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Assessing Safety Culture among Personnel in Governmental Construction Sites at Saudi Arabia: A Quantitative Study Approach

Omar Alrehaili
University of Central Florida

ASSESSING SAFETY CULTURE AMONG PERSONNEL IN GOVERNMENTAL CONSTRUCTION SITES AT SAUDI ARABIA: A QUANTITATIVE STUDY APPROACH

by

OMAR ALREHAILI
B.S. Industrial Engineering, King Abdulaziz University, Saudi Arabia, 2010
M.S. Industrial Engineering, University of South Florida, 2014

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Major Professor: Waldemar Karwowski

ABSTRACT

Safety is an essential issue for organizations to survive, especially for hazardous industries such as the construction industry. The construction industry is considered to be one of the major industries that help in the growth of the economy and the infrastructure of all countries. Recently, scholars have paid increasing attention to the concept of safety culture due to its role in decreasing the occurrences of accidents and injuries. Safety culture has become the focus of all industries and has received much attention in recent years, especially within the construction industry. Absence of this culture is a major cause of injuries and accidents in the construction field.

In the construction industry, personnel's perception of safety culture is vital to prevent accidents or behavior misconduct. Also, focusing on personnel's safety culture on construction sites provides an opportunity to decrease risks and unsafe behaviors to improve the overall safety level. Workers' performance and behaviors are shaped by their awareness and view of safety culture inside their work environment. Generally, safety performance in the construction field is still unsatisfactory based on reporting records.

The present study observed the influence of safety culture on construction's personnel's safety performance on large governmental construction projects in Saudi Arabia. Construction personnel's safety performance is measured by their attitude toward violations and error behaviors. This research also exams the role of personnel's motivation toward construction safety as a mediating variable between construction safety culture and safety performance constructs, including error and violation behaviors.

The research adopted a quantitative method by using a questionnaire for the purpose of data collection and analysis. A total of 434 questionnaires were collected from construction personnel including project managers, engineers, and supervisors through their voluntary participation in this study. Statistical analysis was used to analyze the data collected including descriptive statistics, confirmatory factor analysis (CFA) and structural equation modeling (SEM) techniques. Confirmatory factor analysis is used for validating each factor with its measurable items. Finally, this study applied the concept of structural equation modeling (SEM) to evaluate the correlation between all latent variables in the study's conceptualized model.

The outcomes of the study show that safety culture has a direct influence on construction personnel's attitudes toward violations and an indirect effect on construction personnel's error behavior. Furthermore, safety culture has a significant effect on improving safety motivation, as well. Safety motivation for construction safety has a direct effect on errors behaviors. Conversely, safety motivation does not have a mediating effect on construction personnel's attitudes toward violations. Therefore, safety motivation's mediating role was significant only between safety culture and errors behaviors.

This research has added to the existing knowledge about the important part of safety culture as a key interpreter of safety performance in construction field. The current study contributes to psychological safety through examining the influence of safety culture as the interpreter for enhancing motivation for construction safety. Additionally, this research evaluated safety culture's influence on construction personnel's attitudes toward violations and construction personnel's error behavior. The outcomes of the study are useful and recommended to be used by construction management to better pinpoint the reasons for unsafe behaviors within the construction industry. The results of this research highlights management's role in determining, and affecting, workers' behaviors.

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LIST OF ABBREVIATION/ ACRONYMS

ACSNI: Advisory Committee on the Safety of Nuclear Installations

ASA: Attraction Selection Attrition

BBS: Behavioral Based System

CFA: Confirmatory Factor Analysis

C.R: Critical Ratio

EFA: Explanatory Factor Analysis

GOSI: General Organization of Social Insurance

HSC: Health and Safety Commission

IAEA: International Automatic Energy Agency

OSHA: Occupational Safety and Health Administration

P: Probability

SCI: Safety Culture Interaction

S.E: Standard Error

SEM: Structural Equation Modeling

SMS: Safety Management System

TPB: Theory of Planned Behavior

CHAPTER 1: INTRODUCTION

1.1 Background

Construction industry is considered to be one of the large businesses , which helps in the growth of the economy and the infrastructure of all countries. The construction sector provides the essential facilities people need and use as basic daily necessities by building roads, bridges, airports, as well as residential buildings. The safety performance in the construction fields is still unsatisfactory based on the reporting records. Alasmari et al. (2012) did a study to compare safety performance level among several countries including, the Unites States of America, the United Kingdom, Australia, the United Arab Emirates, Kuwait, Bahrain, Jordan, and Saudi Arabia.

The study concluded that the highest numbers of injuries and deaths occurred in Saudi Arabia with 3,117 per 100,000 workers for injuries and 28 deaths per 100,000 workers in 2008. In the view of the present safety status in Saudi Arabia, the General Organization of Social Insurance (GOSI) (2014) reported that construction field was accounted for 50% of the total work injuries and deaths accidents occurred in all other fields of work. Thus, safety performance investigation research is needed because it will help to improve the safety performance in such high accident risk fields, like construction sites.

It has been found in the literature that measuring safety performance can be performed using either proactive measures described as leading indicators or reactive measures described as lagging indicators. Various prominent scholars support the use of proactive indicators like safety culture investigation rather than focusing on reactive measures, like number of accidents or injuries occurred (Choudhry et al., 2007;Mohamed, 2002;Cooper and Phillips, 2004).

The lack of safety culture is the main cause of injuries and accidents in workplaces especially in high-risk industries like construction sites (Choudhry et al., 2007; Cooper, 2000). In recent years, scholars express an increasing attention to the concept of safety culture due to its crucial role associated with the reduction of accidents and deaths on construction sites (Choudhry et al., 2007; Cooper, 2000). Safety culture is inversely correlated with accidents and injury occurrences in extraordinary hazardous fields, including construction sites.

Safety culture as a term is left flexible for openness and discussion to encompass the cultures dynamic and changing nature. However, in the literature, there is a lack of guidance on how safety culture can be evaluated and measured effectively (Choudhry et al., 2007). There is an urgent need for management support for safety issues to foster safety culture and accountability in order to let the workers become fully informed about safety procedures and the importance of adherence to safety rules. Safety culture is considered to be associated with generating safe work environment (Ismail et al., 2012). Therefore, measuring safety culture among construction personnel is crucially needed to investigate the safety performance in this high-risk environment.

1.2 Statement of the Problem

Safety culture becomes the focus of all industries and received much attention in the recent years, especially in the constructions industry. Choudhry et al. (2007) stress that safety culture is considered to be the main factor that influences employee's attitudes and behaviors in respect to an organizations ongoing safety performance. Safety culture as a concept is intrinsically linked to organizational culture and thus has attracted a wide range of industries (Choudhry et al., 2007). Although the safety culture term has been extensively used for many years, the concept is still not fully clear in the literature (Guldenmund, 2000).

Assessing safety culture in the construction sites is a crucial stage to identify improvement opportunities for safety performance in which, ultimately, it will enhance an organization's future success. There is as a substantial need to understand how safety culture influences construction personnel's safety performance, including their safety behaviors, with the goal in mind to reduce hazards and ensure safe operations.

