for less than one year.

6.3.3. Employee's role.

Respondents were asked to specify their role within their companies (Table 6.3). The majority of the respondents, about 75%, were workers. Out of 276 respondents, 22 were skilled staff, 15 were professional staff, 12 were administrative staff, and nine were team leaders and supervisors. Finally, six respondents were either owners, CEOs or managers.

6.3.4. Availability of safety representative/ committee.

The participants were asked to indicate whether the company has a health and safety representative or committee. The majority of the respondents, over 86%, said that their companies do not have such representatives or committees. The remaining respondents (13.8%) said that their companies have safety representatives.

Table 6. 3

Demographic Analysis

Description	Categories	Frequency	Percent
Company Size	Less than 50 employees	81	29.3
	50 to 499 employees	133	48.2
	More than 500 employees	62	22.5
Work Experience	Less than 1 year	39	14.1
	1 to 5 years	116	42.0
	More than 5 years	121	43.8
Employee's Role	Owner/CEO/President/Senior Management (VP)	6	2.2
	Manager	6	2.2
	Team lead/ Supervisor	9	3.3
	Professional Staff	15	5.4
	Skilled/Trades Staff	22	8.0
	Administrative Staff	12	4.3
	Worker	206	74.6
Availability of safety representative/ committee	Yes	28	13.8
	No	238	86.2

6.4. Factor Analysis Results

Analysis of the study's measurement scale is done in this chapter. The objective of this analysis is to test the constructs in the conceptual model by analyzing their reliability and validity. Validity assesses how accurate an instrument is, while reliability assesses how superior and consistent an instrument is. The factor analysis method — the Exploratory Factor Analysis (EFA) and the Confirmatory Factor Analysis (CFA), in particular — were used to assess this comprehensive analysis.

6.4.1. Reliability.

Reliability is the extent of how reliable the said measurement model in measuring the intended latent construct. In other words, it is the consistency of measurement results. Devellis (1991) defines reliability as "the proportion of variance attributable to the true score of the latent variable". The essence of a reliable scale is covered in its consistency or reproducibility of the test scores. This means that it is the degree to which there is an expected and relatively constant shift in scores of individuals across testing situations on the same or parallel testing measures/scales /instruments.

Before testing the hypotheses, the utilized instruments should be subject to a scale purification process which includes examinations of Cronbach's Coefficient Alpha and item-to-total correlations (Churchill, 1979). Furthermore, the purification of scales should be conducted based on an assessment of Exploratory Factor Analysis (EFA) results, the assessment of the Cronbach's Coefficient Alpha and item-to-total correlations (Lu et al., 2007). An instrument is considered reliable if the measurement procedure consistently assigns the same score to individuals or objects with equal values. In this section, the reliability assessment for a measurement model is described:

6.4.1.1. INTERNAL CONSISTENCY.

Cronbach's alpha (α) and Inter-correlation were deemed to be suitable methods to ascertain the reliability, specifically the internal consistency, of safety performance results in the present study. Although, the terminology "internal consistency" has been widely utilized, but controversies do surround the definition. The terms "internal consistency" and "homogeneity" are used interchangeably by Cronbach (1951), stating that "an internally consistent or homogeneous test should be independent of test length" (p. 323). However, Revelle (1979) defined internal consistency as the degree to which all items in a scale measure the same construct, referring to the general factor saturation. According to Henson (2001), a higher internally consistent score allows the researcher to construe the composite score as a measure of the construct. Hence, the central point is to have homogenous items reflecting the unified underlying construct.

Coefficient alpha has been the most widely used and the most common method of assessing internal consistency/reliability estimates. Although there are three different measures of coefficient alpha, the most commonly utilized indicator is Cronbach's coefficient alpha. Cronbach's alpha is referred to as a reliability coefficient, it assesses the inter-item reliability or the degree of internal consistency/homogeneity among items that measure a single construct i.e. the degree to which different items measuring the same construct attain consistent results. According to Malhotra (2004), the value of the alpha coefficient for ranges from 0 to 1, a value less than 60 normally indicates unsatisfactory internal consistency or poor reliability. According to Hinton et al. (2004) there are four degrees of reliability scale assessed based on the alpha values: if the value of alpha is greater than .90, it is referred to as excellent reliability; a value between .70 and .90 refers to high reliability; a value between .50 and .70 refers to moderate reliability; while values less than or equal to .50 show low reliability. According to Straub et al.'s (2004), the reliability statistic should be over .70 for a confirmatory study. Moreover, according to Hair et al. (2006) in order to indicate suitable convergence or internal consistency the construct reliability should be higher or equal to .70. Additionally, other scholars have recommended that an alpha coefficient of .70 and above is acceptable, in order for a construct to be considered reliable (Pallant, 2005; Robinson et al., 1991; Robinson and Shaver, 1973).

The current study has a total of ten scales that were presented in the survey questionnaire to measure the constructs presented in the safety performance model (Figure 4.1), namely Safety performance (SP); OHS Leadership (LD); Safety Climate (SC); Hazard Management (HZ), OHS Planning (PL); OHS Policy (PO); OHS Promotion (PR); OHS Training (TR); Internal communication & Awareness (CA); and Control, Monitoring & Review (CR). In order to ascertain that the scales in the present study satisfied the model constructs consistently and accurately, scale reliability was assessed using Cronbach's alpha. Scale reliability was assessed using SPSS for each of the constructs in the study that presented in Table 6.4. The results reveal that the Cronbach's alpha value for each variable was over the required .70. This shows that the instrument used in the study are reliable. Hence, exhibiting appropriate internal consistency.

Table 6. 4

Reliability Results

Constructs	No. Of Items	Cronbach's Alpha (α)	Reliability Comment
OHS Planning (PL)	5	0.940	Excellent Reliability
OHS Policy (PO)	3	0.935	Excellent Reliability
OHS Promotion (PR)	4	0.934	Excellent Reliability
Internal communication & Awareness (CA)	3	0.918	Excellent Reliability
OHS Training (TR)	5	0.947	Excellent Reliability
Control, Monitoring & Review (CR)	5	0.928	Excellent Reliability
OHS Leadership (LD)	6	0.956	Excellent Reliability
Safety Climate (SC)	6	0.932	Excellent Reliability
Hazard Management (HZ)	6	0.941	Excellent Reliability
Safety performance (SP)	7	0.952	Excellent Reliability

6.4.1.2. ITEM-TO-TOTAL CORRELATIONS

The items in a particular construct for measurement of a study variable used in the current study were cleansed in the beginning using Corrected Item-to-Total Correlation scores. According to Lu, Lai, and Cheng (2007), Item-total correlation or corrected item-total correlation is the correlation of a particular variable, with the composite score of all items that form the construct. The Corrected Item-to-Total Correlation score ascertains the extent of each item's contribution to the internal consistency of the scale, while to establish the overall consistency of the instrument, Cronbach's Alpha is assessed (Cronbach, 1951). The idea behind the assessment of item-to-total correlation is to remove the “garbage items” (Churchill, 1979) before EFA is conducted. Common statistic for acceptable Corrected Item-to-Total Correlation is that items with values less than .50 shall be removed from further analysis. However, Pallant (2005) and Hair et al. (2006) suggested a more conservative .30 or higher. In the current study, the threshold was set for .30. The results reveal (Tables 6.9 to 6.33), that all values of the Corrected Item-to-Total Correlation were above .30.

6.4.2. Measurement scale validity

To assess the validity of the survey instruments, content and construct validity are established. According to Arino (2003), using expert judgement, the content of the scales is assessed, the expert reviews the scales and provides input if the items in the scale actually measure the intended constructs and that the items have clear wording which is easy to understand and reflect the construct. In the present study, content validity was attained through the pre-testing technique (section 5.4.2).

On the other hand, validity of measure is assessed using construct validity. Construct refers to the degree to which an operational measure correlates with the theoretical concept being investigated. According to Netemeyer, Bearden & Sharma (2003), construct validity assures the researcher that the instrument used to measure a construct actually measures what it is intended to measure. Construct validity is at the centre of any research study where the scholars utilize a measure as an index of a variable that is not itself directly observable or normally referred to as a latent (unobserved) variable. According to Kline (2011), construct validity can be established using a factor analysis technique, such as exploratory factor analysis (EFA).

6.4.3. Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) could be described as an orderly simplification of interrelated measures. According to Child (2006), EFA has been traditionally used to explore the possible underlying factor structure of a set of observed variables without imposing a preconceived structure. According to DeCoster (1998), EFA is utilized when a researcher would like to unearth the possible number of factors influencing variables and to analyze which items in a particular construct converge or 'go together'. EFA tries to uncover complex patterns by exploring the data and testing predictions, and whether the items show a particular factor structure that was expected (Child, 2006). EFA is normally used in cases where a new measure is devised, it is one of the first steps when developing new scales for the measurement of different constructs. The basic aim of conducting EFA is that there are m common 'latent' factors, and find the smallest number of common factors that will account for the correlations (McDonald, 1985). The particular use of EFA is significant in studies that have a few or hundreds of variables, items from questionnaires that could be represented in a smaller set of factors. This is achivied when items that correlate, converge together to create a single factor (Rummel, 1970). EFA involves the assessment of uni-dimensionality, data adequacy and correlation coefficients explaining the suitability for factor analysis.

Uni-dimensionality is one of the main functions of EFA, which is attained when all measuring items have acceptable factor loadings for the unobserved latent construct that it intends to measure. Items that have poor loading are normally removed from further analysis. Apart from the assessment of factor loadings, the sample size adequacy is also assessed prior to the examination of the loadings. Measures of sampling adequacy evaluate if the sample dataset would be adequate for conducting the EFA.

Before proceeding with EFA, a number of different assumptions have to be tested. According to Hair et al. (2006) these assumptions include:

1. Kaiser-Mayer-Olkin (KMO) which indicates the measure of sampling adequacy with a required minimum value for KMO of .60.

2. A statistical test to quantify the extent of inter-correlations among the items, the Bartlett's Test of Sphericity (Bartlett's Test). The Bartlett's Test of Sphericity should be significant at $p<0.05$ for the exploratory factor analysis to be considered appropriate

3. Communalities should be over .50

Further to the assessment of the different assumptions, the next step is to conduct the EFA. This requires identification of the method of rotation. Normally EFA is conducted under the extraction method of principal component analysis with the varimax rotation method. Varimax rotation is favored since it minimizes the correlation across factors and maximizes within the factors (Nunnally, 1978). Once the factor structure is revealed, the next step is to assess if the factor structure is one that was expected, plus the factors loadings are also assessed. Factor loading specifies the strength of the relationship between the item and the latent variable, and can be further utilized to established both reliability and validity (convergent and discriminant) (Hair et al., 2006). The decision on the number of factors is normally based on the eigenvalues; factors with eigenvalues over 1 are retained (Hair et al., 2006). Minimum loading for items is .50 or higher (Fen and

Sabaruddin, 2008; Hair et al., 2006), the items that fails to achieve the required loadings or items that do not load onto their respective factor are removed from further analysis (Fen and Sabaruddin, 2008).

6.4.3.1 Analysis for Safety Performance (SP)

Safety Performance (SP) has seven questionnaire statements to measure overall safety performance. Table 6.5 presents these statements along with their codes and factor loadings. A factor loadings are higher than the recommended cut-off of 0.50, as explained above, which indicates that the Safety Performance items scales are unidimensional. The correlation matrix, as shown in Table 6.6, for all scale items of Safety Performance (SP1 to SP7) shows that the correlation coefficients are greater than 0.3, which supports the adequacy for factor analysis (Pallant, 2005; Hair et al., 2006). Table 6.7 presents results for KMO and Bartlett's Test, which shows that both are significant with 0.938 and Chi-Square of 1807.909 at $p<0.001$, respectively.

Table 6. 5

Coding and Factor Loading of Safety Performance (SP)

Variable Code	Component	Questionnaire Statement
SP1	0.887	Formal safety audit at regular intervals are a normal part of our business.
SP2	0.874	Everyone at this organization values ongoing safety improvement in this organization.
SP3	0.902	Workers and supervisors have the information they need to work safely.
SP4	0.887	Employees are always involved in decisions affecting their health and safety.
SP5	0.897	Those in charge of safety have the authority to make the changes they have identified as necessary.

SP6	0.867	Those who act safely receive positive recognition.
SP7	0.856	Everyone has the tools and/or equipment they need to complete their work safely.

Table 6. 6

Correlation Matrix for Safety Performance (SP) Scale

		SP1	SP2	SP3	SP4	SP5	SP6	SP7
Correlation	SP1	1.000	0.723	0.777	0.753	0.766	0.746	0.704
	SP2	0.723	1.000	0.790	0.713	0.735	0.662	0.769
	SP3	0.777	0.790	1.000	0.782	0.757	0.724	0.731
	SP4	0.753	0.713	0.782	1.000	0.761	0.783	0.675
	SP5	0.766	0.735	0.757	0.761	1.000	0.767	0.742
	SP6	0.746	0.662	0.724	0.783	0.767	1.000	0.669
	SP7	0.704	0.769	0.731	0.675	0.743	0.669	1.000

Table 6. 7

KMO and Bartlett's Test for Safety Performance (SP)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.938
Bartlett's Test of Sphericity	Approx. Chi-Square	1807.909
	df	21
	Sig.	.000

6.4.3.2 Analysis for Safety Leadership (LD)

Table 6.8 presents six questionnaire statements along with the factor loadings for Safety Leadership (LD), which indicates that all factor loadings are greater than the cut-off value of 0.50. This leads to claim the Safety Leadership item scales are unidimensional. Table 6.9 presents the correlation matrix for the Safety Leadership item scale measures, which indicates that all of the correlation coefficients are higher than 0.30. These results indicate that factor analysis is suitable. Both KMO (0.933) and Bartlett's Test (Chi-Square of 1676.301 at $p<0.001$), as shown in Table 6.10, are significant.

Table 6. 8

Coding and Factor Loading of Safety Leadership (LD)

Variable Code	Component	Questionnaire Statement
LD1	0.912	Top management is actively involved in the safety program
LD2	0.892	The safety manager (or, the person in charge of health & safety) receives support from top management.
LD3	0.917	Your company spends time and money on improving safety performance.
LD4	0.917	Your company considers safety to be equally important as operation and quality in the way work is done.
LD5	0.896	Your company analyzes injury and illness data (e.g. claims data, first aid logs) to identify causes and target solutions.
LD6	0.894	The safety program or committee has the responsibility, authority and resources to identify and address safety problems.

Table 6. 9

Correlation Matrix for Safety Leadership (LD) Scale

Factor		LD1	LD2	LD3	LD4	LD5	LD6
Correlation	LD1	1.000	0.799	0.816	0.789	0.761	0.782
	LD2	0.799	1.000	0.786	0.755	0.743	0.766
	LD3	0.816	0.786	1.000	0.831	0.783	0.761
	LD4	0.789	0.755	0.831	1.000	0.815	0.785
	LD5	0.761	0.743	0.783	0.815	1.000	0.764
	LD6	0.782	0.766	0.761	0.785	0.764	1.000

Table 6. 10

KMO and Bartlett's Test for Safety Leadership (LD)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.933
Bartlett's Test of Sphericity	Approx. Chi-Square	1676.30 1
	df	15
	Sig.	.000

6.4.3.3 Analysis for Safety Climate (SC)

As shown in Table 6.11, there are six statements that used to measure the Safety Climate (SC) at the workplaces. It includes, as well, the factor loadings which shows that all values are higher than the cut-off level of 0.50. This concludes that the Safety Climate items measures are unidimensional. The correlation matrix (Table 6.12) for all scale items of Safety Climate (SC1 to SC6) shows that the correlation coefficients are greater than 0.3, which supports the adequacy for factor analysis. Finally, Table 6.13 displays results for KMO and Bartlett's Test, which shows that both are significant with 0.886 and Chi-Square of 1345.695 at $p<0.001$, respectively.

Table 6. 11

Coding and Factor Loading of Safety Climate (SC)

Variable Code	Component	Questionnaire Statement
SC1	0.877	New employees learn quickly that they are expected to follow good health and safety practices.
SC2	0.885	Employees are told when they do not follow good health and safety practices.
SC3	0.897	Workers and management work together to ensure the safest possible conditions.
SC4	0.827	There are no major shortcuts taken when worker health and safety are at stake.
SC5	0.891	The health and safety of workers is a high priority with management where I work.
SC6	0.805	I feel free to report safety problems where I work.

Table 6. 12

Correlation Matrix for Safety Climate (SC) Scale

		SC1	SC2	SC3	SC4	SC5	SC6
Correlation	SC1	1.000	0.745	0.739	0.601	0.725	0.732
	SC2	0.745	1.000	0.817	0.682	0.694	0.636
	SC3	0.739	0.817	1.000	0.720	0.749	0.609
	SC4	0.601	0.682	0.720	1.000	0.757	0.533
	SC5	0.725	0.694	0.749	0.757	1.000	0.687
	SC6	0.732	0.636	0.609	0.533	0.687	1.000

Table 6. 13

KMO and Bartlett's Test for Safety Climate (SC)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.886
Bartlett's Test of Sphericity	Approx. Chi-Square	1345.695
	df	15
	Sig.	.000

6.4.3.4 Analysis for Hazard Management (HZ)

Table 6.14 displays the six questionnaire items for Hazard Management (HZ), along with the factor loadings that all above the cut-off value of 0.50 which supports the unidimensionality of the scale measures. The correlation matrix, as displayed in Table 6.15, for the six scale measures (HZ1 to HZ6) shows that the correlation coefficients are larger than 0.30. In addition, Table 6.16 demonstrates that both KMO (0.894) and Bartlett's Test (Chi-Square of 1497.549 at $p<0.001$) are significant.

Table 6. 14

Coding and Factor Loading of Hazard Management (HZ)

Variable Code	Component	Questionnaire Statement
HZ1	0.904	Health and safety incidents are investigated for root causes.
HZ2	0.900	An analysis of the hazards for each jobsite is performed.
HZ3	0.888	Engineering controls are used for all applicable hazards (e.g. special tools, equipment)
HZ4	0.786	Applicable Ministry of Labour mandated programs, if any, are fully implemented.
HZ5	0.904	Your company documents progress in correcting jobsite hazards.
HZ6	0.889	Hazards are re-assessed during the project as tasks change.

Table 6. 15

Correlation Matrix for Hazard Management (HZ) Scale

		HZ1	HZ2	HZ3	HZ4	HZ5	HZ6
Correlation	HZ1	1.000	.821	.775	.614	.765	0.774
	HZ2	.821	1.000	.769	.573	.783	0.778
	HZ3	.775	.769	1.000	.724	.716	0.702
	HZ4	.614	.573	.724	1.000	.675	0.603
	HZ5	.765	.783	.716	.675	1.000	0.818
	HZ6	.774	.778	.702	.603	.818	1.000

Table 6. 16

KMO and Bartlett's Test for Hazard Management (HZ)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.894
Bartlett's Test of Sphericity	Approx. Chi-Square	1497.549
	df	15
	Sig.	.000

6.4.3.5 Analysis for OHS Planning (PL)

Table 6.17 shows the five OHS Planning's questionnaire statements and its factor loadings. The all factor loadings are higher than the cut-off level of 0.50, which indicate that the five measures are unidimensional. In Table 6.18, all of the scale items' correlation coefficients are greater than 0.30, which supports the adequacy for factor analysis. Finally, both KMO (0.875) and Bartlett's Test (Chi-Square of 1254.473 at $p<0.001$) are significant, as shown in Table 6.19.

Table 6. 17

Coding and Factor Loading of OHS Planning (PL)

Variable Code	Component	Questionnaire Statement
PL1	0.927	Your company has a prevention plan for dealing with OHS hazards and risks.
PL2	0.907	Prevention plans are based on the assessment of OHS hazards and risks in all jobs.
PL3	0.907	Work procedures are based on the assessment of hazards and risks.
PL4	0.875	Your company has a plan for dealing with emergency situations.
PL5	0.877	Periodic drills are conducted to test the effectiveness of the emergency plan.

Table 6. 18

Correlation Matrix for OHS Planning (PL)

		PL1	PL2	PL3	PL4	PL5
Correlation	PL1	1.000	.803	.774	.841	.740
	PL2	.803	1.000	.815	.701	.752
	PL3	.774	.815	1.000	.710	.771
	PL4	.841	.701	.710	1.000	.682
	PL5	.740	.752	.771	.682	1.000

Table 6. 19

KMO and Bartlett's Test for OHS Planning (PL)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.875
Bartlett's Test of Sphericity	Approx. Chi-Square	1254.473
	df	10
	Sig.	.000

6.4.3.6 Analysis for OHS Policy (PO)

The data in Table 6.20 present the OHS Policy’s questionnaire statements along with their factor loadings. It shows that these loadings are higher than the cut-off of 0.50, which support the unidimensionality of their scale measures. Table 6.21 displays the correlation matrix for OHS Policy scale measures, which shows that all correlation coefficients are greater than 0.30. Table 6.22 presents results for KMO and Bartlett's Test, which shows that both are significant with 0.764 and Chi-Square of 697.982 at $p<0.001$, respectively.

Table 6. 20

Coding and Factor Loading of OHS Policy (PO)

Variable Code	Component	Questionnaire Statement
PO1	0.950	Your company coordinates its OHS policy with other human resource policies to ensure worker commitment and well-being.
PO2	0.936	A policy document is available to all workers reflecting management's commitment to protecting worker health and safety.
PO3	0.936	Your company's OHS policy commits to continuous improvement, i.e., attempting to improve beyond objectives already achieved.

Table 6. 21

Correlation Matrix for OHS Policy (PO)

		PO1	PO2	PO3
Correlation	PO1	1.000	.839	.840
	PO2	.839	1.000	.802
	PO3	.840	.802	1.000

Table 6. 22

KMO and Bartlett's Test for OHS Policy (PO)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.764
Bartlett's Test of Sphericity	Approx. Chi-Square	697.982
	df	3
	Sig.	.000

6.4.3.7 Analysis for OHS Promotion (PR)

The following Table, 6.23, provides coding and factor loadings for OHS Promotion. It shows that PR has four questionnaire statements, with factor loadings greater than 0.50, which concludes that the four items scale is unidimensional. The following Table, 6.24, displays the correlation matrix for the four items showing that all of the correlation coefficients are generally higher than 0.30. Finally, Table 6.25 displays results for KMO and Bartlett's Test, which shows that both are significant with 0.850 and Chi-Square of 933.124 at $p<0.001$, respectively.

Table 6. 23

Coding and Factor Loading of OHS Promotion (PR)

Variable Code	Component	Questionnaire Statement
PR1	0.901	Incentives are frequently offered to encourage workers to comply with OHS policies and procedures (e.g., correct use of protective equipment).
PR2	0.917	OHS decisions are frequently based on consultations with or suggestions from workers.
PR3	0.926	Periodic meetings are held between workers and supervisors/managers to make decisions that affect the organization of work.
PR4	0.912	Teams of workers from various parts of your company are frequently used to solve problems about working conditions.

Table 6. 24

Correlation Matrix for OHS Promotion (PR)

		PR1	PR2	PR3	PR4
Correlation	PR1	1.000	0.794	0.760	0.742
	PR2	0.794	1.000	0.793	0.765
	PR3	0.760	0.793	1.000	0.828
	PR4	0.742	0.765	0.828	1.000

Table 6. 25

KMO and Bartlett's Test for OHS Promotion (PR)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.850
Bartlett's Test of Sphericity	Approx. Chi-Square	933.124
	df	6
	Sig.	.000

6.4.3.18 Analysis for OHS Training (TR)

The following Table, 6.26, provides statistics, along with TR coding, showing that all factor loadings are greater than the cut-off level of 0.50, which concludes that TR items scale is unidimensional. Table 6.27 provides the correlation coefficients in the form of correlation matrix for the five scale items (TR1 to TR5) showing that they are greater than 0.30. Finally, Table 6.28 demonstrates that both KMO (0.881) and Bartlett's Test (Chi-Square of 1326.040 at $p<0.001$) are significant.

Table 6. 26

Coding and Factor Loading of OHS Training (TR)

Variable Code	Component	Questionnaire Statement
TR1	0.904	Workers are given sufficient OHS training when joining your company, changing worksites, or using a new technique.
TR2	0.920	OHS training is ongoing and based on a training plan.
TR3	0.910	OHS training plans are decided jointly with workers or their representatives (e.g. unions).
TR4	0.887	Your company supports OHS training opportunities for workers (e.g. leave, scholarships).
TR5	0.921	OHS instruction manuals or work procedures are available.

Table 6. 27

Correlation Matrix for OHS Training (TR) Scale

		TR1	TR2	TR3	TR4	TR5
Correlation	TR1	1.000	.794	.758	.715	.838
	TR2	.794	1.000	.830	.779	.774
	TR3	.758	.830	1.000	.758	.789
	TR4	.715	.779	.758	1.000	.781
	TR5	.838	.774	.789	.781	1.000

Table 6. 28

KMO and Bartlett's Test for OHS Training (TR)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.881
Bartlett's Test of Sphericity	Approx. Chi-Square	1326.040
	df	10
	Sig.	.000

6.4.3.9 Analysis for Internal Communication and Awareness (CA)

Table 6.29 presents the three questionnaire statements for Internal Communication and Awareness (CA) along with their factor loadings. It shows that all loadings are generally above the cut-off level, which supports the claim that the CA scale is unidimensional. The next Table, 6.30, presents the correlation matrix for the CA item scale measures, which indicates that all of the correlation coefficients are higher than 0.30. These results indicate that factor analysis is suitable. Table 6.31 displays data for both KMO and Bartlett's Test. It shows that both tests are significant with 0.754 and Chi-Square of 597.657 at $p<0.001$, respectively.

Table 6. 29

Coding and Factor Loading of Internal Communication and Awareness (CA)

Variable Code	Component	Questionnaire Statement
CA1	0.924	OHS policies and procedures are clearly communicated in regular meetings, presentations, or campaigns.
CA2	0.916	Systems are in place to notify workers of any changes in operation processes or jobs before the changes are made.
CA3	0.940	Workers are informed about OHS hazards through written materials and meetings.

Table 6. 30

Correlation Matrix for Internal Communication and Awareness (CA)

		CA1	CA2	CA3
Correlation	CA1	1.000	.755	.815
	CA2	.755	1.000	.795
	CA3	.815	.795	1.000

Table 6. 31

KMO and Bartlett's Test for Internal Communication and Awareness (CA)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.754
Bartlett's Test of Sphericity	Approx. Chi-Square	597.657
	df	3
	Sig.	.000

6.4.3.10 Analysis for Control, Monitoring and Review (CR)

Table 6.32 provides the Control, Monitoring and Review (CR)'s five questionnaire statements along with their factor loadings, which shows that all loadings are greater than the cut-off level which supports the scale unidimensionality. Table 6.33

presents the correlation matrix for all scale items of CR (CR1 to CR5) shows that the correlation coefficients are greater than 0.3, which supports the adequacy for factor analysis. Finally, both KMO (0.880) and Bartlett's Test (Chi-Square of 1069.391 at p<0.001), as shown in Table 6.34, are highly significant.

Table 6. 32

Coding and Factor Loading of Control, Monitoring and Review (CR)

Variable Code	Component	Questionnaire Statement
CR1	0.882	Your company's fulfillment of its OHS prevention plans is regularly checked.
CR2	0.842	Your company's compliance with legislation and regulations is regularly checked.
CR3	0.899	There are procedures to check the achievement of OHS goals assigned to managers.
CR4	0.910	Accidents and incidents are reported, investigated, analysed, and recorded.
CR5	0.870	People outside of your company (e.g., consultants, ISO auditors) periodically conduct audits of the OHS management system.

Table 6. 33

Correlation Matrix for Control, Monitoring and Review (CR) Scale

		CR1	CR2	CR3	CR4	CR5
Correlation	CR1	1.000	.715	.702	.737	.730
	CR2	.715	1.000	.709	.697	.603
	CR3	.702	.709	1.000	.803	.738
	CR4	.737	.697	.803	1.000	.762
	CR5	.730	.603	.738	.762	1.000

Table 6. 34

KMO and Bartlett's Test for Control, Monitoring and Review (CR)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.880
Bartlett's Test of Sphericity	Approx. Chi-Square	1069.391
	df	10
	Sig.	.000

6.5. Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis (CFA) is a multivariate statistical procedure utilized to assess how well the measured variables represent the number of constructs. Although, both Confirmatory and exploratory technique are factor analysis based techniques. Items from a particular construct when subjected to EFA, provide information about the underlying factor structure for the measure. However, in confirmatory factor analysis (CFA), researchers can specify the number of factors based on what they expect a priori. The number of factors are then assessed based on the data, if the data fits a particular factor structure or not. In CFA, the factors and the particular items that reflect the factors are already established based on theory or previous available research. CFA is a tool that is used to confirm or reject the measurement theory through identification of whether the data fits a particular proposed model or not. In the present study, these methods were used to assess construct validity. In CFA, two different models are proposed. Measurement model and structural model, measurement model is utilized to assess if the data fits the model, to establish construct reliability, convergent, and discriminant validity. Structural model is devised to assess the significance of hypothesized relationships. Construct validity is established when both convergent and discriminant validity are established.

6.5.1. Convergent validity.

Convergent validity is evidence of a survey's ability to positively correlate with other instruments that measure for theoretically or conceptually similar constructs. Convergent validity shows the extent to which two measures capture a common construct (Straub et al., 2004). For a particular construct, convergent validity is established when different items converge together to adequately measure the unobserved latent construct. Convergent validity is calculated based on the factor loadings. According to Brown (2006, p. 2), convergence evidence is provided when “different indicators of theoretically similar or overlapping constructs are strongly interrelated”. In other words, convergent validity essentially refers to whether indicators from a latent variable do belong to that latent variable. In SEM, convergent validity is established using factor loadings from the measurement model (Jöreskog, 1967).

Since 1981, the Fornell-Larcker’s criterion has been regularly used to evaluate the degree of shared variance between models’ latent variables. Average Variance Extracted (AVE) and Composite Reliability (CR) have been used to assess the convergent validity of any particular measures, using the following equations:

The Average Variance Extracted (AVE) ξ_j can be defined as the level of variance captured by a construct versus the level due to measurement error. Values above .7 are considered very good, whereas, the level of .50 is acceptable (Fornell & Larcker, 1981). **(AVE)** for construct ξ_j is defined in equation [6.2] as follows:

$$AVE\xi_j = \frac{\sum_{k=1}^{K_j} \lambda_{j_k}^2}{\left(\sum_{k=1}^{K_j} \lambda_{j_k}^2\right) + \Theta_{j_k}}$$ ……………………….………….. [6.2]

Where:

- K_j denotes the indicators of construct ξ_j.
- λ_{jk} denotes factor loadings
- Θ_{jk} denotes the error variance of the k^{th} indicator ($k = 1, ..., K_j$) of construct ξ_j

CR is a less biased estimate of reliability in comparison to Cronbachs Alpha, According to Hair et al (2006), the minimum acceptable statistic for CR is .70. The Composite Reliability (CR) for construct ξ_j is defined in equation [6.3] as follows:

$$\rho_{c\xi j} = \frac{\left(\sum_{k=1}^{K_j} \lambda_{j_k}\right)^2}{\left(\sum_{k=1}^{K_j} \lambda_{j_k}\right)^2 + \Theta_{j_k}}$$ ……………………. [6.3]

Where:

- K_j denotes the indicators of construct ξ_j.
- λ_{jk} denotes factor loading
- Θ_{jk} denotes the error variance of the k^{th} indicator ($k = 1, ..., K_j$) of construct ξ_j

$$\Theta_{j_k} = \sum_{k=1}^{K_j} 1 - \lambda_{j_k}^2$$ ………………….…………… [6.4]

Table 6.35 shows that the composite reliability for the different constructs in the study exceeded the required criteria of .70. Moreover, Fornell and Larcker (1981) recommends using AVE to assess convergent validity. This could be done through calculating AVE for each construct in the study, which has to exceed the minimum recommended threshold of .50. Therefore, convergent validity was established.

Table 6. 35

Convergent validity results

Constructs	Average Variance Extracted (AVE)	Composite Reliability (CR)
OHS Planning (PL)	0.753	0.938
OHS Policy (PO)	0.828	0.935
OHS Promotion (PR)	0.781	0.935
Internal Communication & Awareness (CA)	0.790	0.918
OHS Training (TR)	0.778	0.946
Control, Monitoring & Review (CR)	0.740	0.934
OHS Leadership (LD)	0.782	0.956
Safety Climate (SC)	0.706	0.935
Hazard Management (HZ)	0.731	0.942
Safety Performance (SP)	0.739	0.952

6.5.2. Discriminant validity.

Discriminant validity refers to the extent to which the constructs in the study are different from each other (Straub et al., 2004). According to Farrell (2010), “discriminant validity is the extent to which latent variable A discriminates against other latent variables (e.g. B, C, D)”. Anderson and Gerbing (1988) claims that discriminant validity could be evaluated using inter-construct correlations. To establish discriminant validity, the inter-construct correlations between constructs is compared to the square root of AVE. Fornell and Larcker (1981) found that the square roots of the AVE must be greater than the correlations to satisfy the requirements of discriminant validity.

In the present research study, discriminant validity was assessed through comparison of square root of AVE with the correlation coefficient between the constructs. According to Fornell and Larcker's (1981) criterion to ascertain discriminant validity, this form of validity is established when the Square root of AVE is greater than the correlations between the constructs. Contrary to the proposed criterion to established discriminant validity, in the present study, the discriminant validity was not established. In more of the cases, the square root of AVE for a construct was lower than the construct correlation with other constructs in the study. However, when the descriptive statistics were analyzed, the mean score for the responses in each construct was approximately 2. It was further revealed that, in most cases for all items in the study, over 70% of the respondents choose option 1 and 2. Lack of variance in the selection of response leads to such high correlation between constructs (see Appendix B for frequency tables).

Table 6. 36

Discriminant validity results

		LD	SP	HZ	PO	PR	CR	CA	PL	TR	SC
LD	1.90	0.884									
SP	1.94	0.965	0.860								
HZ	1.97	0.949	0.991	0.855							
PO	2.00	0.905	0.933	0.916	0.910						
PR	1.92	0.879	0.930	0.901	0.955	0.884					
CR	1.98	0.909	0.948	0.946	0.966	0.947	0.860				
CA	1.97	0.896	0.935	0.931	0.941	0.963	0.968	0.889			
PL	1.99	0.878	0.933	0.913	0.955	0.962	0.989	0.985	0.868		
TR	1.97	0.889	0.934	0.927	0.959	0.972	0.978	0.984	0.989	0.882	
SC	2.06	0.873	0.930	0.922	0.939	0.948	0.963	0.963	0.962	0.952	0.840

CHAPTER 7: MODEL ASSESSMENT AND RESULTS

7.1. Introduction

This chapter presents the process of assessment of the conceptual model as proposed in Chapter 4. The model assessment in this chapter includes evaluation of the measurement and structural models. The aim of the present study is to assess hypotheses proposed that assess the inter-relationship between safety performance, OHS leadership, safety climate, hazard management, OHS planning, OHS policy, OHS promotion, OHS training, internal communication & awareness, and control, monitoring & review. In this study, to test the hypothesized relationships, data were collected from construction companies in Saudi Arabia. The chapter begins with an overview of Structural Equation Modelling (SEM), the technique that has been employed in this research to evaluate the relationships between the model's constructs. This is followed by an assessment of the measurement model and the analysis results. Finally, the results of the structural model assessment were presented.