Construction sites are considered one of the high risk working environments. Effort needs to be spent to effectively manage safety performance of the workers who are doing complex and hazardous work. Investigating safety culture as a major predictor of safety performance will enhance the knowledge of construction safety management and health. Safety culture has been confirmed to foster risk management and mitigation strategies based on increasing the commitment and knowledge of safety in the organization, which leads to better readiness to possible dangerous situations (Pidgeon, 1998). Accident prevention is believed to be affected by the positive safety culture (Choudhry et al., 2009; Cooper, 2000). Developing and keeping to a positive safety culture can be an effective tool for improving overall safety within an organization (Vecchio-Sudus and Griffiths, 2004).

Saudi Arabia has the largest construction industry in the gulf region (US-SABC, 2011). The growth in construction sector is dramatically increasing due to the huge demand for different type of construction projects including industrial, commercial and residential buildings (Venture Middle East, 2011). Although the construction sector in Saudi Arabia is the biggest in the gulf region, the current safety level is considered to be poor (Alasmari et al., 2012).

As discussed, it is known in the literature and from the Saudi General Organization of Social Insurance governmental agency (GOSI) (2014) that Saudi Arabia has one of the highest injuries and accident rates on construction sites compared to other countries worldwide

(Alasmari et al., 2012). Evaluation of the construction sites in Saudi Arabia from the perspective of investigating safety culture is barely addressed in the literature. Safety culture reflects the safety practices and management in the organizations and it has been considered to impact worker behavior positively or negatively.

Thus, there is a lack of research in investigating the effect of safety culture on construction personnel and also on their motivation level to follow safety behaviors. Hence the purpose of this research is to assess safety culture among construction personnel in Saudi Arabia to identify safety culture development opportunities, as well as to shed the light on safety performance improvement areas. In addition, the effects of current safety culture on personnel's safety motivation and safety performance are assessed.

1.3 Research Objectives

Organizational culture has been known to be one of the main attributes or causes of accidents and injuries in the environment of construction sites. Organizational culture is intrinsically linked to safety culture, which attracts a wide range of industries, as it gives justifications about accident occurrence especially in construction industry (Choudhry et al., 2007). According to Hollnagel (2014). In the past, the focus of safety management in analyzing organizational culture was only on failure outcomes caused by ignorance of the organizational factors or daily practices that lead to the accident occurrence.

Measuring safety performance can be either proactive measures described as leading indicators or reactive measures described as lagging indicators. Various prominent scholars support the use of proactive indicators like safety culture rather than focusing on reactive measures such like number of accidents or injuries occurred (Choudhry et al., 2007; Mohamed, 2002; Cooper and Phillips, 2004; Mohamed, 2002; Flin et al., 2000). Measuring safety culture using reciprocal determinism theory based on cooper (2000) model considered to be a proactive measure that is predictive and can serve as a “feed forward” type of control rather than being a feedback, lagging and inactive measure (Flin et al., 2000).

The main purpose of this study is to provide prospects to improve and form a strong safety culture among construction personnel in Saudi Arabia. This will, ideally, increase workers’ overall safety performance in an industry that has the highest rate of injuries and fatalities compared with Unites States of America, the United Kingdom, Australia, the United Arab Emirates, Kuwait, Bahrain, Jordan (alasmari et al, 2012).

The main objective of this research is to evaluate the safety culture among construction personnel in Saudi Arabia by developing a model that the study depends on in conducting a safety culture assessment. The developed study model explains the effects of the predominant safety culture on personnel safety motivation along with their safety performance.

This research focused on the investigation of the effect of construction personnel’s safety culture on their safety performance in terms of personnel error behaviors and their own attitude toward violations. Moreover, this study examines whether a personnel’s safety motivation level has a mediating effect on the relationship between safety culture and safety performance within the environment of construction sites in Saudi Arabia. The quantitative nature of the study finds out if there are existing correlations among personnel safety motivation, safety culture, and safety performance.

1.4 Hypothesis

The proposed set of hypotheses of this research aims to test the correlations between several latent variables. The safety culture in construction sites in this study is considered to be a latent variable. This variable consists of five main factors: 1) management commitment toward safety, 2) employees personal attitude toward safety, 3) coworker's safety support, 4) construction work pressure and 5) construction's site safety management system. The study concentrates on measuring the effect of safety culture on personnel safety motivation along with their safety performance in the construction environment. It was mentioned heavily in the literature that organizational culture has significant effects on employees' motivation (Galler, 1994; Wiegmann et al., 2004; Zohar, 1980). Therefore, the relationships between safety culture and employees' safety motivation in the construction sites environment are investigated in this research. The first hypothesis suggests safety culture in the construction site has a significant influence on workers' safety motivation.

H1: Safety culture has a significant influence on personnel safety motivation in the construction sites.

Organizational factors, including management safety commitment, have great effects on the safety behaviors of the workers in regards to violations or error behaviors (Shappell & Wiegmann, 2001; Fogarty & Shaw, 2010). Moreover, safety culture perception guides employees' behavior in either the direction of making error or violation behaviors (Fogarty & Shaw, 2010).Thus, the second and third hypotheses propose significant effects of safety culture on personnel error behaviors and on their own attitude toward violation behavior in the construction sites.

H2: Safety culture has a significant impact on personnel errors behaviors in the construction sites.

H3: Safety culture has a significant impact on personnel own attitude toward violations in the construction sites.

The next couple of hypotheses related to the effect of personnel safety motivation as a mediator between safety culture and safety performance in the construction sites. Safety performance in the construction sites is measured quantitatively using workers' errors behavior and their own attitudes toward violation behaviors. Personnel motivation to follow safety rules and requirements in the construction sites and is considered to have an essential role by enhancing safety performance (Choudhry et al.,2007). Choudhry et al. (2007) asserted that employees' motivation is crucial to achieve a success in changing safety performance positively in the construction industry. Safety culture has a crucial rule in influencing workers safety motivation. Therefore, the fourth hypothesis investigates the influences of personnel safety motivation as a mediator between safety culture and workers error behaviors in the construction sites. The fifth hypothesis examines the effects of employees' safety motivation as a mediator between safety culture and workers own attitude toward violation in the construction sites.

H4: Personnel safety motivation mediates the relationship between safety culture and employees error behaviors in the construction sites.

H5: Personnel safety motivation mediates the relationship between safety culture and employees own attitude toward violations within construction sites.

1.5 Research Contributions

There is a rising issue in latest research to measure safety culture as a predictor for safety performance. This study contributes substantially to the body of knowledge of measuring safety performance through investigating safety culture as a predicting and diagnosing tool of current safety level. An extensive literature review is presented in this study to enlighten human factors contributions in construction safety, organizational culture role in accidents occurrences and prevention in constructions industry, safety culture related concepts and models and safety culture assessment in construction environment. Furthermore, this research intends to measure personnel commitment and motivation to construction safety, in addition to their relationships with safety culture and employees safety performance through workforce self-reported violation and errors behaviors. The research outcomes underline the importance of management commitment in influencing and changing employees' manners and attitudes toward safety positivity (Fogarty & Shaw, 2010).