7.2. Structural Equation Modelling (SEM) Overview

The proposed model in the present study was tested through Structural Equation Modelling (SEM). SEM is a statistical methodology based on latent variable theory. According to Kline (2005), SEM is not a single technique, but a family of related procedures, with several important characteristics. Not only does SEM provide basis for testing research hypotheses, it also aids in assessment of the measurement model through an assessment of whether the data fits the model in an adequate manner. SEM is a set of statistical techniques that have been used widely for a long time. However, more recently, it has been increasingly utilized in perceptual studies enabling confirmatory or hypothesis-testing modelling by specifying a model which is tested to substantiate a proposed hypothesis (Tight & Huisman, 2015). SEM is utilized to infer the relationship among different variables within a single framework (Dörnyei & Ushioda, 2013). According to Vavra (1997), SEM is an analytical procedure for testing to see just how well the observed data confirms the model and its relationships. According to Byrne (2001), the relationships are assessed in SEM through provision of path coefficients and their significance. SEM is highly recommended in behavioral studies research (Gefen, Straub, and Boudreau, 2000). According to Bollen (1989), SEM is a multivariate technique used to test models proposing causal relationships between their variables; it consists of two primary components: a measurement model and a structural model. According to Hair et al. (2006), SEM is used to test theoretical models. SEM is used to its fullest advantage in models that include both measurement and structural components (Robins, Fraley, & Krueger, 2009)

The measurement model that represents the theory may be broadly defined as models expressing the relationships between latent (unobserved) variables and measured (i.e., observed or manifest) variables. The measurement model displays the relationships between a set of indicators or items with its construct or dimension (Robins, Fraley, & Krueger, 2009). It is worth noting that the measurement model approach helps represent a small set of model structures that represent a large variety of observed responses (Byrne, 2006).

The structural model represents the proposed theory, it specifies how constructs are related to different constructs in the proposed model. The structural model is the part of a model that specifies the relationships between the latent variables (Hair et al., 2006)

Where in a measurement model there is no depiction of how the variables are related to each other, the emphasis of the structural model is more towards which variable impacts the other variable and is measured in terms of nature and magnitude of the relationships between constructs (Hair et al., 2006). A significant advantage of SEM is that it allows researchers to explore the overall structural model at once. SEM is thus designed to maximize, then test, the degree of consistency between the theoretical model, and the actual data (Kline, 2005). Byrne (2001) claimed that SEM has four significant benefits over other multivariate techniques:

- While traditional multivariate techniques are not capable of providing clear estimates of error variance, the modern SEM techniques have the capability of assessing for measurement error;
- SEM allows incorporation of both latent (unobserved) and observed variables, but traditional data analysis methods only cater to observed measurements;
- The SEM techniques provides significant number of features that include modelling multivariate relationships, or assessment of moderating or indirect effects, whilst there are no widely and easily applied methods to conduct such analysis in tradition data analysis methods; and

- Finally, data analysis in SEM is based on a confirmatory approach rather than an exploratory approach.

7.3. Measurement Model Assessment

The measurement model is the part of SEM that involves CFA, (i.e. the part of the model that explains how observed variables represent a factor that is not measured directly) (Hair et al., 2006). To conduct SEM, latent variables/factors must be defined appropriately using a measurement model before they are incorporated into a SEM model (Wang & Wang, 2012). To assess the measurement model, the model is evaluated using goodness-of-fit (GOF) indices. Several different fit indices are available in the literature that can be utilized to assess a model fit. Model fit refers to how the data reflects underlying theory. There are several different fit indices available. According to Hooper, Coughlan, and Mullen (2008), there is a significant difference in agreement on the indices to report and their cut-offs values.

Literature identifies numerous indices that can be utilized to ascertain the goodness of fit of a specified model to the observed data. Although, there is a significant lack of agreement to these indices, there are several recommendations on which fit indices to utilize. A summary of recommendations is presented in the following Table 7.1.

Table 7. 1

Recommended Fit Indices

S. No	Fit Indices	Source
1	SRMR, Comparative Fit Index (CFI), Tucker-Lewis index (TLI), and Root Mean Square Error of Approximation (RMSEA).	Hu and Bentler (1999)
2	Chi square statistics, RMSEA, CFI.	Hair at al. (2006)
3	Chi-Square, CFI, TLI, RMSEA and SRMR.	Bandalos and Finney (2010)
4	RMSEA, SRMR, and at least one of CFI, NFI and TLI.	Hancock, Mueller, & Stapleton (2010)

Brown (2006) asserts that a research study shall consider and report various fit indices for model fit evaluation. Keeping in line with the recommendation for reporting different fit indices, the present study reports CMIN, SRMR, CFI, TLI, and RMSEA.

To assess the model, each of the fit indices has been provided with a designated cut-off value. Hu and Bentler (1998) recommend a cut-off value of .08 for SRMR while the recommended cutoff value for RMSEA is .06 (and should not exceed 0.08). According to Wang & Wang (2012), the traditional cut off value for CFI is suggested to be .90, however Bentler (1990) recommends that, for both CFI and TLI, the values should be in range of .90-.95 for them to indicate an acceptable model fit. CMIN is the relative chi-square, the value of which equals the chi-square statistic divided by the degrees of freedom (df). According to Schumacker & Lomax (2004), the acceptable range for CMIN is between 2 less than 5. Moreover, the factor loading of the measurement items is used to assess the measurement model. According to Bollen (1989), the larger the factor loadings with significant *t*-values, the more robust is the evidence that the measured variables represent the underlying factor. Hair et al. (2006) a suggested factor loading value of a minimum .50.

Table 7. 2

Summary of Recommended Fit Indices

Level of Fit Measures					
RMSEA	SRMR	CFI	TLI	CMIN	Factor Loading
$\leq .08$	$\leq .08$	$\geq .90$	$\geq .90$	Between 2 to 5	.50

7.3.1 Measurement model results.

The results for the measurement model are presented in Table 7.3 along with the loadings and fit indices, while the model is shown in Figure 7.1. In a measurement model, distinguishing between dependent and independent variables is not required. So, latent variables are shown in the oval shapes. Two-headed arrows indicate covariance while one-headed connectors indicate a causal path from a construct to an indicator. As presented in Tables 7.3 and 7.4, the model showed an acceptable level of fit ($\chi 2$= 2844.582, *df* =1119, $\chi 2/df$ (CMIN) = 2.542, SRMR = .03, CFI = 0.90, TLI = 0.90, RMSEA = 0.07). As for factor loadings, all items show acceptable loadings onto their respective factors with all loadings greater than 0.50 ($p < 0.001$).

Table 7. 3

Factor Loadings and Fit Indices

Indicators	Constructs	Estimate	S.E.	C.R.	P
LD6	LD	.871			
LD5	LD	.870	.047	20.345	***
LD4	LD	.889	.046	21.254	***
LD3	LD	.893	.044	21.498	***
LD2	LD	.869	.047	20.307	***
LD1	LD	.912	.045	22.511	***
SP7	SP	.811			
SP6	SP	.855	.057	17.428	***
SP5	SP	.876	.056	18.106	***
SP4	SP	.858	.057	17.527	***
SP3	SP	.879	.061	18.200	***
SP2	SP	.846	.058	17.155	***
SP1	SP	.889	.054	18.552	***
HZ6	HZ	.838			
HZ5	HZ	.874	.046	22.914	***
HZ4	HZ	.760	.066	15.195	***
HZ3	HZ	.872	.057	18.980	***
HZ2	HZ	.882	.054	19.401	***
HZ1	HZ	.897	.058	20.012	***
PO3	PO	.907			

Indicators	Constructs	Estimate	S.E.	C.R.	P
PO2	PO	.902	.041	24.260	***
PO1	PO	.921	.041	25.687	***
PR4	PR	.887			
PR3	PR	.892	.045	22.362	***
PR2	PR	.886	.044	21.969	***
PR1	PR	.871	.045	21.145	***
CR5	CR	.885			
CR4	CR	.881	.048	21.824	***
CR3	CR	.844	.047	19.859	***
CR2	CR	.822	.047	18.843	***
CR1	CR	.868	.047	21.071	***
CA3	CA	.905			
CA2	CA	.884	.041	23.085	***
CA1	CA	.876	.045	22.598	***
PL5	PL	.861			
PL4	PL	.814	.063	17.707	***
PL3	PL	.884	.053	20.691	***
PL2	PL	.891	.048	21.009	***
PL1	PL	.886	.055	20.786	***
TR5	TR	.919			
TR4	TR	.840	.040	21.123	***
TR3	TR	.865	.035	22.682	***

Indicators	Constructs	Estimate	S.E.	C.R.	P
TR2	TR	.869	.035	22.985	***
TR1	TR	.914	.036	26.452	***
SC6	SC	.737			
SC5	SC	.864	.070	14.948	***
SC4	SC	.804	.065	13.784	***
SC3	SC	.885	.062	15.404	***
SC2	SC	.888	.061	15.428	***
SC1	SC	.839	.062	16.959	***

Note: S.E. (Standard Error); C.R. (Critical Ratio); P (Probability Value)

***: < .001

Table 7. 4

Goodness-of-fit indices for Measurement Model

χ^2	*df*	$\chi2/df$ (CMIN)	SRMR	CFI	TLI	RMSEA
2844.582	1119	2.542	.03	0.90	0.90	0.07

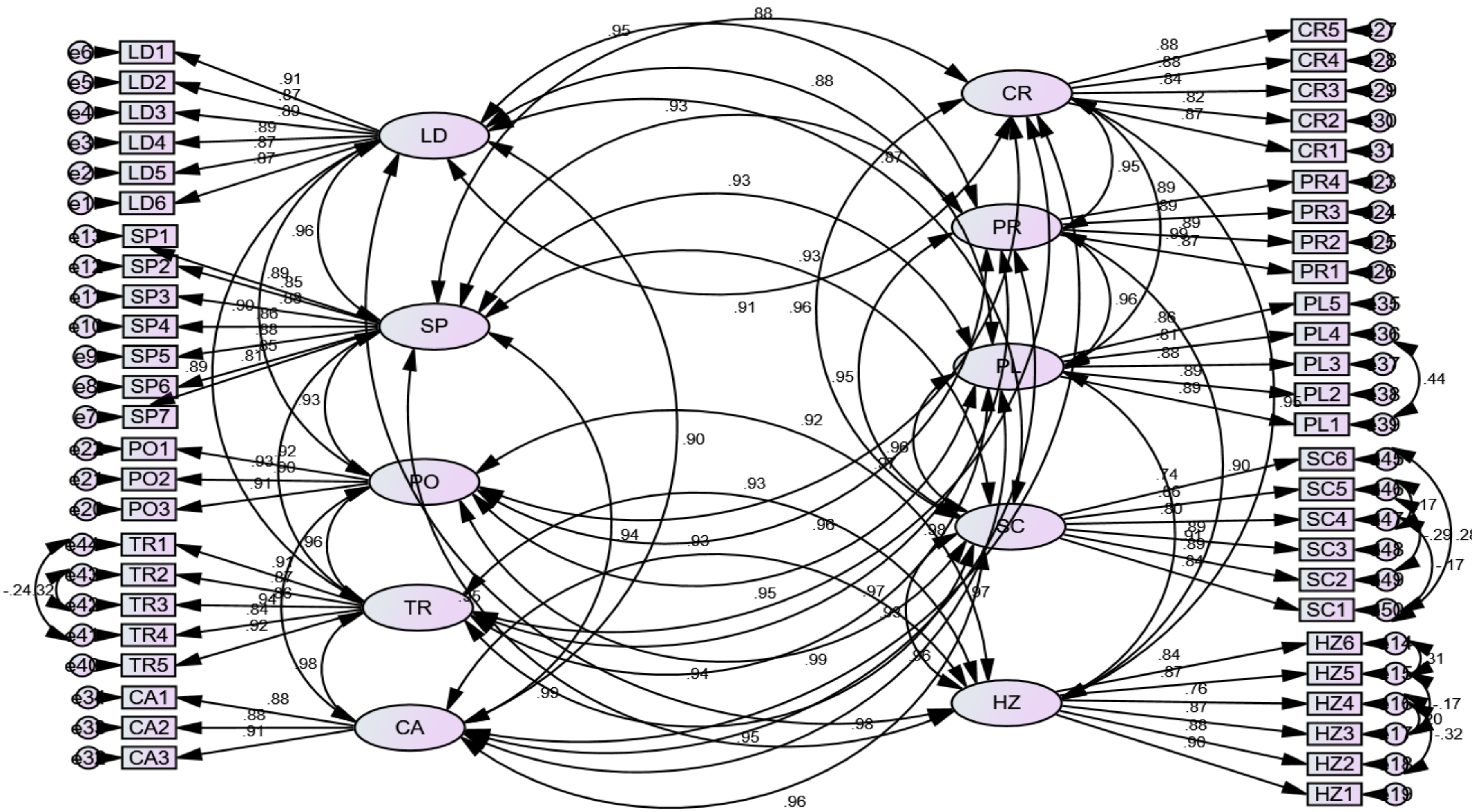

Figure 7. 1: The Measurement Model Results

7.3.2. Correlation analysis.

Correlation analysis was performed to assess the bi-variate relationships. The results revealed that all the variables in the study have a strong and significant relationship with each other ($r => .70$, $p < .001$). The results of the correlation analysis are summarized in Table 7.5.

Table 7. 5

Correlation Analysis

Constructs	LD	SP	HZ	PO	PR	CR	CA	PL	TR	SC
LD										
SP	0.965									
HZ	0.949	0.991								
PO	0.905	0.933	0.916							
PR	0.879	0.930	0.901	0.955						
CR	0.909	0.948	0.946	0.966	0.947					
CA	0.896	0.935	0.931	0.941	0.963	0.968				
PL	0.878	0.933	0.913	0.955	0.962	0.989	0.985			
TR	0.889	0.934	0.927	0.959	0.972	0.978	0.984	0.989		
SC	0.873	0.930	0.922	0.939	0.948	0.963	0.963	0.962	0.952	

7.4. Structural Model

In SEM, the structural model is designed and tested to assess the proposed hypothesized relationships among the different constructs in the research study. The previous chapter presented the statistical analysis and results which indicated that the research model has demonstrated satisfactory reliability and validity while in the previous section of this chapter, the measurement model was assessed to have an acceptable fit. Once the study assessed the measurement model, the next step is to evaluate the structural model to test the hypothesized framework or the proposed relationships between difference variable in the study. The following structural model and hypotheses were proposed in the present study:

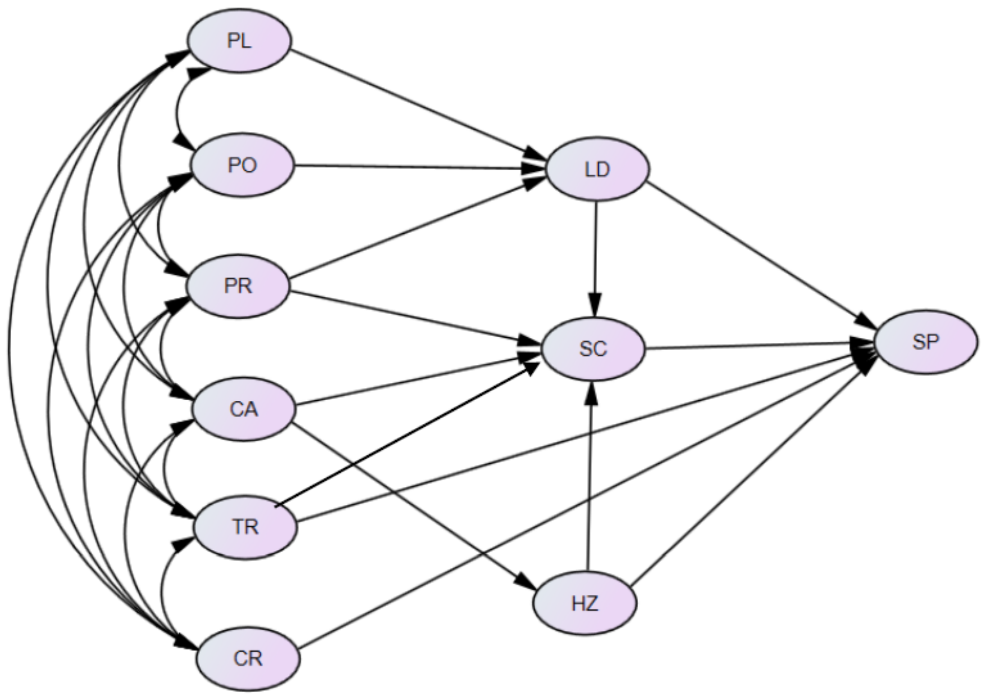

Figure 7. 2: The Proposed Structural Model

H1: Planning has a significant impact on Leadership

H2: Policy has a significant impact on Leadership

H3: Promotion has a significant impact on Leadership

H4: Promotion has a significant impact on Safety Climate

H5: Internal Communication & Awareness has a significant impact on Safety Climate

H6: Internal Communication & Awareness has a significant impact on Hazard Management

H7: Training has a significant impact on Safety Climate

H8: Training has a significant impact on Safety Performance

H9: Control, Monitoring & Review has a significant impact on Safety Performance

H10: Leadership has a significant impact on Safety Climate

H11: Leadership has a significant impact on Safety Performance

H12: Hazard Management has a significant impact on Safety Climate

H13: Hazard Management has a significant impact on Safety Performance

H14: Safety Climate has a significant impact on Safety Performance

To assess the structural model, different statistics were reviewed. These included examination of model fit indices to assess if the data fits the model. Furthermore, the standardized path coefficient, t-statistics, and p values were also reviewed to identify which hypothesized relationships are supported. The fit indices utilized for the model fit were similar to those used in the measurement model assessment (explained in Section 7.4). As for the assessment of the hypothesized relationships, the standardized path coefficients were required to be significant at the $p < 0.05$ level. The following section summarizes the results from the proposed hypothesized relationships.

7.4.1. Structural model results.

The fit indices are summarized below, while the proposed structural model is depicted in Figure 7.3. Overall, the model showed an acceptable level of fit: ($\boldsymbol{\chi 2}$ = 2954.537, *df* = 1135, $\boldsymbol{\chi 2}/df$ = 2.603, CFI = 0.90, TLI = 0.90, SRMR = .03, RMSEA = 0.07).

7.5. Mathematical Model Equations

Base on the hypothesized structure with the model's latent constructs in place and related measured indicators, the safety performance model can be operationalized as demonstrated in Figures 4.1 and 7.3. This path diagram denotes a set of 54 structural equations, one for each endogenous variable with a total of four, and 50 equations from the measurement part of the model. To mathematically annotate both portions of the model, measurement and structural models, respectively, let the general equations be given as:

a) Measurement models

$\boldsymbol{y_i = \lambda_{yiFj}\eta_{Fj} + \varepsilon_{yi}}$ ….. (7.1) and $\boldsymbol{x_i = \lambda_{xiFj}\xi_{Fj} + \delta_{xi}}$ ….….. (7.2)

b) Structural model

$$\boldsymbol{\eta = \gamma\xi + \beta\eta + \zeta} \quad \text{……………………………………………. (7.3)}$$

Where:

- η the endogenous latent constructs
- ξ the exogenous latent constructs
- λ regression of measurement indicators
- ε measurement error, disturbances
- δ measurement error, disturbances
- γ regression of η on ξ, association between exogenous and endogenous
- β regression of η on η, association between endogenous constructs
- ζ structural error

Tables 7.6 and 7.7 list all 54 structural equations and their related endogenous (dependent) and exogenous (independent) constructs that jointly denote the model in Figure 7.3.

Table 7. 6

Structural Equations of the Model: Structural Portion

Endogenous Variable	Structural Equations	Exogenous Variables
[F7] OHS Leadership (LD)	$\eta_{F7} = \gamma_{F7F1}\xi_{F1} + \gamma_{F7F2}\xi_{F2} + \gamma_{F7F3}\xi_{F3} + \zeta_{F7}$	[F1] OHS Planning (PL) [F2] OHS Policy (PO) [F3] OHS Promotion (PR)
[F8] Safety Climate (SC)	$\eta_{F8} = \gamma_{F8F3}\xi_{F3} + \gamma_{F8F4}\xi_{F4} + \gamma_{F8F5}\xi_{F5} + \beta_{F8F7}\eta_{F7} + \beta_{F8F9}\eta_{F9} + \zeta_{F8}$	[F3] OHS Promotion (PR) [F4] Communication & Awareness (CA) [F5] OHS Training (TR) [F7] OHS Leadership (LD) [F9] Hazard Management (HZ)
[F9] Hazard Management (HZ)	$\eta_{F9} = \gamma_{F9F4}\xi_{F4} + \zeta_{F9}$	[F4] Communication & Awareness (CA)
[F10] Safety Performance (SP)	$\eta_{F10} = \beta_{F10F7}\eta_{F7} + \beta_{F10F8}\eta_{F8} + \gamma_{F10F5}\xi_{F5} + \gamma_{F10F6}\xi_{F6} + \beta_{F10F9}\eta_{F9} + \zeta_{F10}$	[F7] OHS Leadership (LD) [F8] Safety Climate (SC) [F5] OHS Training (TR) [F6] Control, Monitoring & Review (CR) [F9] Hazard Management (HZ)

Table 7. 7

Structural Equations of the Model: Measurement Portion

Endogenous Variable	Structural Equations	Exogenous Variables
[x1] PL1	$x_1 = \lambda_{x1F1}\xi_{F1} + \delta_{x1}$	
[x2] PL2	$x_2 = \lambda_{x2F1}\xi_{F1} + \delta_{x2}$	
[x3] PL3	$x_3 = \lambda_{x3F1}\xi_{F1} + \delta_{x3}$	[F1] OHS Planning (PL)
[x4] PL4	$x_4 = \lambda_{x4F1}\xi_{F1} + \delta_{x4}$	
[x5] PL5	$x_5 = \lambda_{x5F1}\xi_{F1} + \delta_{x5}$	
[x6] PO1	$x_6 = \lambda_{x6F2}\xi_{F2} + \delta_{x6}$	[F2] OHS Policy (PO)
[x7] PO2	$x_7 = \lambda_{x7F2}\xi_{F2} + \delta_{x7}$	
[x8] PO3	$x_8 = \lambda_{x8F2}\xi_{F2} + \delta_{x8}$	
[x9] PR1	$x_9 = \lambda_{x9F3}\xi_{F3} + \delta_{x9}$	
[x10] PR2	$x_{10} = \lambda_{x10F3}\xi_{F3} + \delta_{x10}$	[F3] OHS Promotion (PR)
[x11] PR3	$x_{11} = \lambda_{x11F3}\xi_{F3} + \delta_{x11}$	
[x12] PR4	$x_{12} = \lambda_{x12F3}\xi_{F3} + \delta_{x12}$	
[x13] CA1	$x_{13} = \lambda_{x13F4}\xi_{F4} + \delta_{x13}$	[F4] Communication & Awareness (CA)
[x14] CA2	$x_{14} = \lambda_{x14F4}\xi_{F4} + \delta_{x14}$	
[x15] CA3	$x_{15} = \lambda_{x15F4}\xi_{F4} + \delta_{x15}$	
[x16] TR1	$x_{16} = \lambda_{x16F5}\xi_{F5} + \delta_{x16}$	
[x17] TR2	$x_{17} = \lambda_{x17F5}\xi_{F5} + \delta_{x17}$	
[x18] TR3	$x_{18} = \lambda_{x18F5}\xi_{F5} + \delta_{x18}$	[F5] OHS Training (TR)
[x19] TR4	$x_{19} = \lambda_{x19F5}\xi_{F5} + \delta_{x19}$	
[x20] TR5	$x_{20} = \lambda_{x20F5}\xi_{F5} + \delta_{x20}$	
[x21] CR1	$x_{21} = \lambda_{x21F6}\xi_{F6} + \delta_{x21}$	
[x22] CR2	$x_{21} = \lambda_{x22F6}\xi_{F6} + \delta_{x22}$	[F6] Control, Monitoring & Review (CR)
[x23] CR3	$x_{23} = \lambda_{x23F6}\xi_{F6} + \delta_{x23}$	
[x24] CR4	$x_{24} = \lambda_{x23F6}\xi_{F6} + \delta_{x24}$	
[x25] CR5	$x_{25} = \lambda_{x25F6}\xi_{F6} + \delta_{x25}$	
[y1] LD1	$y_1 = \lambda_{y1F7}\eta_{F7} + \varepsilon_{y1}$	
[y2] LD2	$y_2 = \lambda_{y2F7}\eta_{F7} + \varepsilon_{y2}$	
[y3] LD3	$y_3 = \lambda_{y3F7}\eta_{F7} + \varepsilon_{y3}$	
[y4] LD4	$y_4 = \lambda_{y4F7}\eta_{F7} + \varepsilon_{y4}$	[F7] OHS Leadership (LD)
[y5] LD5	$y_5 = \lambda_{y5F7}\eta_{F7} + \varepsilon_{y5}$	
[y6] LD6	$y_6 = \lambda_{y6F7}\eta_{F7} + \varepsilon_{y6}$	
[y7] SC1	$y_7 = \lambda_{y7F8}\eta_{F8} + \varepsilon_{y7}$	[F8] Safety Climate (SC)

[y8] SC2	$y_8 = \lambda_{y8F8}\eta_{F8} + \varepsilon_{y8}$	
[y9] SC3	$y_9 = \lambda_{y9F8}\eta_{F8} + \varepsilon_{y9}$	
[y10] SC4	$y_{10} = \lambda_{y10F8}\eta_{F8} + \varepsilon_{y10}$	
[y11] SC5	$y_{11} = \lambda_{y11F8}\eta_{F8} + \varepsilon_{y11}$	
[y12] SC6	$y_{12} = \lambda_{y12F8}\eta_{F8} + \varepsilon_{y12}$	
[y13] HZ1	$y_{13} = \lambda_{y13F9}\eta_{F9} + \varepsilon_{y13}$	[F9] Hazard Management (HZ)
[y14] HZ2	$y_{14} = \lambda_{y14F9}\eta_{F9} + \varepsilon_{y14}$	
[y15] HZ3	$y_{15} = \lambda_{y15F9}\eta_{F9} + \varepsilon_{y15}$	
[y16] HZ4	$y_{16} = \lambda_{y16F9}\eta_{F9} + \varepsilon_{y16}$	
[y17] HZ5	$y_{17} = \lambda_{y17F9}\eta_{F9} + \varepsilon_{y17}$	
[y18] HZ6	$y_{18} = \lambda_{y18F9}\eta_{F9} + \varepsilon_{y18}$	
[y19] SP1	$y_{19} = \lambda_{y19F10}\eta_{F10} + \varepsilon_{y19}$	[F10] Safety Performance (SP)
[y20] SP2	$y_{20} = \lambda_{y20F10}\eta_{F10} + \varepsilon_{y20}$	
[y21] SP3	$y_{21} = \lambda_{y21F10}\eta_{F10} + \varepsilon_{y21}$	
[y22] SP4	$y_{22} = \lambda_{y22F10}\eta_{F10} + \varepsilon_{y22}$	
[y23] SP5	$y_{23} = \lambda_{y23F10}\eta_{F10} + \varepsilon_{y23}$	
[y24] SP6	$y_{24} = \lambda_{y24F10}\eta_{F10} + \varepsilon_{y24}$	
[y25] SP7	$y_{25} = \lambda_{y25F10}\eta_{F10} + \varepsilon_{y25}$	

7.6. Hypotheses Testing

According to the findings in Table 7.8, six out of the fourteen (14) hypotheses were statistically supported. Results from each of the hypotheses are described below

H1: Planning has a significant impact on Leadership

Hypotheses (H1) seeks to assess if planning has a significant impact on leadership. The findings reveal that planning factor has a significant impact on leadership (B = .568, t = 2.871, p = .004), thus supporting H1.

H2: Policy has a significant impact on Leadership

Hypotheses (H2) seeks to assess if policy has a significant impact on leadership. The findings reveal that policy has a significant impact on leadership ($B = .720$, $t = 3.836$, $p < .001$), thus supporting H2.

H3: Promotion has a significant impact on Leadership

Hypotheses (H3) seeks to assess if promotion has a significant impact on leadership. The findings reveal that promotion has moderately significant impact on leadership ($B = -.366$, $t = -1.681$, $p = .093$), thus Rejected H3.

H4: Promotion has a significant impact on Safety Climate

Hypotheses (H4) seeks to assess if promotion has a significant impact on safety climate. The findings reveal that promotion does not have a significant impact on safety climate ($B = .456$, $t = 1.570$, $p = .116$), thus rejecting H4.

H5: Internal communication & Awareness has a significant impact on Safety Climate

Hypotheses (H5) seeks to assess if Internal communication & Awareness has a significant impact on safety climate. The findings reveal that Internal communication & Awareness has a significant impact on safety climate ($B = 1.516$, $t = 2.394$, $p = .017$), thus supporting H5.

H6: Internal Communication & Awareness has a significant impact on Hazard Management

Hypotheses (H6) seeks to assess if Internal Communication & Awareness has a significant impact on hazard management. The findings reveal that Internal Communication & Awareness has a significant impact on hazard management ($B = .945$, $t = 18.364$, $p < .001$), thus supporting H6.

H7: Training has a significant impact on Safety Climate

Hypotheses (H7) seeks to assess if training has a significant impact on safety climate. The findings reveal that training does not have a significant impact on safety climate ($B = -.984$, $t = -1.261$, $p = .207$), thus rejecting H7.

H8: Training has a significant impact on Safety Performance

Hypotheses (H8) seeks to assess if training has a significant impact on safety performance. The findings reveal that training does not have a significant impact on safety performance ($B = .152$, $t = 1.039$, $p = .299$), thus rejecting H8.

H9: Control, Monitoring & Review has a significant impact on Safety Performance

Hypotheses (H9) seeks to assess if Control, Monitoring & Review has a significant impact on safety performance. The findings reveal that Control, Monitoring & Review does not have a significant impact on safety performance ($B = -.207$, $t = -1.109$, $p = .267$), thus rejecting H9.

H10: Leadership has a significant impact on Safety Climate

Hypotheses (H10) seeks to assess if leadership has a significant impact on safety climate. The findings reveal that leadership has moderately significant impact on safety climate (B = -.130, t = -1.894, p = .058), thus Rejected H10.

H11: Leadership has a significant impact on Safety Performance

Hypotheses (H11) seeks to assess if leadership has a significant impact on safety performance. The findings reveal that leadership has significant impact on safety performance (B = .389, t = 6.662, p < .001), thus accepting H11.

H12: Hazard Management has a significant impact on Safety Climate

Hypotheses (H12) seeks to assess if hazard management has a significant impact on safety climate. The findings reveal that hazard management does not have a significant impact on safety climate (B = .114, t = 1.197, p = .231), thus rejecting H12.

H13: Hazard Management has a significant impact on Safety Performance

Hypotheses (H13) seeks to assess if hazard management has a significant impact on safety performance. The findings reveal that hazard management has significant impact on safety performance (B = .599, t = 7.321, p < .001), thus accepting H13.

H14: Safety Climate has a significant impact on Safety Performance

Hypotheses (H14) seeks to assess if safety climate has a significant impact on safety performance. The findings reveal that safety climate does not have a significant impact on safety performance (B = .102, t = .977, p = .329), thus rejecting H14.

Table 7. 8

The Structural Model Results

Hypotheses	DV	IV	Standardized Estimate	S.E.	C.R.	P	Results
H1	LD	PL	.568	.212	2.871	.004	Accepted
H2	LD	PO	.720	.175	3.836	***	Accepted
H3	LD	PR	-.366	.212	-1.681	.093	Rejected
H4	SC	PR	.456	.284	1.570	.116	Rejected
H5	SC	CA	1.516	.610	2.394	.017	Accepted
H6	HZ	CA	.945	.044	18.364	***	Accepted
H7	SC	TR	-.984	.684	-1.261	.207	Rejected
H8	SP	TR	.152	.122	1.039	.299	Rejected
H9	SP	CR	-.207	.181	-1.109	.267	Rejected
H10	SC	LD	-.130	.069	-1.894	.058	Rejected
H11	SP	LD	.389	.056	6.662	.000	Accepted
H12	SC	HZ	.114	.107	1.197	.231	Rejected
H13	SP	HZ	.599	.088	7.321	.000	Accepted
H14	SP	SC	.102	.099	.977	.329	Rejected

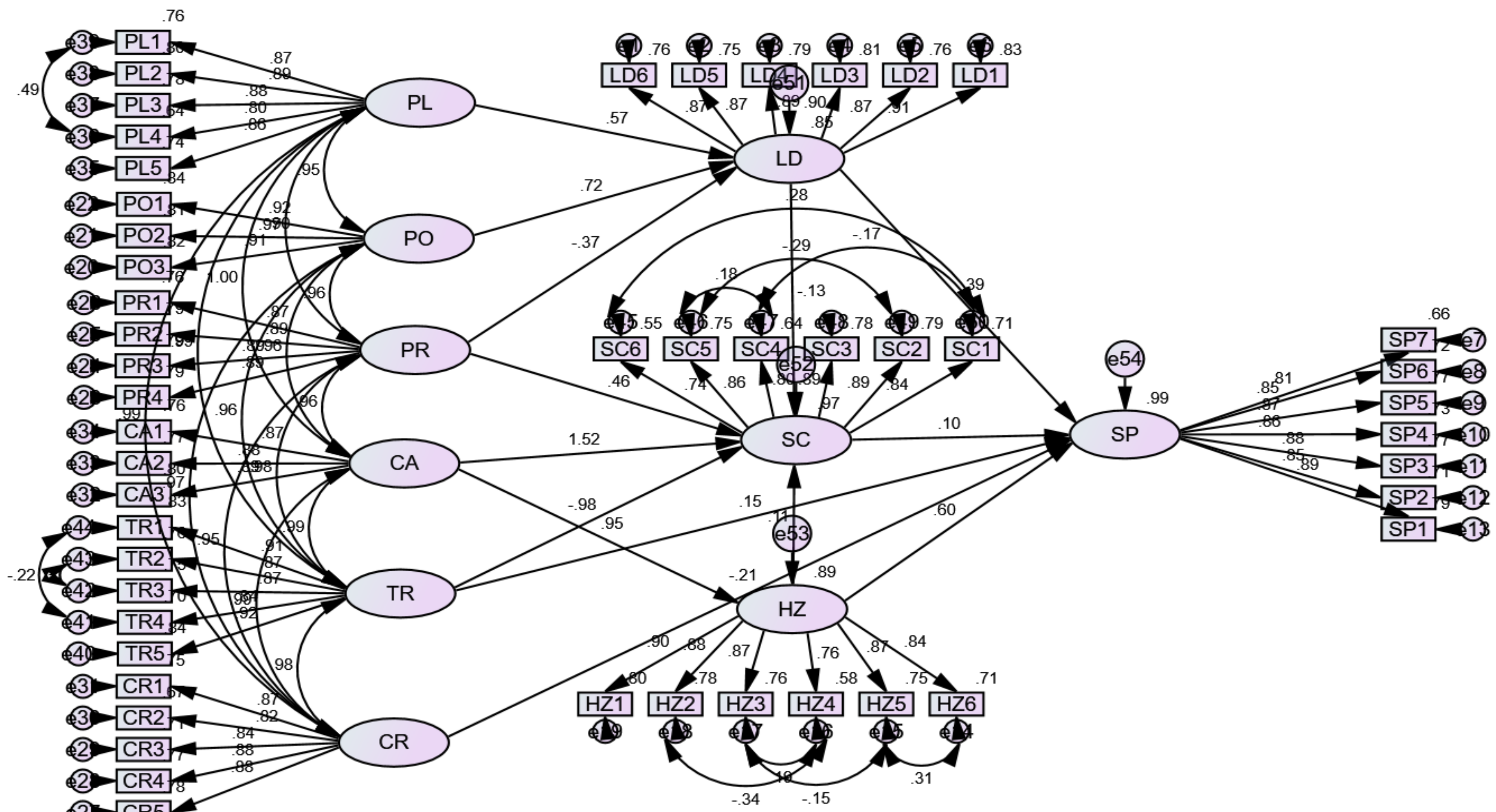

Figure 7. 3: The Structural Model Resul

CHAPTER 8: DISCUSSION AND CONCLUSION

8.1. Introduction

Whereas the preceding chapter presented the results of primary research and analysis with relatively little commentary, Chapter 8 offers a critical and evidence-based consideration of the significance of the data and their relationship to existing knowledge. To this end, this chapter unfolds as follows.