The supervisors and engineers who work in large government construction projects operated by large construction firms at Saudi Arabia are the participants of this research. The purpose of this study is to evaluate the current safety culture in Saudi Arabian mega construction sites among engineers and supervisors. Additionally, this research aims to examine the extent to which safety culture would have an effect on personnel safety motivation as well as their safety performance regarding construction safety. The current study adds on to construction safety through its attempt to investigate the impact of safety culture as an interpreter to improve personnel safety motivation.

Furthermore, the current research attempts to find out the extent to which safety culture in the governmental construction projects in Saudi Arabia has a direct or indirect influence on personnel error behaviors and their attitude toward safety violations. Thus, management of construction firms and the government of Saudi Arabia will receive insights and recommendations in improving their safety levels through this research. The outcomes of this research have significant contributions to help managers and Saudi government safety officials in the construction industry to improve workers safety motivation toward construction safety and also to take on appropriate procedures and arrangements to minimize worker error behavior toward violations in construction environment.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter elaborates definitions of the concepts related to safety culture such as organizational culture, organizational climate, safety culture, organizational safety culture, safety climate, Behavioral Based System (BBS) and safety management system. Then, a thorough discussion about important issue affecting the formation of safety culture is presented, including positive safety culture indicators, cultural diversity impact and cultural structure on organizational context. Additionally, a detailed elaboration of previous models of safety culture is discussed based on the following types including multifactor analysis models, reciprocal safety culture models, construction sites safety culture reciprocal models, nation-specific safety culture models and theoretical safety culture models.

Next, a general outline of factors affecting safety culture in construction sites is discussed followed by a thorough analysis of a safety culture assessment. Furthermore, perception of safety is discussed in relation to safety culture. Finally, a discussion of future research thoughts is provided to highlight future opportunities for researchers who aim to conduct safety culture studies.

The aims of the literature review of this research is to conduct a thorough and complete review of safety culture concepts, safety culture issues, safety culture assessment, factors of safety culture in construction industry, safety culture models classification and perspectives of safety measurement in a synthesized manner based on a systematic literature review specifically for construction industry.

2.2 Definition of the Concepts Related to Safety Culture in Construction Sites

2.2.1 Organizational Culture

There have been arguments and much debate for elaboration of the term of organizational culture. There is no apparent consensus on describing an organizational culture (Guldenmund, 2000). Organizational culture is the interaction between organizational norms and individual perceptions as two entities where employees' actions and behaviors can be changed positively or negatively through mutual interactions (Choudhry et al., 2007). The degree of which organizational culture is going to be positive mainly depends on management reinforcement and commitment.

Researchers may use the terms of organizational culture and corporate culture interchangeably. Corporate culture together with safety culture is the reflection of shared behaviors, beliefs, attitudes and values in respect to the organization's main functions, goals and procedures (Cooper, 2000). Cooper (2000) describes safety culture as "the product of multiple goal-directed interactions between people (psychological), jobs (behavioral) and the organization (situational)."

Guldenmund (2000) stated that organizational culture consists of several main characteristics with the emphasis that organizational culture must be constructed holistically and should be stable. He also highlighted that it should have effects on many dimensions in the organization, should be shared among the groups either as corporate or national culture, covers various aspects, has norms and values that clearly defined and lastly organizational culture must be functional.

Richter and Koch (2004) explain organizational culture as the common and adopted perception within a specific organization. Reiman and Oedewald (2004) argued that organizational culture consisted of the values and norms beneath the assumptions that formed overtime and these assumptions affect all organizational activities. On the other hand, organizations are affected by its core values and norms hidden under these assumptions. Nevertheless, organizational culture is the intrinsic belief and internal norms adopted by groups of employees in a society or community that influenced the organization's goals, mission and function (Cooper, 2000; Ekvall, 1996). Table 1 below discusses the summary of organizational culture definitions.

Table 1 Definitions of Organizational Culture

Reference	Definition of Organizational Culture
Choudhry et al. (2007).	Organizational culture is the interaction between organizational and individuals as two entities where employees actions and behaviors can be changed positively or negatively through mutual interactions.
Cooper (2000)	Corporate culture including safety culture is the reflection of shared behaviors, beliefs, attitude and values in respect to the organization's main functions, goals and procedures.
Guldenmund (2000)	Organizational culture must be constructed holistically and should be stable. He also highlighted that it should have effects on many dimensions in the organization, it should be shared among the groups either as corporate or national culture, covers various aspects, has norms and values that clearly defined and lastly organizational culture must be functional.
Richter and Koch (2004)	Explained organizational culture as the common and adopted perception within a specific organization.
Reiman and Oedewald (2004)	Organizational culture consisted of the values and norms beneath the assumptions that formed overtime and these assumptions affect all organizational activities.
Ekvall (1996)	Organizational culture is the intrinsic beliefs and internal norms adopted by groups of employees in a society or community that impacted organization's goals, mission and function.

2.2.2 Organizational Climate

The organizational climate term gained substantial attention and popularity since the 1980s. Currently, one of the definitions that remains widely accepted is the one developed by Schneider & Salvaggio (2002) in which they state that organizational climate is mainly focused on perceptions of policies, procedures, and practices of the organizations. Climate perception has been studied in regard to morality output in such a way that associates each perception with generated observed behavior as a product of their perception (Kozlowski & Doherty, 1989). Nevertheless, it is discussed that each individual will have different perceptions and therefore will produce different behaviors that may not necessarily be consistent with organizational values and desired culture.

Organizational climate can be classified into three approaches in which Schneider and Salvaggio (2002) have been developed for explaining the concept. The first one is called the Attraction Selection Attrition (ASA) approach, which focuses on the significant members of the organization who have the power to structure the company, its values and operational processes (Schneider and Reichers, 1983). The second approach is called the structuralist approach, which concentrates on the structure of the organization, including hierarchy levels, size, authority structure, system and technological utilization and regulations that have an impact on values, attitudes, and individuals' awareness. The third model is called symbolic interaction approach in which it assumes that individual perception depends on their explanation and understanding of organizational regulations and current settings through their interaction with their environment (Schneider & Reichers, 1983). Figure 1 below shows a summary of organizational climate approaches.