First, the findings presented in the preceding chapter are discussed, contextualized, and critically evaluated. Following this discussion, key facets of the data are summarized for clarity. Second, the significance of this research project is briefly discussed, again with close reference to summarized literature review findings, but also with respect to the current state of practice in the Saudi construction industry, which may be of interest to scholars, workers, managers, and policymakers alike. Third, the significance of this work is tempered using critical discussion of the possible limitations associated with the data, the research methodology, and the findings of the present study.

The aim here is to give peer reviewers a useful reference point when evaluating these results, as well as to provide a basis for highlighting lingering questions and recommending strategies for answering those questions. This last activity is made explicit in the fourth section of this chapter, in which potentially lucrative directions for future research are suggested. Finally, a summative conclusion provides a brief overview of the essential components of this study, including its methods, most important findings, and limitations.

Overall, the need for both further study of the role of safety and safety systems in the Saudi construction industry, as well as the necessity of making significant and proactive investments in improving safety processes and performance in that industry, are both strongly emphasized.

8.2. Discussion of Findings

This section offers a critical discussion of the research findings presented in the preceding chapter. Specifically, findings are considered in relation to research questions, to the scholarly literature, to industry practice, and to one another. While this study has focused primarily on a series of correlational analyses using the SEM methodology in order to systematically evaluate a proposed safety model, in the interest of thoroughness, this chapter also highlights interesting findings related to individual survey items and more general trends in response patterns—even when these findings do not ultimately generate profound differences in terms of the model, its measured validity, or other questions which served as the focus of the previous chapter.

8.2.1. Research question one

Research Question One asked, "What is the current state of safety processes and practices in the Saudi construction industry?" This study collected primary survey data in order to address this question, but it might be useful to begin with a brief review of several key points derived from secondary research processes conducted in support of that aim.

Although the Saudi construction industry is clearly on a growth trajectory with respect to both volume and funding, it is important to note that scholars have argued for decades (often with empirical data in hand) that safety practices and procedures in KSA are chronically inadequate (Alh-Hammad & Abdul-Mohsen, 1995; Arain et al., 2006). This poor safety and risk management reputation has been attributed to a number of factors, including a lack of familiarity with local culture by expert contractors and the general lack of consistently observed and enforced construction standards, to name just a few (Alh-Hammad & Abdul-Mohsen, 1995; Arain et al., 2006; Jannadi, 2008). Whatever the reason, the reality is that while, reporting systems are inadequate, there is strong empirical evidence suggesting that serious accidents are disturbingly common, occurring more frequently and with greater severity, not only compared to the estimated global averages, but also relative to KSA's regional neighbors (Jannadi, 2008; Alamsari et al., 2012).

All of this is to say that the present study did not take place in a vacuum, and to remind the reader that the focus of this project was not simply to evaluate the adequacy of safety systems and culture in the Saudi construction industry. Instead, it sought to build on an increasingly robust body of scholarship indicating that safety in this context is far from adequate, and to begin the work of developing tools that might be of use in remedying these shortcomings. Nonetheless, responding comprehensively to the first research question means, in part, stepping beyond the complex SEM results in order to consider an illustrative selection of survey response distributions on their own merits, having simply summarized them using descriptive statistics.

For instance, more than one in three respondents indicated that at their firms, unsafe working conditions were "never" promptly identified or improved, and an even larger proportion indicated that supervisors and managers never "confront and correct unsafe behaviours and hazards when they occur" (Q7). On no item relating to safety leadership did more than 4% of respondents select the most positive response ("Always", indicating that the leadership always exhibits the desirable safety behavior), and no fewer than 26% selected the most negative response ("Never") (Q8). With respect to Safety Performance (SP) and Hazard Management (HZ), the two negative Likert responses ("Never" and "Sometimes") combined, never outnumbered the two positive responses ("Always" and "Most of the time") combined, by less than a factor of five (Q9).

This trend in favour of negative response categories, with only tiny minorities of respondents selecting positively valenced response categories, was observed throughout virtually all response distributions in the survey data. In examining this fact, it is notable that the percentage of respondents selecting positively valenced categories was often smaller than the 7.7%, respondents who indicated they occupied leadership roles at their firms (either owner/CEO/President/Senior Management [VP], manager, or team lead/supervisor), indicating that even leadership acknowledges safety shortcomings. For instance, the *highest-rated* item in the OHS Planning (PL) section, which read "Your company has a prevention plan for dealing with OHS hazards and risks" was only positively endorsed by 2.8% of respondents (Q15).

Once again, for every other item in this section, the proportion of positive responses was lower than this figure. This section speaks directly to the responsibilities of organizational leaders to plan for basic OHS hazards and risks—and if even half of the respondents in leadership roles indicated that PL activities were taking place, and the remainder of the respondents were neutral or disagreed, the proportion of positive responses would be nearly double the figure observed in the actual data.

Even without the safety model that is the primary focus of this study, these individual item response distributions should raise serious red flags for the Saudi construction industry. This needs to be stressed because much of this study is highly technical. These patterns in the response distributions are not and can be easily understood by those without a background in safety management or statistics. They indicate widespread recognition among organizational stakeholders that safety practices are substandard and crucial activities are routinely ignored in a range of safety-relevant dimensions.

Let us re-examine some interesting features of the statistical results, therefore, in light of the concerning context provided by these primary and secondary research findings.

The first, and in some respects most important evidence that was found in support of the components of the proposed model, is that all correlations between individual variables were found to be significant in the course of the statistical analysis. As illustrated in the correlation analysis table in the preceding chapter, significant bivariate correlations were found to exist between all pairs of measured variables (LD, SP HZ, PO, PR, CR, CA, PL, TR, SC). With reference to the preceding paragraphs, however, it is worth noting that, while it is encourage that the model design used here is closely related to empirically validated models, is encouraging, these correlations are largely driven by the dominance of negative perceptions of safety dimensions in the survey data. This is to say that correlations exist between any pair of these variables in large part because response distributions are nearly universally skewed toward responses of negative valence. This does not render the correlations meaningless, but the reader should keep in mind that there are no prominent counterexamples where a safety dimension was viewed largely favorably by respondents.

Despite this remarkable consistency, when assessed in a complex model with multiple independent and dependent variables through a multiple regression-based SEM model, several relationships were not found to be significant: for example, neither Promotion, Hazard Management, nor Training were not found to have a significant impact on Safety Climate, for instance (H4, H7, H12). Similarly, Training, Control, Monitoring, & Review, and Safety Climate were all found to have no significant impact on Safety Performance (H8, H9, H14). The significance of these findings is somewhat more difficult to interpret, although at a broad level, several arguments are possible.

These arguments are discussed in more detail below in relation to the third research question, which is more directly concerned with the model itself. For the purposes of this subsection, however, it might be noted that these rejected hypotheses are useful insofar as they create some empirical basis for prioritizing certain safety-related activities above others. Alternatively, it would not be unreasonable to suggest that they serve as indicators that the model requires some refinement, needs to be tested against a larger and more diverse dataset, or (ideally) both.

Based on these results, many of the previously-identified relationships between structural, cultural, and logistical factors on the one hand, and safety outcomes on the other, appear to hold true in the context of the Saudi construction industry. This offers some cause for encouragement, because it suggests that existing models may be useful in efforts to improve the safety performance of Saudi construction firms. Despite this, however, there is no escaping the overarching conclusion that the current state of safety processes and practices in the Saudi construction industry—as exemplified by the primary data collected in the course of this study, as well as previous research on the topic—is profoundly inadequate. At best, safety processes and practices in this setting have significant room for improvement along virtually every dimension and activity category; at worst, they are routinely ignored to the point of willful negligence. Further study should certainly seek to reproduce these findings, but even given the small sample used in this study, the available evidence should be taken seriously by managers, executives, policymakers, and regulators alike.

8.2.2. Research question two

Research Question Two asked, "What measures can be implemented with a reasonable expectation of improving safety performance along the dimensions of safety management systems, climate, leadership, and hazards management?" One consequence of the dismal view of safety expressed by survey respondents is that this research question is actually quite easy to answer, and furthermore, that the conclusion is both straightforward and actionable. Namely, it would not be unreasonable, based on the evidence presented here, to suggest that the consistent adoption and implementation of virtually any safety measure, or any combination of safety measures, that have been outlined in the construction safety literature, would likely improve safety performance overall.

In other words, while safety management can be a complex and diverse topic, managers and policymakers working in the Saudi construction setting should avoid falling victim to analysis paralysis; our results suggest that safety performance is substandard along virtually every dimension measured, so these stakeholders should begin by seeking to implement whatever practices, measures, and protocols they feel are most accessible. Further study might be useful for impact maximization, refinement, or the prioritization of interventions, but should not be viewed as prerequisite for taking action. Simply investing in the implementation of straightforward safety-relevant activities like developing plans for dealing with emergency situations, implementing them, communicating them to workers, and perhaps even carrying out periodic drills to test plan efficacy would likely constitute a major step in the right direction for most firms, if our results can be generalized to the industry as a whole (*see* e.g. PL1-PL5). This is the most concrete, substantive, and actionable recommendation to be drawn from the present study.

Another extremely tentative possible recommendation would be to determine which safety outcome managers are most interested in improving (climate or performance), and then prioritize activities which were found to have a statistically significant relationship with that outcome in the SEM analysis. For example, if the goal is to improve safety performance, then interventions targeted at leadership, planning, or internal communication and awareness might be assigned a higher priority than training, safety climate, or control, monitoring, and review. Similarly, if the goal is to improve the safety climate but limited resources are available (and a comprehensive revision of the entire safety system is not feasible), then one might tentatively focus on leadership, planning, and policy, while leaving training, hazard management, and OHS promotion for later.

It should be emphasized that the empirical basis for this recommendation is highly questionable, and in fact, the author of this study would likely have refrained from even raising this possible application of its results at all under other circumstances. It is suggested here only because of the consistently low ratings assigned to safety practices across the board in the survey data, and in recognition of the fact that building safety processes, culture, and systems is a time- and resource-intensive process. Given the low standard of safety in the Saudi construction industry identified in this and other studies, it is unlikely that comprehensive safety overhauls targeting all the areas identified in either this model or other studies in the research literature will be undertaken in organizations that currently fall short of every safety dimension measured here. However, progress, in short, is likely to be incremental. Since implementing improved safety practices in any area is likely to improve safety given this low bar, then beginning with the relationships found to be most supported in the proposed safety model represents at least as useful a starting point as any other.

8.2.3. Research question three

Research Question Three asked, "How do we capture the factors affecting safety performance in the Saudi Arabian construction industry with maximum effectiveness using the proposed Safety Performance Model?"

Among the most notable and intriguing findings that emerged from the SEM analysis relates to the lack of a statistically significant impact of variables like HZ, TR, PR on SC, or of TR, CR, and SC on SP, when the model was evaluated as a whole (H4, H7-9, H12, H14). At an abstract, purely mechanical level, this is a product of the multiple regression analysis of the proposed model structure as a whole, with many variables interacting together. It is important to keep in mind that significant relationships existed between all these variables when examined in isolation. In the context of the model, however, the directionality of these relationships is sometimes opposed, such that the impact of one (or a group of) variable(s) can, as a whole or in part counter another variable.

As suggested above, one possible way to interpret these findings in relation to the third research question is by indicating that this might offer some preliminary basis for prioritizing improvement efforts. The rationale is simply that the multiple regression analysis of these interacting factors highlights only critical variables, while the other (partially-balanced) relationships are found to lack statistical significance when integrated into the multivariate model.

However, it is important to stress again that the validity of this strategy is largely contingent upon the validity and reliability of the model itself, which unquestionably requires further testing in this setting. After all, the notion that activities like control, monitoring, and review would have no impact on safety performance—whatever the moderating and mediating variables—runs counter to the bulk of the topical scholarly literature, common sense, and the results of individual variable pair correlation analysis. This does not mean that the model should be rejected, of course, nor does it suggest that the model it is not capable of providing valuable insights into how multiple variables interact simultaneously to produce safety outcomes. Indeed, the evidence overall suggests the model is likely to provide a useful starting point for future research—provided, of course, that practitioners do not interpret these results as indicating that it is not worth investing in training if one wishes to improve safety performance (for example).

In this regard, in order to better understand aggregate relationships within the model, it is worth briefly highlighting that the most prominent mediating variables impacting safety performance in the model are safety climate, OHS leadership, and hazard management; apart from these variables, only training and control, monitoring, and review exhibit direct, unmediated interactions with safety performance. Additionally, the connection between safety climate and hazard management is bidirectional. Thus, the lack of a significant relationship between hazard management and safety climate (H12) is not particularly concerning, partly because these two variable function primarily as parallel mediators of safety performance, and partly because the net relationship between safety climate and hazard management appears to have been forced below the threshold of significance by the reciprocal nature of their own relationship (e.g. the two directions of this relationship are in tension with one another). Eliminating this directionality by expressing this relationship in terms of an absolute value may show, as in the individual pair correlation analysis, a significant relationship between these two variables.

Similarly, the fact that TR and CR are the only two first-tier model variables exhibiting direct connections to SP—but both have unmediated and significant unidirectional impacts on the remainder of the first-tier variables (CA, PR, PO, and PL). Thus, while the direct effect of these two variables on safety performance may not meet the threshold for statistical significance, it is possible that their overall influence is largely mediated through the other first-tier variables. In this regard, a simple binary rejection of H8 and H9, while accurate, fails to convey potential indirect effects on safety performance transmitted through the other variables of the same tier and subsequently mediated by leadership and safety climate. It is precisely this kind of indirect, distributed effect that multiple regression analysis often filters out as it seeks to reveal the most critical—which is to say, singularly decisive—relationships in the model.

In addition to these considerations, it should be noted that variations in factor weights could plausibly have a substantive effect on the outcome of the SEM analysis and could reveal that significant relationships do exist where this study failed to identify them. This sort of refinement would not necessarily require a re-structuring of the basic relationships composing the model itself, and instead could simply emerge from research along the lines of the present study, but utilizing significantly larger samples and more comprehensive data. This is not to rule out the possibility that further study will indicate that a substantive restructuring of the model may be required, but rather to illustrate the range of possible modifications that might be made pending further study.

Overall, maximizing the effectiveness with which factors affecting safety performance in this context, will clearly require further research. These preliminary results generally show that the proposed model is functioning as intended, although several possible sources of uncertainty have been highlighted. One possibility that deserves serious consideration is that the model, the survey, or both are not sufficiently sensitive to data which so consistently skews toward negative extremes. The pervasive dominance of negative response in the survey data could complicate correlation analysis in ways that are difficult to identify without further study, for instance. It may be advisable to test this survey and model in comparable settings, but where perspectives on safety practices and performance are more varied, rather than where respondents exhibit a clear consensus around the idea that safety is suboptimal in virtually every regard.

8.3. Summary of Findings and Recommendations

The current state of safety processes and practices in the Saudi construction industry, as assessed in the course of the present study, leaves much to be desired. This relatively small-scale (n = 276) survey failed to identify a single dimension of the safety process, culture, or system that respondents generally rated as satisfactory. For reference, in the sample, more than 8 of 10 respondents had been working at their present company for at least one year and the sample included workers as well as employees in professional and leadership roles. While self-identified workers dominated the sample, on many items the proportion of respondents that expressed positive views of the safety landscape at their firms, was markedly smaller than the minority of respondents who self-identified as occupying leadership roles, indicating that decision-makers and other organizational stakeholders are critical of safety standards in this setting. This finding is consistent with previous research involving lax (and in some cases effectively non-existent) safety standards in the Saudi construction industry (Jannadi & Bu-Khamsin, 2002; Al-Hammad & Abdul-Mohsen, 1995; Arain, Low Sui, & Assaf, 2006; Alamsari, Chrisp, & Bowles, 2012; Moosa, 2015).