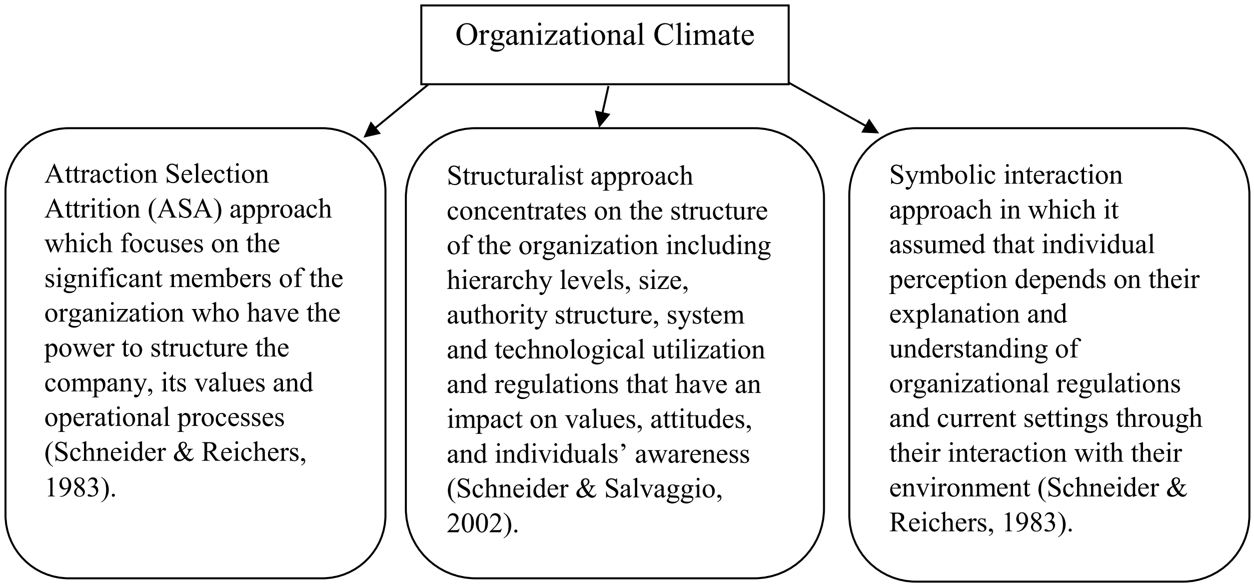

Figure 1 Organizational Climate Classifications (Schneider & Salvaggio, 2002)

2.2.3 Safety Culture

Safety culture has become the focus of all the industries and has received much attention in the recent years. Choudhry et al. (2007) stressed that safety culture is considered to be the main factor that influencing employees' attitudes and behaviors in respect to organization ongoing safety performance. It is intrinsically linked to organizational culture and has attracted a wide range of industries (Choudhry et al., 2007). Safety culture can be encapsulated in the characteristics of the organizational culture that have impacts on attitudes and behaviors related to hazard control and elimination (Guldenmund, 2000). Although the term "safety culture" has been extensively used for many years, the concept is still not fully clear (Guldenmund, 2000).

The expression 'safety culture' as a conceptual term first originated through the International Nuclear Safety Advisory Group of International Automatic Energy Agency (IAEA) following the Chernobyl disaster in 1986 (Mearns & Flin, 1999). Since then, many definitions of safety culture have appeared in the literature and most of them have focused on the beliefs and perspectives regarding the way people think and their behaviors in an organization. IAEA (1991) detailed their safety culture definition as “that assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.”

This definition underlines two major concepts: (1) safety culture is not merely focusing on safety attitudes; instead it is a positive indication of safety management performance; (2) excellent safety culture assigns the highest priority to safe conduct (Cooper, 2000). This definition stresses that the term “safety culture” encapsulates good management and not just good behaviors.

The most cited definition of safety culture is the one developed by Health and Safety Commission (HSC) (1993) published in Advisory Committee on the Safety of Nuclear Installations (ACSNI) report, which reads as follows, “the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of an organization’s health and safety management.” Also, Cox and Cox (1991) defined safety culture as the attitudes, beliefs, perceptions and the values employees have in common in regards to safety. Additionally, Fang et al. (2006) defined safety culture as a group of dominant indicators of values and beliefs that the organization maintains about safety. Safety culture has been confirmed to foster risk management and mitigation strategies based on increasing the commitment and knowledge of safety in the organization, which resulted in better readiness to possible dangerous situations (Pidgeon, 1998).

The paradox of the culture of safety occurs when there is a certain focus on specific sides of safety in a particular environment while neglecting other safety tasks due to our understanding that was shaped by the culture we embraced (Pidgeon, 1998). Cooper (2000) argued that the Health and Safety Commission's (1993) definition of safety culture reflected both an interpretive view and a functionalist view of culture based on the idea that safety culture is a product that has values, attitudes and patterns of behavior that can be manipulated as a functionalist view supports. Likewise, it supports interpretive approach by dealing with safety culture as emergent property created by social grouping in a workplace. Therefore, this indicated that normative beliefs are exposed to organizational members within dynamic reciprocal relationships among persons, environment and behavior constructs (Cooper, 2000).

Cooper (2000) criticized the HSC's (1993) definition of safety culture by indicating the need to clarify more about the "product" term in the definition with emphasis on the necessity to define what safety culture is practically not just what safety culture contains theoretically. Cooper emphasized the importance of mentioning sub goals of achieving an overall "good" safety culture. As a result, Cooper defines safety culture concept as several goal directed interactions between employees, work, and the organization.

Glendon and Stanton (2000) argued that safety culture consisted of attitudes, behaviors, norms and values, personal accountabilities, as well as training and development. Choudhry et al. (2007) inspected 27 studies regarding safety culture, and they believe that Cooper (2000) and Hale (2000) have the most suitable and practical definition of safety culture because of the outlining summarization of safety culture contents. Hale (2000) considered safety culture to be related to beliefs, attitudes and perceptions that are common by group of individuals in which they constitute norms and rules which regulate actions and reactions in relation to hazard control and elimination systems. Hale (2000) listed several elements for good safety culture, including safety importance, worker participation in all organization, safety staff contribution, trust and care, effectiveness in communication, safety improvements and integrating safety in all organizational functions.

Since Cooper's (2000) and Hale's (2000) definitions did not link safety culture and safety behaviors to safety performance in regards to the organization safety system, Choudhry et al. (2007) defines safety culture, particularly for construction industry, as follows, "the product of individual and group behaviors, attitudes, norms and values, perceptions and thoughts that determine the commitment to, and style and proficiency of, an organization's system and how its personnel act and react in terms of the company's on-going safety performance within construction site environment." Guldenmund (2000) argued that safety culture analysis must be in a specific context of application and related to crucial and central issue.

Fang and Wu (2013) proposed a definition of construction project safety culture as "mixture of attitudes, beliefs, values, behaviors and norms held by Individuals and groups from different parties in construction project for both workers and management, and it is gradually formed and evolved in the construction project environment that would influence the commitment to, style, and the proficiency of how all parties in the project and its personnel act and react in terms of the ongoing safety performance."

Mohamed (2003) discussed that safety culture is a subculture of organizational culture, which has an effect on workers' behaviors and attitudes in regards to the safety performance in the organization. He et al. (2012) summarized that safety culture is basically the notion of safety management in the context of safety culture in construction. He et al. raised several elements of safety culture from construction safety literature including awareness of safety, safety values and safety attitude in work environment. Table 2 below shows definitions of safety culture to elaborate this important concept.