This finding had profound implications for the assessment of the second research question. If accurate, these data suggest that virtually any evidence-based measures implemented in this industry setting would be expected to improve safety performance along the dimensions of safety management systems, climate, leadership, and hazards management. The need for decision-makers, managers, and policymakers dealing with this industry to invest in substantive action to improve safety outcomes cannot be emphasized strongly enough. In hopes of increasing the probability that action is taken, it was suggested that organizational leadership may consider beginning by taking measures targeted at variables shown to have statistically significant impacts on safety performance and safety climate in the present analysis of the proposed model. These most critical variables include SP, LD, SC, PL, PO, CA, and CR; and SP, LD, HZ, PL, PO, PR, and CA for safety climate and safety performance, respectively. Once again, this does not mean that improvements targeting omitted variables are not expected to generate improvements. Ideally, organizations will target all dimensions of safety and seek a comprehensive overhaul of practices, systems, processes, and culture.

The proposed safety performance model enables a unique view of the relationships between various factors and determinants that accounts for the complex interactions between factor groups, with elements often evaluated sequentially as both dependent and independent variables. In some cases, bidirectional or multiply-mediated relationships balance out to reduce the overall impact of certain variables on targeted outcomes following multiple regression analysis. This does not mean that variables involved in relationships which failed to meet the threshold for statistical significance do not matter and should be ignored, particularly based on preliminary data like that reported here, and especially when this conclusion runs counter to individual pairwise correlation analyses and previous scholarly research such as (Swedler et al., 2015). Organizational leaders and policymakers are encouraged to take any and all steps to improve the safety situation in the Saudi construction industry. To help improving the safety performance and practice in the Saudi Arabian construction industry, the following recommendations were proposed:

- Establishing a supreme body of safety in Saudi Arabia which is responsible for governing all safety related activities.
- Stakeholders should begin by seeking to implement whatever practices, measures, and protocols they feel are most accessible;
- Investing in the implementation of straightforward safety-relevant activities like developing plans for dealing with emergency situations, implementing them, communicating them to workers, and perhaps even carrying out periodic drills to test plan efficacy would likely constitute a major step in the right direction for most firms; and
- Determining which safety outcome managers are most interested in improving (climate or performance), and then prioritize activities which were found to have a statistically significant relationship with that outcome in the SEM analysis.
- Establishing related safety laws and regulation for forcing construction companies to keep records of their accidents and injuries, in addition to addressing the injuries' responsibilities, so the country develops an effective reporting system.

8.4. Research Contribution

This study seeks to make a contribution to developing a practical, evidence-based solution to the problems posed by the growing frequency of accidents and injuries that occur on Saudi Arabian construction sites through the creation of an empirically-derived model of safety performance. The ineffectiveness of safety training, safety management systems, and lack of a healthy safety climate will most likely be ranked as the most pressing, definite challenges that face Saudi Arabia's construction industry today. However, this study's most significant contribution is expected to be its use of an industrial engineering perspective to synthesize secondary research and original findings to produce empirically-derived conceptual and mathematical models of safety performance in this context. In addition to providing a foundation for future research, it is possible that the model will lend itself to modification, allowing it to be adapted to other research contexts in which safety is a salient concern. Thus, it is hoped that this research will provide a basis for future research and developments in regards to the Kingdom's workplace safety, preventing devastating incidents. Future research that uses this study as its foundation may explore a variety of methods and designs through which safety management can be applied to the construction industry of Saudi Arabia. Furthermore, tolerance limits may be developed for a variety of strength parameters. As stated by Al-Saleh (1995), even a fraction of improvement in Saudi Arabian construction safety has the potential to save both millions of dollars and millions of innocent lives.

Ideally, this study can offer a starting point for future research exploring complex safety models with potential applicability to the Saudi construction context, and it adds another data point to the existing literature, indicating that managers and policymakers involved in this industry would be well advised to take its safety practices seriously—and urgently invest in steps to improve them.

At the end of the day, the safety of workers in the construction site workplace is one of the most critical concerns in the construction industry, raising ethical and logistical issues alike. It is now a challenge for the construction industry to create a culture that embraces a zero tolerance in regards to job injuries. One may hope that if this is achieved, the construction industry will mature into a safe, well-regulated workplace rather than one of Saudi Arabia's most dangerous sectors.

8.5. Limitations

Certain limitations may exist in this study that are related to threats of external and internal validity. The data that were collected might not large enough; as a result, it might decrease the external and internal validity of the study. Another limitation that was the use of items of high theoretical relevance. They might relate to a plethora of social contexts, and as a result must be examined and configured. The study was be based on quantitative research, which might require more careful consideration. While quantitative data can be consistent and precise, it might not explain complex issues. Further, while quantitative data is easy to analyze, its use may make it difficult to understand context. Finally, questionnaires were distributed with time constrains and in hot Summer.

8.6.Future Work

As indicated above, future researchers aiming to build on this study should begin by seeking to reproduce its results using larger and more diverse samples. It is possible that this may mean testing the model using sample populations drawn from beyond the Saudi construction industry, where safety standards are at least marginally higher and safety processes are more robust. This will allow the descriptive value of the model to be tested against data that do not reflect such a strong consensus view as was the case in this study. In this regard, it is worth emphasizing that the OLIP indicator framework, from which the survey used in this study was adapted, was designed for a very different context, where safety practices and expectations are substantially more advanced, culturally salient, and benefit from active institutional support.

The applicability of this tool, even adapted as was done in the course of the present project, to context apparently dominated by more ad hoc safety approaches is not obvious, and further study will be required to verify it—and potentially further adapt it to the accident-prone realities of the Saudi construction context. It is possible, though unlikely, that an entirely new measure will need to be developed. This possibility might be investigated using qualitative research and mixed-methods case study-based designs, for instance, which may be capable of tolerating nuance in a way that rigidly quantitative approaches like this one cannot—and in doing so, potentially elucidate an alternative paradigm at work in KSA.

Although this study collected self-report data regarding respondents' organizational roles, data were not segmented on this basis. Since different dimensions of safety are impacted in different ways by different stakeholders, future quantitative study along the lines described here might seek to attend more closely to data segmentation. This could elucidate divergences of opinion on safety based on role, and thus form the basis for more effective and targeted strategies aimed at improving safety policies, practices, and perceptions.

8.7. Conclusion

While this study has sought to contribute to more systematic approaches to safety management in the Saudi construction industry, it is also necessary to stress the fact that, in many respects, this study has added to a growing body of research indicating that safety systems, practices, culture, and performance are sorely lacking in this context. There is a way in which the statistical findings and suggested safety model are arguably less significant than the often-dismal views of safety practices and protocols expressed in the response distributions to the survey instrument. As indicated above, scholars certainly may be interested in detailed examinations of the statistical relationships underpinning the model described in this study, in theoretical comparative discussions regarding how cultural and institutional factors shape construction safety, and so forth.

It is vital, however, that construction and safety managers, as well as policymakers and regulators, resist the temptation to get bogged down in the complexities of this study and lose sight of the forest for the trees, so to speak. If they take nothing else from these results, these important stakeholder groups are urged to acknowledge that this study contains representative primary data adding to a growing number of previous studies which indicate that the Saudi construction industry is failing to meet safety expectations—and improvements appear to be badly needed.

REFERENCES/BIBLIOGRAPHY

Abdallah, H. (1995). Improving construction productivity in Saudi Arabia. In *Development of Technical and Industrial Base in Saudi Arabia*. Paper presented at the Fourth Saudi Engineering Conference: Jeddah, Saudi Arabia (173-178). Jeddah, Saudi Arabia.

Abdelhamid, T. S., & Everett, J. G. (2000). Identifying root causes of construction accidents. *Journal of Construction Engineering and Management*, *126*(1), 52–60.

Abowitz, D. A., & Toole, T. M. (2009). Mixed method research: Fundamental issues of design, validity, and reliability in construction research. *Journal of Construction Engineering and Management*, *136*(1), 108–116.

Akpan, E. (2011). Effective Safety and Health Management Policy for Improved Performance of Organizations in Africa. International Journal Of Business And Management, 6(3).

Al Omran, Ahmed. *Saudi arabia blames strong winds, safety standards failure for crane collapse.* Retrieved from http://www.wsj.com/articles/saudi-arabia-blames-strong-winds-safety-standards-failure-for-crane-collapse-1442333407.

Al-Amoudi, W. A., (1997). "Assessment of safety level in performing building maintenance work in Saudi Arabia," unpublished master's thesis, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.

Al-Darrab, I., Gulzar, W., & Ali, K. (2013). Status of implementation of safety, quality and environmental management systems in Saudi Arabian industries. *Total Quality Management & Business Excellence, 24(3–4), 336–354*.

Al-Hammad, & Abdul-Mohsen. (1995). Interface problems between owners and maintenance contractors in Saudi Arabia. *Journal of Performance of Constructed Facilities*, *9*(3), 194–204.

Al-Saleh, H. 1995. Improving construction productivity in Saudi Arabia. The 4th Saudi Engineering Conference, November 1995, Saudi Arabia.

Al-Utaibi, M. A., (1996). "The relationship between the project size and the safety level in building construction projects in Saudi Arabia," unpublished master's thesis, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.

Alasamri H; Chrisp M.T. and Bowles G (2012) *A framework for enhancing and improving the safety culture on Saudi construction sites.* In Smith, S.D (Ed) Procs 28th Annual ARCOM Conference, 3–5 September 2012, Edinburgh, UK, Association of Researchers in Construction Management, 475-485.

Alasamri H; Chrisp M.T., & Bowles G. (2012, September). A model for enhancing and improving the safety culture on Saudi construction sites. In S. Smith (Ed.). *Twenty-Eighth Annual Conference 2012.* Paper presented at 28th Annual ARCOM Conference: Edinburgh, Scotland (475-486). Reading, Berkshire.

Alasmari, H., (2010). “Safety management: A study of the application of safety management on construction sites, for large and small firms, in Saudi Arabia,” unpublished master’s thesis, School of Built Environment, Heriot-Watt University, United Kingdom.

Alshehri, M. A. (2012). *Using the UTAUT model to determine factors affecting acceptance and use of e-government services in the Kingdom of Saudi Arabia* (Doctoral dissertation). Retrieved from the Griffith University database.

Amick, B. C., & Saunders, R. (2013) Developing leading indicators of work injury and illness. Government of Canada Institute for Work & Health. Issue briefing. October 2013. <http://www.iwh.on.ca/system/files/documents/iwh_briefing_leading_indicators_2013.pdf>

Anderson, G.J & Arsenault, N. (1998). *Fundamentals of educational research*. London: Routledge.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, *103*(3), 411.

Arain, F. M., Low Sui., P & Assaf, S.A. (2006). Contractors’ views of the potential causes of inconsistencies between design and construction in Saudi Arabia. *Journal of Performance of Constructed Facilities*, *20*(1), 74–83.

Arbuckle, J.L. (1996). Full estimation in the presence of incomplete data. In G.A. Marcoulides & R. E. Schumacker [Eds.] Advanced structural equation modeling. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Arino, A. (2003) 'Measures of Strategic Alliance Performance: An Analysis of Construct Validity', Journal of International Business Studies 34(1): 66-79.

Assaf, S., Al-Khalil, M., & Al-Hazmi, M. (1995). Causes of delay in large building construction projects. *Journal of Management Engineering, 11*(2), 45–50.

Awang, Z. (2015). SEM made simple: a gentle approach to learning structural equation modeling. Selangor: MPWS Rich Publication

Bagozzi, R. P. and Y. Yi (2012). "Specification, evaluation, and interpretation of structural equation models." *Academy of Marketing Science Journal,* 40(1): 8-34.

Baig, M. M., (2001). "Safety assessment in industrial construction projects in Saudi Arabia," unpublished master's thesis, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.

Baker, F. B. (2004). *Item response theory: parameter estimation techniques.* New York: Marcel Dekker.

Bandalos, D. L., & Finney, S. J. (2010). Factor analysis: Exploratory and confirmatory. *The reviewer's guide to quantitative methods in the social sciences*, 93-114.

Bentler, P. M. and C.P. Chou (1987). "Practical Issues in Structural Modeling." Sociological Methods & Research 16(1): 78-117.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological bulletin*, *107*(2), 238.

Biggs, H. C., Dinsdag, D., Kirk, P. J., & Cipolla, D. (2010). Safety culture research, lead indicators, and the development of safety effectiveness indicators in the construction sector. *International Journal of Technology, Knowledge and Society*, *6*(3), 133–140.

Blair, E. (2003). Culture and leadership. *Professional Safety*, *48*(6), 18.

Blunch, N. (2008). *Introduction to structural equation modelling using SPSS and AMOS.* Sage Publications.

Bollen, K. A. (1989). A new incremental fit index for general structural equation models. *Sociological Methods & Research*, *17*(3), 303-316.

Bollen, K. A. (1989). *Structural equations with latent variables.* New York: John Wiley.

Brown, T.A. (2006). *Confirmatory factor analysis for applied research.* New York: Guilford Press.

Bubshait, A. A., & Al-Gobali, K. H. (1996). Contractor prequalification in Saudi Arabia. *Journal of Management in Engineering*, *12*(2), 50-54.

Burke, M. J., Sarpy, S. A., Smith-Crowe, K., Chan-Serafin, S., Salvador, R. O., & Islam, G. (2006). Relative effectiveness of worker safety and health training methods. *American Journal of Public Health*, *96*(2), 315–324.

Byrne, B. M. (2001). *Structural equation modelling with AMOS: basic concepts, applications, and programming.* Mahwah, NJ: Lawrence Erlbaum.

Byrne, B. M. (2006). *Structural equation utilization with EQS: Basic concepts, applications, and programming* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum

Byrne, B. M. (2012). Choosing Structural Equation Modeling Computer Software: Snapshots of LISREL, EQS, Amos, and Mplus. Handbook of Structural Equation Modeling. R. H. Hoyle, Guilford Publication: 307-324

Child, D. (1990). *The essentials of factor analysis* (2nd ed.). London: Cassel Educational Limited.

Chin, W. W., & Todd, P. A. (1995). On the use, usefulness, and ease of use of structural equation modelling in MIS research: A note of caution. *MIS Quarterly, 19*(2), 237–246.

Churchill, G.A. (1979). A paradigm for developing better measures of marketing constructs. Journal of Marketing Research, 16, 64-73

Choudhry, R. M., Fang, D., & Lingard, H. (2009). Measuring safety climate of a construction company. *Journal of Construction Engineering and Management*, *135*(9), 890–899.

Choudhry, R. M., Fang, D., & Mohamed, S. (2007b). The nature of safety culture: A survey of the state-of-the-art. *Safety Science*, *45*(10), 993–1012.

Christianson, M. K., Sutcliffe, K. M., Miller, M. A., & Iwashyna, T. J. (2011). Becoming a high reliability organization. *Critical Care*, *15*(6), 1.

Classen, D. C., & Metzger, J. (2003). Improving medication safety: the measurement conundrum and where to start. *International Journal for Quality in Health Care*, *15*(suppl 1), i41–i47.

Cochran, W. G. (1977). Sampling techniques (3rd ed.). New York: John Wiley & Sons

Cooper, D.C & Shindler, P. (2003). *Business research methods*. New York: McGraw-Hill.

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

Creswell, J. W. (2013). *Research Design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research.* London: Hochschule and Lichtenstein.

Darrab, I. A. Al-, Gulzar, W. A., & Ali, K. S. (2013). Status of Implementation of Safety, Quality and Environmental Management Systems in Saudi Arabian industries. *Total Quality Management & Business Excellence*, *24*(3–4), 336–354.
data analysis, 7th Ed., Pearson Education, London.

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

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

DeVellis, R.F. (1991). Scale Development: theory and applications (Applied Social Research Methods Series, Vol. 26). Newbury Park: Sage.

Dörnyei, Z., & Ushioda, E. (2013). *Teaching and researching: Motivation*. Routledge.

Dunn, J. & Charlton, C. (2015). *It was an act of God*. Retrieved from http://www.dailymail.co.uk/news/article-3232175/Pictures-devastating-aftermath-Mecca-crane-disaster-killed-people-world-s-largest-mosque.html.

Farrell, A. M. (2010). Insufficient discriminant validity: A comment on Bove, Pervan, Beatty, and Shiu (2009). *Journal of Business Research, 63*(3), 324-327

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science*, *34*(1), 177–192.

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of marketing research*, 382-388.

France, A. (2015). Mecca crane collapse: Saudi king sanctions Binladin group. The Guardian. Retrieved from http://www.theguardian.com/world/2015/sep/15/mecca-crane-collapse-saudi-arabia-king-sanctions-binladin-group

Gable, R. K. (1993). *Instrument development in the affective domain: Measuring attitudes and values in corporate and school settings* (2nd ed.). Boston, MA: Sage Publications.

Gallo, P. J., & Christensen, L. J. (2011). Firm size matters: An empirical investigation of organizational size and ownership on sustainability-related behaviours. *Business and Society*, 0007650311398784.

Gefen, D., & Straub, D. (2000). The relative importance of perceived ease of use in is adoption: A study of e-commerce adoption. *Journal of the Association for Information Systems, 1*(8), 1–28.

Geller, E. S. (2005). Behaviour-based safety and occupational risk management. Behaviour Modification, 29(3), 539–561.

Gherardi, S., Nicolini, D., & Odella, F. (1998). What do you mean by safety? Conflicting perspectives on accident causation and safety management in a construction firm. *Journal of Contingencies and Crisis Management*, *6*(4), 202–213.

Ginsburg, L. R., Chuang, Y. T., Blair Berta, W., Norton, P. G., Ng, P., Tregunno, D., & Richardson, J. (2010). The relationship between organizational leadership for safety and learning from patient safety events. *Health services research*, *45*(3), 607–632.

Goetsch, D. L. (2014). *Occupational safety and health for technologists, engineer, and managers* (Global Edition). White Plains, NY: Pearson.

Gorsuch, R. L. (1983). *Factor analysis* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Gorvett, Jon. (2008). Jeddah's building boom. *Middle East*, *390*, 40–41.