Table 2 Definitions of Safety Culture

Reference	Definition of Safety Culture
IAEA (1991)	"Assembly of characteristics and attitudes in organizations and individuals, which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance."
HSC (1993)	"The product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of an organization's health and safety management."
Choudhry et al. (2007)	"The product of individual and group behaviors, attitudes, norms and values, perceptions and thoughts that determine the commitment to, and style and proficiency of, an organization's system and how its personnel act and react in terms of the company's on-going safety performance within construction site environment."
Fang and Wu (2013)	"Mixture of attitudes, beliefs, values, behaviors and norms held by Individuals and groups from different parties in construction project for both workers and management, and it is gradually formed and evolved in the construction project environment that would influence the commitment to, style, and the proficiency of how all parties in the project and its personnel act and react in terms of the ongoing safety performance."
He et al. (2012)	Safety culture is basically the notion of safety management in the context of safety culture in construction.
Cox and Cox (1991)	The attitudes, beliefs, perceptions, as well as the values that employees have in common in regards to safety.
Cooper (2000)	"The product of multiple goal-directed interactions between people (psychological), jobs (behavioral) and the organization (situational)."
Galler (1994)	Everyone is accountable for safety compliance and tracking indicated in his total safety culture (TSC) model.
Glendon and Stanton (2000)	Safety culture consisted of attitudes, behaviors, norms and values, personal accountabilities as well as training and development.
Hale (2000)	Safety culture related to beliefs, attitudes and perceptions that are common by group of individuals in which they constitute norms and rules that regulate actions and reactions in relation to hazards control and elimination system .

Reference	Definition of Safety Culture
Guldenmund (2000)	Safety culture can be encapsulated in the characteristics of the organizational culture that have impact on attitudes and behaviors related to hazards control and elimination.
Fang et al. (2006)	A group of dominant indicators of values and beliefs that the organization maintains about safety.
Mohamed (2003)	Safety culture is a subculture of organizational culture, which has an effect on workers' behavior and attitudes in regards to the safety performance in the organization.

2.2.4 Organizational Safety Culture

The interpretation of organizational safety culture is explained and tailored flexibly in respect to a specific academic discipline or area of research (Helmreich & Merritt, 2001). Therefore, multiple diverse organizational safety culture definitions were developed in different contexts of research. However, these numerous organizational safety culture definitions resulted from different fields of research can be grouped into two major categories, "socio-anthropological" and "organizational psychology" perspectives (Wiegmann et al., 2004). Figure 2 below, shows the categories of organizational safety culture with clear illustration.

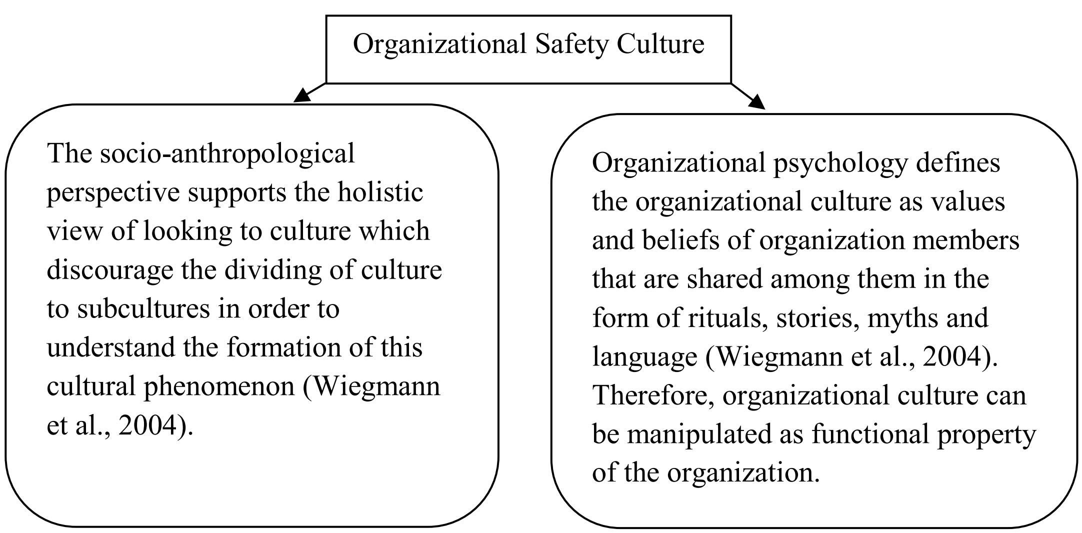

Figure 2 Organizational Safety Culture Categories (Wiegmann et al., 2004)

The socio-anthropological perspective underlines the formation of symbols, norms, meanings, heroes, and rituals shown in the common values and myths of the organization in attempt to conceptualize the organizational culture (Wiegmann et al., 2004). Members' attitudes and behaviors reveal the culture of an organization. Therefore, culture origins cannot be experienced by an outside individual but, rather, an inside individual who is immersed in it. It is essential to use ethnographic methods to learn about a culture while using a socio-anthropological perspective that includes observations and interviews with employees (Schein, 1991; Wiegmann et al., 2004). Organizational culture is assumed to be a developing property shaped by members of the organization. This view of organizational culture supports the holistic view of looking to culture, which discourages the dividing of culture to subcultures in order to understand the formation of this phenomenon. Wiegmann et al. (2004) discussed that the socio-anthropological perspective views the organizational culture as a grown concept that has changed and accumulated over time, has been adopted by groups of people, and is difficult to be changed and manipulated.

On the other hand, the organizational psychology perspective defines the organizational culture as values and beliefs of members of the organization, which are shared among them in the form of rituals, stories, myths and language (Wiegmann et al., 2004). Compared with socio-anthropological perspective, organizational psychology focuses on the idea that organizational culture can be manipulated as a functional property of the organization and, therefore, productivity can be increased (Schein, 1991; Wiegmann et al., 2004)

Organizational culture provides a sense of belonging to individuals, which contributes to the increasing of organizational commitment along with social stability. Therefore, behaviors can be effectively shaped and generated positively (Wiegmann et al., 2004). The organizational psychology perspective builds the conceptual connection between strategic management and organizational behaviors (Wiegmann et al., 2004).

Moreover, scholars prefer the organizational psychology perspective to the socio-anthropological perspective due to the functional property of a culture that enables a means of manipulation and enhancement of organizational culture through an organizational psychology perspective. In addition, organizational psychology perspective can demonstrate the relationships between a specific culture and the stated study hypothesis empirically (Schein, 1991).

Schein (1991) discussed that culture has separate subcultures or smaller components, which can be traced and observed through analytical methods. Thus, many of the organizational culture studies employed the use of the organizational psychology approach when observing a particular culture and its output effects. Nevertheless, researchers in organizational culture divided the concept of organizational culture into several application contexts, such as service culture, motivation culture, creativity culture and lastly safety culture (Galler, 1994; Wiegmann et al., 2004; Zohar, 1980).

2.2.5 Safety Climate

Safety climate was first introduced by Zohar (1980) to demonstrate a term that encapsulates employees' perceptions in regards to their safety roles in the organization. Safety climate is a snapshot of the safety state that indicates the safety culture level in a particular organization, group or plant (Flin et al., 2000). However, Zohar (2000) came with another definition of safety climate as follows: "safety climate relates to shared perceptions with regard to safety policies, procedures and practices." Safety perceptions of the employees can include management assertiveness to safety, observed level of risk, workplace effects, safety training, and social status of safety (Mohamed, 2002). Although safety climate might be thought of just a measure of perception or psychological aspect, safety management strengths and weaknesses can be assessed and then appropriate remedial actions can be proposed through conducting safety climate analysis (Cooper, 2000).

Safety climate analysis through surveys can be used to identify the relationships between safety important dimensions within an organization and how it can contribute to the overall outcome of safety culture (Cooper, 2000). Mohamed (2002) conducted a study aiming to examine the relationships between safety climate and safe work behavior in construction site environment. He used a questionnaire as an instrument measurement technique aiming to ease the collection of information from construction sites. The results of his study elaborated the importance of management commitment, communication, workers participation, attitude, capability and skills along with management positive monitoring in achieving positive safety climate.

Flin et al. (2000) examined eighteen safety climate questionnaires to assess safety climate as an instrument created by industrial psychologists for the purpose of quantifying safety. They found that the most assessed metrics of safety climate among the 18 studies are related to management, safety system and risk, followed by work pressure and competence.

Fang and Wu (2013) stated that it is widely known and accepted that safety climate can be regarded as a measurable reflection of safety culture in an organization. Another definition proposed safety climate can be used as a proactive measure that increases the warning signs of possible injuries and loss of life if necessary precautions are not encouraged (Mearns et al., 2003). Moreover, safety climate as defined by Brown and Holmes (1986) is the group of beliefs held by group of individuals about a certain object. Good safety climate is crucial to perform safe operations within the organization. Nevertheless, safety climate is considered as one of the essential dimensions to measure safety culture and is done so by employing a survey measurement technique (Fogarty & Shaw, 2009; Cooper, 2000). Table 3 below provides definitions of safety climate for more elaborations.

Table 3 Definitions of Safety Climates

Reference	Definition of Safety Climate
Zohar (1980)	A term that encapsulates employees' perceptions in regards to their safety roles in the organization.
Flin et al. (2000)	Safety climate is a snapshot of the safety state that indicates the safety culture level in a particular organization, group or plant.
Fang and Wu (2013)	Safety climate can be regarded as a measurable reflection of safety culture in an organization.
Mearns et al. (2003)	Safety climate can be used as a proactive measure that rises the warning sign of possible injuries and loss of life if necessary precaution do not encouraged and followed up.
Wiegmann, et al. (2004)	Safety climate can be considered as a psychosomatic or intangible subject that measures the state of safety culture at a point of time.
Lopez et al. (2013)	Safety climate encompasses many different aspects of safety culture by measuring its reflection on policies, procedures related to safety, employees' safety perception and priorities coming from daily tasks.
Brown and Holmes (1986)	The group of beliefs held by group of individuals about a certain object.

2.2.6 Safety Management System

A safety management system includes all aspect of safety management like policies, procedures, monitoring and continuous improvement with necessary corrective actions as needed (Choudhry et al., 2007). Choudhry and Fang (2008) attempted to find out why unsafe behavior occurs. They argued that the main reasons for unsafe behavior occurrences are due to lack of safety knowledge, failure to follow safety procedures and workers attitude toward safety (Choudhry and Fang, 2008). Safety management of construction projects is not a simple mission due to the complexity nature and the work type performed which raise a challenge to safety improvement (Biggs et al., 2012). Figure 3 illustrates the main components of safety management system.

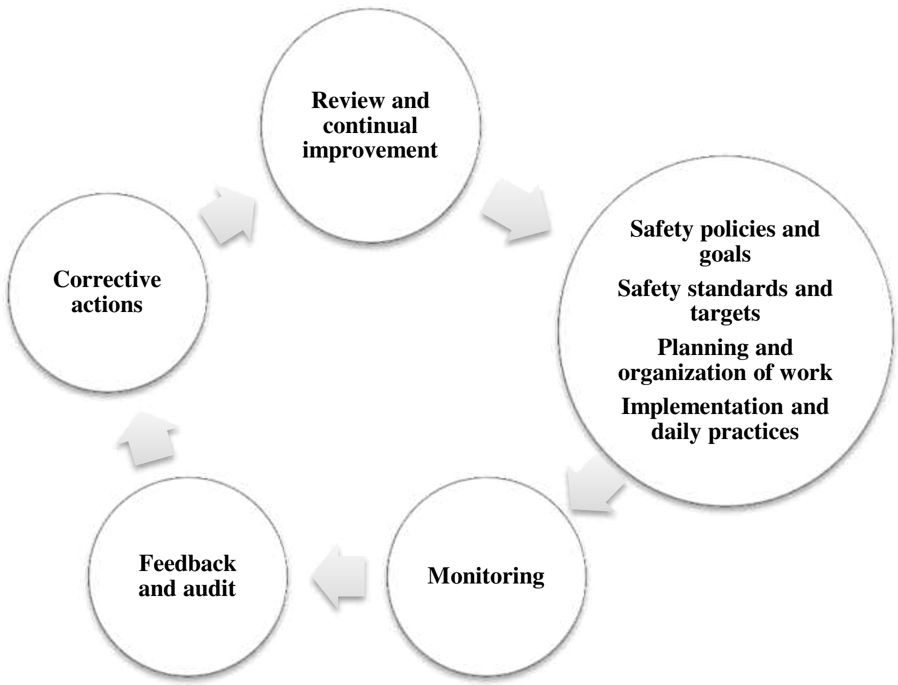

Figure 3 Safety Management Systems Components in Construction Sites (Choudhry et al., 2007)

The positive safety culture will be reflected through application of and adhering to excellent safety management systems in the construction site environment. Choudhry et al. (2007) asserted that both management commitment and employee support are crucially needed to successfully change safety culture positively.

2.2.7 Behavioral Based System

Behavioral Based System (BBS) is a system that observes employee's behaviors, and it aims to find out and diagnose unsafe behaviors with quantifiable time scores. After recording such scores, necessary meetings with violating individuals should be done to make corrective actions for these unsafe behaviors (Choudhry et al., 2007).

2.3 Issues Affecting the Formation of Safety Culture

2.3.1 Cultural Diversity and Level of Aggregation

Culture can be viewed either by functionalist approach or by interpretative approach (Glendon et. al, 2006). An interpretative approach views the culture as an emergent issue which needs to be dealt with and cannot be solved scientifically but instead it requires learning over time (Cox and Cheyne, 2000). On the other hand, functionalist approach views the culture as if it can be managed and enhanced to the direction of company's interests; it is generally controlled beginning from uppder management and downward (Biggs et al., 2013). Biggs et al. (2013) study findings support for the functionalist perspective due to the importance of management and leadership as factors that can crucially play in influencing safety culture in construction sites.

Cultural difference has an impact on safety culture in the organization especially if the employees are from diverse ethnic backgrounds. Glendon and Stanton (2000) believe culture is not owned by any one group, instead it is created by all employees in an organization. Culture definition must be integrated in such a way that must reflect a central unit or different subculture that is melded to form a holistic culture as a whole (Schein, 1991; Guldenmund, 2000). Culture means consensus on dimensions expressed from society, traditions and customs as behavioral norms, and rules, way of thinking (Choudhry et al. 2007; Cooper, 2000). If there is no consensus on such key issues, there will be no culture as a result. There is a need to pay appropriate attention to whether a group, organizational department or level is truly encompassing a similar culture before conducting a safety culture study (Schein, 2010).