Grabowski, M., Ayyalasomayajula, P., Merrick, J., Harrald, J. R., & Roberts, K. (2007). Leading indicators of safety in virtual organizations. *Safety Science*, *45*(10), 1013–1043.

Graff, C. (2014). Mixed methods research. *Evidence based practice: An integrative approach to research, administration and practice*, 45–64.

Griffin, M. A., & Curcuruto, M. (2016). Safety climate in organizations. *Annual Review of Organizational Psychology and Organizational Behaviour*, *3*, 191–212.

Guldenmund, F. W. (2000). The nature of safety culture: a review of theory and research. *Safety Science*, *34*(1), 215–257.

Guldenmund, F. W. (2007). The use of questionnaires in safety culture research: An evaluation. *Safety Science*, *45*(6), 723–743.

Guldenmund, F. W. (2010). (Mis)understanding safety culture and its relationship to safety management. *Risk Analysis*, *30*(10). http://www.ilo.org/labadmin/info/pubs/WCMS_346714/lang--en/index.htm.

Hair Jr., J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010) Multivariate Data Analysis: A Global Perspective. 7th Edition, Pearson Education, Upper Saddle River.

Hair, J., Black, W., Babin, B., Anderson, R., & Tatham, R. (2006). *Multivariate date analysis* (6th ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Hallowell, M. R., Hinze, J. W., Baud, K. C., & Wehle, A. (2013). Proactive construction safety control: measuring, monitoring, and responding to safety leading indicators. *Journal of Construction Engineering and Management*,*139*(10), 04013010.

Hancock, G. R., Mueller, R. O., & Stapleton, L. M. (2010). *The reviewer's guide to quantitative methods in the social sciences*. Routledge

Henson, R. K. (2001). Understanding internal consistency reliability estimates: A conceptual primer on coefficient alpha. Measurement and Evaluation in Counseling and Development, 34(3), 177-189.

Hinze, J., Pedersen, C., & Fredley, J. (1998). Identifying root causes of construction injuries. *Journal of Construction Engineering and Management*, *124*(1), 67–71.

Hinton, A., Gatti, D. L., and Ackerman, S. H. (2004) *J. Biol. Chem.* **279,** 9016 –9022

Ho, J.K.L. and Zeta, K.C (2000).Cultural factors and their Significance to the Hong Kong Association of Occupational Health and Safety 1921 January 2000 , Hong Kong.

Hofmann, D. A., Jacobs, R., & Landy, F. (1995). High reliability process industries: Individual, micro, and macro organizational influences on safety performance. *Journal of Safety Research*, *26*(3), 131–149.

Hoyle, R. H. (1999). Statistical strategies for small sample research, Sage.

Hoyle, R. H. (2012). Handbook of Structural Equation Modeling, Guilford Publication.

Hoonakker, P., Loushine, T., Carayon, P., Kallman, J., Kapp, A., & Smith, M. J. (2005). The effect of safety initiatives on safety performance: A longitudinal study. *Applied Ergonomics*, *36*(4), 461–469.

Hooper, D., Coughlan, J., & Mullen, M. (2008). Evaluating model fit: a synthesis of the structural equation modelling literature. In *7th European Conference on research methodology for business and management studies* (pp. 195-200).

Hopkins, W. G. (2000). Quantitative research design. *Sports Science*, 4(1). Retrieved from http://www.sportsci.org/jour/0001/wghdesign.html

Hosseinian, S. S., & Torghabeh, Z. J. (2012). Major theories of construction accident causation models: A literature review. *International Journal of Advances in Engineering and Technology, 4*(2), 53–66.

Howe, K. R. (2012). Mixed methods, triangulation, and causal explanation. *Journal of Mixed Methods Research*, *6*(2), 89–96.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.

Iacobucci, D. (2010). "Structural equations modeling: Fit Indices, sample size, and advanced topics." Journal of Consumer Psychology 20(1): 90-98.

ILO (International Labour Organization). (2015). Safety and health at work. Retrieved October 18, 2015, from http://www.ilo.org/global/topics/safety-and-health-at-work/lang--en/

Ismail, F., Hashim, A.E., Ismail, R. and Majid, M.Z.A(2009)The operationalisation of safety culture for the Malaysian construction organizations, *Journal of Business and Management*, 4(9), 226237.

Jackson, D. L. (2003). "Revisiting Sample Size and Number of Parameter Estimates: Some Support for the N:q Hypothesis." Structural Equation Modeling: A Multidisciplinary Journal 10(1): 128-141.

Jannadi, M. O., & Al-Sudairi, A. (1995). Safety management in the construction industry in Saudi Arabia: Survey shows that level of company practice influences safety performance. *Building Research and Information*, *23*(1), 60–63.

Jannadi, M.O & Assaf, S. (1998). Safety assessment in the built environment of Saudi Arabia. *Safety Science*, *29*, 15–24.

Jannadi, O. A. (2008). Risks associated with trenching works in Saudi Arabia. *Building and Environment*, *43*(5), 776–781.

Jannadi, O. and Almishari, S. (2003). Risk assessment in construction. *Journal of Construction Engineering Management*, *129*(5), 492–500

Jannadi, O.,A., & Bu-Khamsin, M.S. (2002). Safety factors considered by industrial contractors in Saudi Arabia, *Building and Environment*, 37(5), 539–547

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, *33*(7), 14–26.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*,*1*(2), 112–33.

Jöreskog, K. G. (1967). A general approach to confirmatory maximum likelihood factor analysis. ETS Research Bulletin Series, 183-202

Kang, H., 2013, The prevention and handling of the missing data. The Korean Journal of Anesthesiology. 64(5): 402–406.

Karahalios, D. (2005). *An investigation of attitudes towards safety in the Ontario construction industry* (Master's thesis). Retrieved from University of Toronto. (5858974).

Katsakiori, Sakellaropoulos, G., & Manatakis, E. (2009). Towards an evaluation of accident investigation methods in terms of their alignment with accident causation models. *Safety Science*, *47*(7), 1007–1015.

Kim, J. O., & Mueller, C. W. (1978). *Introduction to Factor Analysis*. Beverly Hills: Sage Publications.

Kline, R. B. (2005). *Principles and practice of structural equation modelling* (2nd ed.). New York: Guildwood.

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guildwood.

Kontogiannis, T. (2010). A contemporary view of organizational safety: Variability and interactions of organizational processes. *Cognition, Technology & Work*, *12*(4), 231–249.

Kumar, R. (2011) Research Methodology: A Step-by-Step Guide for Beginners. 3rd Edition. Sage, New Delhi.

Lauver K.J., Trank C.Q. Safety and Organizational Design Factors: Decentralization and Alignment; *Journal of Business and Management* –, 18 (1) (2012)

Lenne, M., Mitsopoulos-Rubens, E., Rudin-Brown, C., Salmon, P., & Williamson, A. (2014). *Accident causation and analysis: Human factors methods and accident analysis.* Farmham, UK: Ashgate.

Leveson, N., Dulac, N., Marais, K., & Carroll, J. (2009). Moving beyond normal accidents and high reliability organizations: A systems approach to safety in complex systems. *Organization studies*, *30*(2-3), 227–249.

Levy, Y. (2006). Assessing the value of e-learning systems. Hershey, PA: Information Science Publishing.

Loehlin, J. C. (1987, 1992). Latent variable models: An introduction to factor, path, and structural analysis.. Hillsdale, NJ: Lawrence Erlbaum. Second edition 1992.

Lomax, R. G., & Schumacker, R. E. (2004). *A beginner's guide to structural equation modeling*. Psychology Press.

Lu, H., While, A. E., & Barriball, K. L. (2007). Job satisfaction and its related factors: a questionnaire survey of hospital nurses in Mainland China. International Journal of Nursing Studies, 44(4), 574-588.

Mahmoudi, S., Ghasemi, F., Mohammadfam, I., & Soleimani, E. (2014). Model for continuous assessment and improvement of occupational health and safety issues in construction companies. *Safety and Health at Work*, *5*(3), 125–130.

MacCallum, R. C. and J. T. Austin (2000). "Applications of structural equation modeling in psychological research." Annual Review of Psychology 51(1): 201.

Malhotra, N. K. (2004) *Marketing research: an applied orientation, 4th edition,* Prentice-Hall International, London.

Maurice, P., Lavoie, M., Laflamme, L., Svanstrm, L., Romer, C., & Anderson, R. (1998). Safety and safety promotion: definitions for operational developments. Injury Control And Safety Promotion, 8(4), 237-240

Measures in the OLIP survey (2014) Canada Institute for Work & Health. < http://www.iwh.on.ca/system/files/documents/olip_all_about_the_measures_august_9_2013.pdf>

Mitropoulos, P., & Cupido, G. (2009). Safety as an emergent property: Investigation into the work practices of high-reliability framing crews. *Journal of Construction Engineering and Management*, *135*(5), 407–415.

Mohamed, S (2002) Safety climate in construction site environments. *Journal of Construction Engineering and Management, 128*(5), 375–384.

Moosa, M. (2015). *Factors causing construction accidents*. In The 6th National Occupational Injury Research Symposium (NOIRS 2015). Kingwood, WV USA.

Moosa, M.; Oriet. L. (2016). Deaths, Accidents, and Injuries: Measuring Perceptions of Personal Safety in Saudi Arabia's Workplaces. In 29th WSO International EOSH Professional Development Symposium. Houston, TX USA.

Moosa, M.; Oriet, L. (2017). A Conceptual Framework to Measure Safety Performance in Construction Using Leading Indicators,. In 30th Annual WSO International Environmental & Occupational Safety & Health Professional Development Symposium. Las Vegas, NV USA

Moosa, M., Oriet, L. (2018). Factors Affecting Safety Performance in the Construction Industry: An Empirical Study Using Structural Equation Modeling (SEM). Manuscript submitted for publication in International Journal of Occupational Safety and Ergonomics (JOSE)

Morse, JM (1991) Approaches to qualitative-quantitative methodological triangulation. *Nursing research, 40*(1), 120–123

Netemeyer, R. G., Bearden, W. O., & Sharma, S. (2003). *Scaling Procedures: Issues and Applications.* Thousand Oaks, CA: Sage Publications.

Norman, G. (2010). Likert scales, levels of measurement and the “laws” of statistics. *Advances in Health Sciences Education*, *15*(5), 625–632.

Noweir, M. H., Alidrisi, M. M., Darrab, I. A. Al-, & Zytoon, M. A. (2013). occupational safety and health performance of the manufacturing sector in Jeddah Industrial Estate, Saudi Arabia: A 20-year follow-up study. *Safety Science*, *53*(Journal Article), 11–24.

Olen, K., Utne, I. B., & Herrera, I. A. (2011). Building safety indicators: Part 1–theoretical foundation. *Safety science*, *49*(2), 148–161.

Oztuna D, Elhan AH, Tuccar E. Investigation of four different normality tests in terms of type 1 error rate and power under different distributions. Turkish Journal of Medical Sciences. 2006;36(3):171–6.

Parker, D., Lawrie, M., & Hudson, P. (2006). A model for understanding the development of organizational safety culture. *Safety Science*, *44*(6), 551–562.

Payne, S. C., Bergman, M. E., Beus, J. M., Rodríguez, J. M., & Henning, J. B. (2009). Safety climate: Leading or lagging indicator of safety outcomes?.*Journal of Loss Prevention in the Process Industries*, *22*(6), 735–739.

Pillay, M. (2014). Progressing zero harm: a review of theory and applications for advancing health and safety management in construction. *Achieving Sustainable Construction Health and Safety*.

PRNewswire. (2014, December 14). Saudi Arabia construction industry: 10.98% CAGR Forecast to 2018. Retrieved October 18, 2015, from http://www.prnewswire.com/news-releases/saudi-arabia-construction-industry-1098-cagr-forecast-to-2018-285917141.html

Raouf, A. (2011). Theory of accident causes. In *Encyclopedia of Occupational Health and Safety* (Part VIII). Retrieved from http://www.iloencyclopaedia.org/part-viii-12633/accident-prevention/92-56-accident-prevention/theory-of-accident-causes

Reason, J. (1995). Understanding adverse events: Human factors. *Quality in health care*, *4*(2), 80–89.

Reason, J. (1998). Achieving a safe culture: Theory and practice. *Work & Stress*, *12*(3), 293–306.

Reason, J. (2000a). Safety paradoxes and safety culture. *Injury Control and Safety Promotion*, *7*(1), 3-14.

Reason, J. (2000b). Human error: Models and management. *Bmj*, *320*(7237), 768–770.

Reiman, T., & Pietikäinen, E. (2012). Leading indicators of system safety-monitoring and driving the organizational safety potential. *Safety Science*,*50*(10), 1993–2000.

Roberts, K. H. (1990). Some characteristics of one type of high reliability organization. *Organization Science*, *1*(2), 160–176.

Robins, R. W., Fraley, R. C., & Krueger, R. F. (Eds.). (2009). *Handbook of research methods in personality psychology*. Guilford Press.

Robins, R. W., Fraley, R. C., & Krueger, R. F. (Eds.). (2009). *Handbook of research methods in personality psychology*. Guilford Press.

Roscoe, J.T. 1975. Fundamental Research Statistics for the Behavioral Sciences. (2nd Ed.). New York: Holt, Rinehart and Winston.

Rouse, A. C., & Corbitt, B. (2008). *There's SEM and 'SEM': A Critique of The Use of PLS Regression in Information Systems Research.* Paper presented at the Australasian Conference in Information Systems (ACIS).

Rowlinson, S.M. (2004). *Construction Safety Management Systems*. New York: Taylor & Francis.

Rozenfeld, O., Sacks, R., Rosenfeld, Y., & Baum, H. (2010). Construction job safety analysis. *Safety Science*, *48*(4), 491–498.

Sale, J. E., Lohfeld, L. H., & Brazil, K. (2002). Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality and quantity*, *36*(1), 43–53.

Schwatka, N. V., Hecker, S., & Goldenhar, L. M. (2016). Defining and measuring safety climate: A review of the construction industry literature. *Annals of occupational hygiene*, *60*(5), 537–550.

Sekaran, U. (2003). Research methods for business: A skill-building approach (4th ed.). John Wiley & Sons, Inc.

Severin, C. (2014) "Leading organizational indicators survey." Government of Canada Institute for Work and Health. Ontario Leading Indicators Project.

Shannon, H. S., Robson, L. S., & Guastello, S. J. (1999). Methodological criteria for evaluating occupational safety intervention research. *Safety Science*, *31*(2), 161–179.

Singer, S. J., Gaba, D. M., Geppert, J. J., Sinaiko, A. D., Howard, S. K. S., & Park, K. C. (2003). The culture of safety: Results of an organization-wide survey in 15 California hospitals. *Quality and safety in health care*, *12*(2), 112–118.

Sposito, V. A., Hand, M. L., & Skarpness, B. (1983). On the efficiency of using the sample kurtosis in selecting optimal lpestimators. Communications in Statistics-simulation and Computation, 12(3), 265-272

Stevens, J. (2002). *Applied multivariate statistics for the social sciences* (4th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Straub, D., Boudreau, M.-C., and Gefen, D. Validation guidelines for IS positivist research, *The Communications of the Association for Information Systems* (13:1) 2004, pp 380-427.

Sutcliffe, K. M. (2011). High reliability organizations (HROs). *Best Practice & Research Clinical Anaesthesiology*, *25*(2), 133–144.

Sydenstricker-Neto, J. (1997). *Research design and mixed-method approach: A hands-on experience.*

Swedler DI, Verma SK, Huang YH, Lombardi DA, Chang WR, Brennan M, Courtney TK. A structural equation modelling approach examining the pathways between safety climate, behaviour performance and workplace slipping. Occup Environ Med. 2015 Jul; 72(7):476-81

Tabachnick, B. G. and L. S. Fidell (2013). Using multivariate statistics (6th Edition). Boston, MA, Allyn and Bacon.

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

Tight, M., & Huisman, J. (2015). *Theory and method in higher education research*. Emerald Group Publishing.

Turocy, P. S. (2002). Survey research in athletic training: The scientific method of development and implementation. *Journal of Athletic Training*, 37(4S), 174–179.

Van Dongen, T. W. (2011). Break it down: An alternative approach to measuring effectiveness in counterterrorism. *Journal of Applied Security Research*, *6*(3), 357–371.

Vavra, T. G. (1997). *Improving your measurement of customer satisfaction: A guide to creating, conducting, analyzing, and reporting customer satisfaction measurement programs*. ASQ quality press.

Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS quarterly*, *37*(1), 21–54.

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), 2082-2093.

Wan, T. T. H. (2002). Evidence-Based Health Care Management: Multivariate Modeling Approaches. Boston, MA: Kluwer Academic Publishers.

Wang, J., & Wang, X. (2012). *Structural equation modeling: Applications using Mplus*. John Wiley & Sons.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2008). Organizing for high reliability: Processes of collective mindfulness. *Crisis management*, *3*(1), 81–123.

Weitzner, M. A., Meyers, C. A., Steinbrueker, S., Saleeba, A. K., & Sandifer, S. D. (1997). Developing a care giver quality-of-life instrument: Preliminary steps. *Cancer Practice*, *5*(1), 25–31.

Zohar, D. (2003). Safety climate: Conceptual and measurement issues. *Handbook Of Occupational Health Psychology.* Washington, DC: American Psychological Association, xvii, pp. 123–142.

Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis and Prevention*, *42*(5), 1517–1522.

Zou, P. X., Sunindijo, R. Y., & Dainty, A. R. (2014). A mixed methods research design for bridging the gap between research and practice in construction safety. *Safety science*, *70*, 316–326.

APPENDICES

Appendix A: Frequency Tables

LD1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	101	36.6	36.6	36.6
	Sometimes (25%)	130	47.1	47.1	83.7
	Half of the time (50%)	19	6.9	6.9	90.6
	Most of the time (75%)	19	6.9	6.9	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

LD2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	73	26.4	26.4	26.4
	Sometimes (25%)	156	56.5	56.5	83.0
	Half of the time (50%)	19	6.9	6.9	89.9
	Most of the time (75%)	19	6.9	6.9	96.7
	Always (100%)	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

LD3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	93	33.7	33.7	33.7
	Sometimes (25%)	138	50.0	50.0	83.7
	Half of the time (50%)	24	8.7	8.7	92.4
	Most of the time (75%)	14	5.1	5.1	97.5
	Always (100%)	7	2.5	2.5	100.0

	Total	276	100.0	100.0	

LD4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	99	35.9	35.9	35.9
	Sometimes (25%)	134	48.6	48.6	84.4
	Half of the time (50%)	23	8.3	8.3	92.8
	Most of the time (75%)	9	3.3	3.3	96.0
	Always (100%)	11	4.0	4.0	100.0
	Total	276	100.0	100.0	

LD5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	127	46.0	46.0	46.0
	Sometimes (25%)	107	38.8	38.8	84.8
	Half of the time (50%)	20	7.2	7.2	92.0
	Most of the time (75%)	17	6.2	6.2	98.2
	Always (100%)	5	1.8	1.8	100.0
	Total	276	100.0	100.0	

LD6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	117	42.4	42.4	42.4
	Sometimes (25%)	109	39.5	39.5	81.9
	Half of the time (50%)	25	9.1	9.1	90.9
	Most of the time (75%)	18	6.5	6.5	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

SP1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	116	42.0	42.0	42.0
	Sometimes (25%)	117	42.4	42.4	84.4
	Half of the time (50%)	23	8.3	8.3	92.8
	Most of the time (75%)	13	4.7	4.7	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

SP2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	70	25.4	25.4	25.4
	Sometimes (25%)	145	52.5	52.5	77.9
	Half of the time (50%)	31	11.2	11.2	89.1
	Most of the time (75%)	21	7.6	7.6	96.7
	Always (100%)	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

SP3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	100	36.2	36.2	36.2
	Sometimes (25%)	119	43.1	43.1	79.3
	Half of the time (50%)	28	10.1	10.1	89.5
	Most of the time (75%)	17	6.2	6.2	95.7
	Always (100%)	12	4.3	4.3	100.0
	Total	276	100.0	100.0	

SP4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	115	41.7	41.7	41.7
	Sometimes (25%)	115	41.7	41.7	83.3
	Half of the time (50%)	23	8.3	8.3	91.7
	Most of the time (75%)	16	5.8	5.8	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

SP5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	109	39.5	39.5	39.5
	Sometimes (25%)	116	42.0	42.0	81.5
	Half of the time (50%)	30	10.9	10.9	92.4
	Most of the time (75%)	14	5.1	5.1	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

SP6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	110	39.9	39.9	39.9
	Sometimes (25%)	115	41.7	41.7	81.5
	Half of the time (50%)	30	10.9	10.9	92.4
	Most of the time (75%)	13	4.7	4.7	97.1
	Always (100%)	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

SP7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	97	35.1	35.1	35.1
	Sometimes (25%)	112	40.6	40.6	75.7
	Half of the time (50%)	39	14.1	14.1	89.9
	Most of the time (75%)	19	6.9	6.9	96.7
	Always (100%)	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

HZ1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	107	38.8	38.8	38.8
	Sometimes (25%)	118	42.8	42.8	81.5
	Half of the time (50%)	31	11.2	11.2	92.8
	Most of the time (75%)	9	3.3	3.3	96.0
	Always (100%)	11	4.0	4.0	100.0
	Total	276	100.0	100.0	

HZ2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	77	27.9	27.9	27.9
	Sometimes (25%)	152	55.1	55.1	83.0
	Half of the time (50%)	24	8.7	8.7	91.7
	Most of the time (75%)	16	5.8	5.8	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

HZ3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	70	25.4	25.4	25.4
	Sometimes (25%)	149	54.0	54.0	79.3
	Half of the time (50%)	31	11.2	11.2	90.6
	Most of the time (75%)	17	6.2	6.2	96.7
	Always (100%)	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

HZ4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	85	30.8	30.8	30.8
	Sometimes (25%)	118	42.8	42.8	73.6
	Half of the time (50%)	43	15.6	15.6	89.1
	Most of the time (75%)	23	8.3	8.3	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

HZ5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	107	38.8	38.8	38.8
	Sometimes (25%)	121	43.8	43.8	82.6
	Half of the time (50%)	30	10.9	10.9	93.5
	Most of the time (75%)	11	4.0	4.0	97.5
	Always (100%)	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

HZ6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never (0%)	104	37.7	37.7	37.7
	Sometimes (25%)	125	45.3	45.3	83.0
	Half of the time (50%)	27	9.8	9.8	92.8
	Most of the time (75%)	15	5.4	5.4	98.2
	Always (100%)	5	1.8	1.8	100.0
	Total	276	100.0	100.0	

PO1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	105	38.0	38.0	38.0
	Disagree	109	39.5	39.5	77.5
	Neutral	31	11.2	11.2	88.8
	Agree	20	7.2	7.2	96.0
	Strongly Agree	11	4.0	4.0	100.0
	Total	276	100.0	100.0	

PO2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	75	27.2	27.2	27.2
	Disagree	139	50.4	50.4	77.5
	Neutral	31	11.2	11.2	88.8
	Agree	20	7.2	7.2	96.0
	Strongly Agree	11	4.0	4.0	100.0
	Total	276	100.0	100.0	

PO3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	113	40.9	40.9	40.9
	Disagree	109	39.5	39.5	80.4
	Neutral	28	10.1	10.1	90.6
	Agree	17	6.2	6.2	96.7
	Strongly Agree	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

PR1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	114	41.3	41.3	41.3
	Disagree	114	41.3	41.3	82.6
	Neutral	29	10.5	10.5	93.1
	Agree	11	4.0	4.0	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

PR2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	85	30.8	30.8	30.8
	Disagree	134	48.6	48.6	79.3
	Neutral	30	10.9	10.9	90.2
	Agree	19	6.9	6.9	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

PR3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	102	37.0	37.0	37.0
	Disagree	120	43.5	43.5	80.4
	Neutral	29	10.5	10.5	90.9
	Agree	17	6.2	6.2	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

PR4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	119	43.1	43.1	43.1
	Disagree	103	37.3	37.3	80.4
	Neutral	30	10.9	10.9	91.3
	Agree	17	6.2	6.2	97.5
	Strongly Agree	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

TR1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	109	39.5	39.5	39.5
	Disagree	103	37.3	37.3	76.8
	Neutral	35	12.7	12.7	89.5
	Agree	21	7.6	7.6	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

TR2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	70	25.4	25.4	25.4
	Disagree	158	57.2	57.2	82.6
	Neutral	25	9.1	9.1	91.7
	Agree	14	5.1	5.1	96.7
	Strongly Agree	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

TR3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	86	31.2	31.2	31.2
	Disagree	138	50.0	50.0	81.2
	Neutral	33	12.0	12.0	93.1
	Agree	13	4.7	4.7	97.8
	Strongly Agree	6	2.2	2.2	100.0
	Total	276	100.0	100.0	

TR4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	107	38.8	38.8	38.8
	Disagree	111	40.2	40.2	79.0
	Neutral	35	12.7	12.7	91.7
	Agree	14	5.1	5.1	96.7
	Strongly Agree	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

TR5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	121	43.8	43.8	43.8
	Disagree	90	32.6	32.6	76.4
	Neutral	35	12.7	12.7	89.1
	Agree	21	7.6	7.6	96.7
	Strongly Agree	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

CA1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	106	38.4	38.4	38.4
	Disagree	107	38.8	38.8	77.2
	Neutral	34	12.3	12.3	89.5
	Agree	19	6.9	6.9	96.4
	Strongly Agree	10	3.6	3.6	100.0
	Total	276	100.0	100.0	

CA2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	80	29.0	29.0	29.0
	Disagree	139	50.4	50.4	79.3
	Neutral	28	10.1	10.1	89.5
	Agree	21	7.6	7.6	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

CA3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	119	43.1	43.1	43.1
	Disagree	104	37.7	37.7	80.8
	Neutral	29	10.5	10.5	91.3
	Agree	16	5.8	5.8	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

PL1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	104	37.7	37.7	37.7
	Disagree	105	38.0	38.0	75.7
	Neutral	37	13.4	13.4	89.1
	Agree	23	8.3	8.3	97.5
	Strongly Agree	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

PL2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	75	27.2	27.2	27.2
	Disagree	141	51.1	51.1	78.3
	Neutral	38	13.8	13.8	92.0
	Agree	15	5.4	5.4	97.5
	Strongly Agree	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

PL3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	101	36.6	36.6	36.6
	Disagree	120	43.5	43.5	80.1
	Neutral	30	10.9	10.9	90.9
	Agree	16	5.8	5.8	96.7
	Strongly Agree	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

PL4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	85	30.8	30.8	30.8
	Disagree	116	42.0	42.0	72.8
	Neutral	35	12.7	12.7	85.5
	Agree	27	9.8	9.8	95.3
	Strongly Agree	13	4.7	4.7	100.0
	Total	276	100.0	100.0	

PL5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	118	42.8	42.8	42.8
	Disagree	111	40.2	40.2	83.0
	Neutral	28	10.1	10.1	93.1
	Agree	13	4.7	4.7	97.8
	Strongly Agree	6	2.2	2.2	100.0
	Total	276	100.0	100.0	

CR1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	95	34.4	34.4	34.4
	Disagree	125	45.3	45.3	79.7
	Neutral	33	12.0	12.0	91.7
	Agree	15	5.4	5.4	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

CR2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	56	20.3	20.3	20.3
	Disagree	159	57.6	57.6	77.9
	Neutral	31	11.2	11.2	89.1
	Agree	24	8.7	8.7	97.8
	Strongly Agree	6	2.2	2.2	100.0
	Total	276	100.0	100.0	

CR3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	95	34.4	34.4	34.4
	Disagree	135	48.9	48.9	83.3
	Neutral	24	8.7	8.7	92.0
	Agree	14	5.1	5.1	97.1
	Strongly Agree	8	2.9	2.9	100.0
	Total	276	100.0	100.0	

CR4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	100	36.2	36.2	36.2
	Disagree	119	43.1	43.1	79.3
	Neutral	31	11.2	11.2	90.6
	Agree	17	6.2	6.2	96.7
	Strongly Agree	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

CR5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	113	40.9	40.9	40.9
	Disagree	103	37.3	37.3	78.3
	Neutral	41	14.9	14.9	93.1
	Agree	13	4.7	4.7	97.8
	Strongly Agree	6	2.2	2.2	100.0
	Total	276	100.0	100.0	

SC1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	90	32.6	32.6	32.6
	Disagree	115	41.7	41.7	74.3
	Neutral	30	10.9	10.9	85.1
	Agree	31	11.2	11.2	96.4
	Strongly Agree	10	3.6	3.6	100.0
	Total	276	100.0	100.0	

SC2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	65	23.6	23.6	23.6
	Disagree	156	56.5	56.5	80.1
	Neutral	30	10.9	10.9	90.9
	Agree	18	6.5	6.5	97.5
	Strongly Agree	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

SC3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	73	26.4	26.4	26.4
	Disagree	155	56.2	56.2	82.6
	Neutral	24	8.7	8.7	91.3
	Agree	15	5.4	5.4	96.7
	Strongly Agree	9	3.3	3.3	100.0
	Total	276	100.0	100.0	

SC4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	106	38.4	38.4	38.4
	Disagree	118	42.8	42.8	81.2
	Neutral	31	11.2	11.2	92.4
	Agree	14	5.1	5.1	97.5
	Strongly Agree	7	2.5	2.5	100.0
	Total	276	100.0	100.0	

SC5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	110	39.9	39.9	39.9
	Disagree	102	37.0	37.0	76.8
	Neutral	40	14.5	14.5	91.3
	Agree	13	4.7	4.7	96.0
	Strongly Agree	11	4.0	4.0	100.0
	Total	276	100.0	100.0	

SC6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	79	28.6	28.6	28.6
	Disagree	109	39.5	39.5	68.1
	Neutral	37	13.4	13.4	81.5
	Agree	35	12.7	12.7	94.2
	Strongly Agree	16	5.8	5.8	100.0
	Total	276	100.0	100.0	

Appendix B: Consent Form

University of Windsor

CONSENT TO PARTICIPATE IN RESEARCH
Development of a Model for Determining Factors Affecting Safety Performance in the Construction Industry Using Structural Equation Modelling (SEM)

You are asked to participate in a research study conducted by Majed Moosa from the College of Engineering at the University of Windsor in Canada. The study's results will contribute to a dissertation. If you have any questions or concerns about the research, please feel free to contact Majed Moosa.

The study aims to decrease the number of workplace deaths and injuries in Saudi Arabia's construction industry by contributing to a growing body of research on Saudi Arabia's safety performance. It will collect quantitative data and use it to create a dynamic systems model that will foster an understanding of the various factors that affect safety performance in Saudi Arabia's construction industry. The model will support the growing need for increased workplace safety on Saudi Arabian construction sites while making a unique and topical contribution to scholarly safety performance literature.

If you volunteer to participate in the study, you will be asked to fill out a questionnaire based on the Ontario Leading Indicators Project (OLIP) used by the Institute of Work and Health in Ontario. The questionnaire will have 73 short questions, all related to the safety performance, climate, and culture at your workplace. "Safety climate" refers to what you and your coworkers think of the way the company you work for approaches safety. "Safety culture" refers to the attitudes, beliefs, and perceptions that you and your coworkers have towards workplace safety. The questions will require both short answer and selected responses. The selected responses will ask you to rate how often safety activities or attitudes occur by using a five-point scale from "never," or 0, to "always," or 5.

This survey will be distributed by email, social media and personal visits to over 50 organizations within the Saudi Arabian construction industry. The names and addresses of these organizations will be randomly selected. You have the option of receiving and completing the study in either Arabic or English, and will only need to complete the questionnaire once. Completing the survey will take between 15 and 20 minutes. The questionnaire may be filled out either online, if received through email or social media, or on a tablet, if received by personal visits, wherever you see fit. You will have 30 days to complete the survey. You will not be required to complete any additional questionnaires if you choose not to participate. You will be automatically removed from the study by selecting "no" to the first survey question.

You may feel uncomfortable disclosing information about your workplace, as you may worry that the information you share will jeopardize your standing at your job. However, participation in the study is strictly anonymous. Any identifying information you provide will be confidential. Moreover, the survey may be completed at a location of your choice, so you may complete it when you are alone and in an area where you feel comfortable.

While English is the primary technical language used in Saudi Arabia, you may be worried about language barriers. The questionnaire is available in both English and Arabic, the two most common languages in Saudi Arabia, so you may choose the language that is most comfortable for you.

If you experience pain when sitting or writing for long periods of time, you may be concerned about completing the survey all at once. The survey may be completed at your own pace. There are no significant physical or psychological risks that may cause the researcher to terminate the study.

Saudi Arabia's construction industry is one of the most dangerous industries in the world in regards to workplace health and safety. This study's data and the dissertation will be published and will support and advocate for increased safety measures and decreased construction injuries and deaths in your country of work.

The study is designed to address the considerable need for improved safety practices through a combination of quantitative data collected through the study's survey and mathematical modelling. The survey's data will be used to create a dynamic systems model of safety performance tailored specifically to the Saudi Arabian context. The dissertation will support and advocate for increased safety measures and a positive safety culture and climate in Saudi Arabia's construction industry.

You will not receive payment of any kind for your involvement in the study. Participation in the study is anonymous. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. The results of this study will be published in a dissertation. It will only report findings, which in some instances may be illustrated by short, anonymous quotes carefully selected so as not to breach individual confidentiality. Your questionnaire will be retained until the study has been completed and the data has been summarized and analyzed. Prior to study completion, all of the data will be stored securely under lock and key. After completion of the study, all of the data will be destroyed.

Although it will be most helpful if you answer all questions as honestly as possible, do not feel obliged to answer any material that you find objectionable or that makes you feel uncomfortable. Your identity will not be recorded and therefore your anonymity will be protected. To help us ensure confidentiality, please do not put your name on any response.

You may withdraw from the study at any time without consequence. If you withdraw prior to completing and submitting the survey all data you entered will be permanently removed. There will be no adverse consequence of choosing not to participate in the study. The investigator may withdraw you from the study only if circumstances arise which warrant doing so.

The study's findings will be available to participants in the form of a dissertation that will be published by the University of Windsor upon its completion. The study's data may also be used in subsequent studies, publications, and presentations. Should you be interested in learning about the dissertation, the study's findings, or subsequent publications, or if you have any questions or concerns about the research, please contact Majed Moosa.

If you have questions regarding your rights as a research participant, please contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca.

These are the terms under which I will conduct research.

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I understand the information provided for the study Development of a Model for Determining Factors Affecting Safety Performance in the Construction Industry Using Structural Equation Modelling as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

These are the terms under which I will conduct research.

_______________________________________   _____________________

Signature of Investigator

VITA AUCTORIS

Majed Moosa was born 1982 in Jazan, Saudi Arabia. Mr. Moosa is a Ph.D. candidate in Industrial Manufacturing Systems Engineering at the University of Windsor in Canada and is expected to graduate in Fall 2018. He obtained a Master's degree in Engineering Project Management from the University of Melbourne in Australia in 2011 and a Bachelor of Science degree in Mechanical Engineering from King Abdul-Aziz University in Saudi Arabia in 2007. He has worked as a technical manager for a logistics company, and then as a university lecturer in Saudi Arabia.