It has been reported that each worker coming from a different nationality has a different response to safety matters, as their perception of work circumstances is not always congruent. Also, the safety regulations and adherence policies will have different effects on them as well. Chan and Tse (2003) conducted a cultural investigation through surveying three international construction sites located in London, Sydney and Hong Kong. They found that cultural clashes play an important role in creating disputes which ultimately affect the perception of safety instructions, as well as the overall quality of safety culture.

2.3.2 Subcultures Existence in the Organizational Context

An individual will not have the same response as another due to different personalities and perceptions. Choudhry, Fang and Mohamed (2007) stated that safety culture is intrinsically linked to organizational culture, which has attracted a wide range of industries. Schein (1991) and Cooper (2000) found that organizational culture consists of several subcultures such as engineer, executive and operator cultures. It can be seen that two departments may have different safety priorities and commitments within a shared organization, which may lead to organizational culture contradictions and instability.

This leads to an inconsistency of values, attitudes and behaviors among employees and, therefore, negative safety culture and outcomes will result. However, the existence of subcultures within an organization is a useful phenomenon due to the diverse reactions and perspectives initiated in response to unsafe issues (Pidgeon, 1998).

2.3.3 Positive Safety Culture Indicators

HSC (1993) indicated that organizations with positive safety culture can be identified by their communication, and is based on interchangeable trust, shared perceptions of the importance of safety and by their confidence on the productivity of preventive measures. Accident prevention is believed to be always affected by positive safety culture (Choudhry et al. 2009; Cooper, 2000). Developing and maintaining a positive safety culture can be an effective tool for improving overall safety within an organization (Vecchio-Sudus and Griffiths, 2004).

Choudhry et al. (2009) believe that positive safety culture comprises of management's commitment to safety, management's care about workers, communication between management and workers, workers understanding of procedures, communication openness, continuous checking, taking necessary corrective actions and, lastly, systems of continuous improvement to reflect the dynamic nature of safety on the construction site. Vecchio-Sudus and Griffiths (2004) discusses many factors that can improve positive safety culture in the organization including management commitment, employee participation, continuous evaluation, change of attitudes and behaviors, awards for good safety culture, training and promoting of strong safety practices.

Ismail et al. (2012), based on the questionnaire approach of their study, stated that behavioral improvement and good safety behavior reassurance are the building blocks of a quality safety program. They revealed several factors including leadership, management support, organizational commitment, training and resource allocations that allow for the conversion from regular to a dynamic and positive safety culture motivated organization (Ismail et al., 2012). Table 4 below provides a summary of the characteristics of positive safety culture.

Table 4 Characteristics of Positive Safety Culture

Reference	Characteristics of Positive Safety Culture
HSC (1993)	Communication based on interchangeable trust, shared perceptions of the importance of safety and the confidence on the productivity and the efficiency of current preventive measures.
Choudhry et al. (2007)	Management commitment to safety, management care about workers, communication between management and workers, workers understanding, communication openness, continuous checking, taking necessary corrective actions and system continuous improvement to reflect the dynamic nature of safety in the construction sites.
Vecchio-Sudus and Griffiths (2004)	Management commitment, employee participation, continuous evaluation, change of attitudes and behaviors, awards to good safety culture and training and promoting of good safety practices.
Ismail et al. (2012)	Behavioral improvement and good safety behavior reassurance are the main blocks that consisted positive safety program. They revealed several factors including leadership, management commitment, organizational commitment, training and resource allocation that allow for the conversion from regular to a dynamic positive safety cultural-focused organization.

2.4 Earlier Models of Safety Culture

Table 5 below, exhibits a detailed summary of the classification of safety culture models. Each model's characteristics are explained, along with its related references for each discussed. The detailed information for each model discussed is explained in the following sections.

Table 5 Summaries of Previous Models of Safety Culture

Model Type	Characteristics of the Model	Reference
Multifactor Analysis Model	The model aims to find out organizational dimensions that justify the classifications of low and high likelihood of accidents occurrences as group of factors. Several studies used multifactor analysis model concluded that management's attitude regarding safety is a significant factor affecting safety culture in organizations. Employees' perception about management safety concern, level of risks encountered as well as how management respond to such safety concern were found as important factors affecting safety culture.	Zohar (1980) Mohamed (2002) Brown & Holmes (1986)
Reciprocal Safety Culture Model	Created firstly by Bandura (1986) and then developed by Cooper (2000) and Geller (1994) based on psychological theory called "Reciprocal determinism." The main constructs/factors of the model are person, behavior and environment/situation and they are mutually interact with each other. Geller (1994) instituted the ten principles of achieving total safety culture. These principles are the following (1) the culture should maintain the safety process , not OSHA, (2) success depends heavily on behavior based and person based factors, (3) attention must be paid to process not outcomes, (4) behavior is guided by activators and motivated by consequences , (5) focus is on achieving success not avoiding failure, (6) continuous observation contribute to safe actions, (7) coaching is a key factor, (8) observing and coaching are vital caring process, (9) self-esteem, belonging and empowerment increase safety, and (10) safety is a value not a priority. Measuring only safety climate has a tendency to overlook other aspect of the reciprocal model like situational which related to environmental aspect and behavioral aspects as well. (Person) psychological, (Environment) situational and (Behavior) behavioral factors of safety culture derived from Social Cognitive Theory (Bandura, 1986). Triangulation approach in measuring safety culture using Reciprocal safety culture model allows multi-level analyses and lead to better measurement of the reciprocal interaction among model components.	Bandura (1986) Cooper (2000) Geller (1994)

Model Type	Characteristics of the Model	Reference
Reciprocal Safety Culture Model	Each component can be measured through specific method; situation components related to environment and it can be measured through safety management system audit; behavior component can be measured by behavioral based system sampling and lastly the person component can be measured by designing and implementing safety climate questionnaire (Cooper, 2000).	
Construction Sites Safety Culture Reciprocal Model	The pertinent reciprocal models of safety culture developed by prominent researchers in the field like Bandura (1986), Geller (1996) and Cooper (2000) models are not suitable for construction industries because their generic nature approach and lacking of technical and characteristics of constructions' works.	Fang and Wu (2013)
	Choudhry et al. (2007) developed a combining framework of safety culture based on Cooper (2000) model with difference that it focuses only on safety culture of construction sites. Choudhry's et al. model merged three related safety measurement tools into Cooper model which are Behavior Based System (BBS), safety climate and safety system audit. This enables the assessment of safety culture component individually or as a whole. A great advantage in Choudhry's et al. model is the reflection of project condition as a whole in the term "environment/situation" in which takes into account organization's environment as well. Choudhry's et al. model ignores the role of top management as a significant and necessary component in managing construction project Zohar (1980) finding that top management is a significant safety climate component in any type of industrial or manufacturing company.	Choudhry et al. (2007)
	Pellicer and Molenaar (2009) emphasizes that training is important safety climate dimension in all hazardous environment including the construction sites. They argued that Choudhry's et al. (2007) model should give more focus on this training by classifying training based on workers' job type. Cyclic approach in dealing with daily working requirements should be maintained because of the ability to correct unsafe behavioral mistakes if occurred along with the continuous improvement and feedback cycle.	Pellicer and Molenaar (2009)
	Chinda & Mohamed (2008) argued that previous model of safety culture have a lack of consistency between organization goals and organization daily operational work (enabler) in regard to safety performance.	Chinda & Mohamed (2008)

Model Type	Characteristics of the Model	Reference
Construction Sites Safety Culture Reciprocal Model	Building upon Choudhry's et al. (2007) model, safety culture interaction (SCI) model was proposed by Fang and Wu (2013) specifically for construction project site as continual improvement of the reciprocal model created firstly by Bandura (1986) and then developed by Cooper (2000). They divided the construction project into three components shown in their model which they are owner safety culture component, subcontractor safety culture component and contractor safety culture component (Fang and Wu, 2013). Safety culture interaction (SCI) model including owner safety culture component, subcontractor safety culture component and contractor safety culture component is evaluated based on two layers approach. The first layer is studying the current practices and performances of the management in each component and the second layer is concerning workers aspect in each component as well. This two layered evaluation mechanism including management and workers is following literature reciprocal model of safety culture that include the assessment of environment, behavior and perception in each component.	Carvajal and Pellicer (2006) Fang and Wu (2013).
Nation specific safety culture model	There are few models designed to capture the current assessment of safety culture in a specific nation or country. For Example, these countries include Australia, Hong Kong, Malaysian and China with the concern of modeling the current status of their safety culture in Construction Industry. The models are created after conducting safety culture assessment showing the significant factors specifically for each country. It has been found that each country have a different safety culture model because they have different cultures and context of application. They used safety climate questionnaire approach and found out that the main constructs that control safety behaviors as well as embedded in organizational safety culture.	Ismail et al. (2012) Biggs et al. (2013).
Theoretical safety culture model	Various safety culture and safety climate studies were lacking in explaining the conceptual theoretical outlines of the founded safety culture significant constructs in regards to their role in forming workers safety performance.	Fogarty and Shaw (2009)

Model Type	Characteristics of the Model	Reference
Theoretical safety culture model	Fogarty and Shaw (2009) did a study aiming to find out the relationships and the mechanisms that link between significant safety climate constructs and behaviors of workers using theory of planned behavior. Theory of planned behavior was employed in developing safety culture models. This theory developed by Ajzen (1991; 2005) to investigate workers' safety behavior. The theory of planned behavior (TPB) developed by Ajzen (1991; 2005) was employed by Fogarty and Shaw (2009) to guide the relationships of the variables and pathway analysis structure of their model.	Ajzen (1991; 2005)

2.4.1 Multifactor Analysis Models

Zohar (1980) did studies on several industries including metal, food processing, chemical, and textile. He was the first researcher who conducted safety culture investigation in these high-risk workplaces. Zohar designed and conducted a safety climate survey instrument for industries and workplaces in Israel and his samples are drawn from 20 factories, with total sample size of 400 participants. The survey included 40 items and eight factors with the aim to discover organizational dimensions that justify the classifications of low and high likelihood of accident occurrences as an outcome of the study.

The eight factor study of safety climate created by Zohar (1980) includes safety training, management attitudes toward safety, reward for good safety conduct, risk taken by workers, work pressure to meet requirements, safety observer condition, safety effect on all workers and safety observer group condition. Each factor was allocated between two and nine questions for measurement. Zohar concluded in his study that the two safety climate factors that had the most significant effect on generating positive safety climate are management attitude toward safety and perceived relevance of safety to job behavior. Several studies concluded that management's attitude towards safety is a significant factor affecting safety culture in organizations (Zohar, 1980; Mohamed, 2002).

Brown and Holmes (1986) did a study to evaluate the validity of Zohar‘s (1980) safety climate measurement instrument. They used an explanatory factor analysis to refine the climate structures of the smaller version model and to differentiate between employees with previous accidents and those who had no accidents. However, they developed a smaller version as a three-factor model, which differs from Zohar‘s eight-factor model. Then, confirmatory factor analysis was employed to test the covariance structures of Zohar‘s proposed hypothesis with data taken from ten industrial companies in the United States.

They found that the climate structure was the same between the groups and their smaller version of the climate model. Also, the smaller version model was more flexible in fitting the data (Brown and Holmes, 1986). Nevertheless, the smaller version of safety climate model developed by Brown & Holmes (1986) includes three factors, which are employees' perception about management safety concerns, employees' perception of how management respond to such safety concerns and perception of employees about level of risks encountered.

2.4.2 Reciprocal Safety Culture Models

The reciprocal model of safety culture was created by Bandura (1986) and then developed by Geller (1994) and Cooper (2000) based on a psychological theory called reciprocal determinism. Geller (1994) developed a model of safety culture, which differentiated and elaborated the three dynamic and interactive factors developed firstly by Bandura (1986). These factors are person, behavior and environment (Bandura, 1986; Geller, 1994).

Geller (1994) also instituted the ten principles of achieving total safety culture, which are as follows, (1) the culture should maintain the safety process, not forced by Occupational Safety and Health Administration (OSHA), (2) success depends heavily on behavior based and person based factors, (3) attention must be paid to process not outcomes, (4) behavior is guided by activators and motivated by consequences, (5) focus is on achieving success not avoiding failure, (6) continuous observation contributes to safe actions, (7) coaching is a key factor, (8) observing and coaching are vital caring processes, (9) self-esteem, belonging and empowerment increase safety, and (10) safety is a value not a priority. Figure 4 below shows Geller (1994) total safety culture model for more illustration.

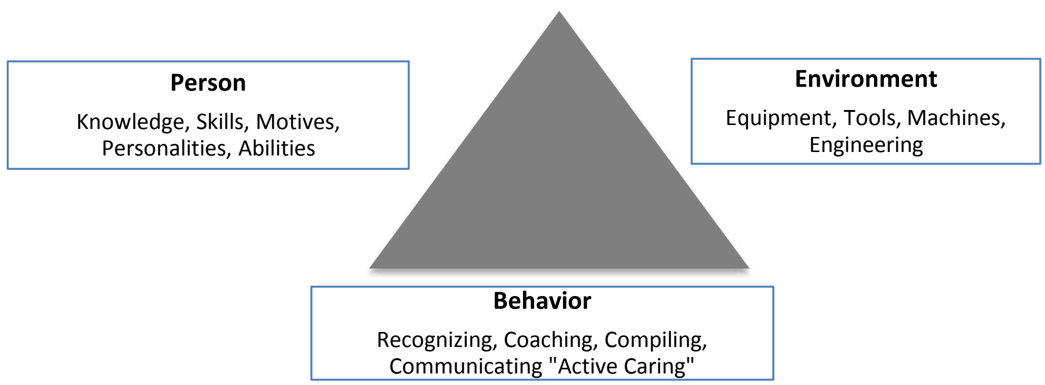

Figure 4 Total Safety Culture Model (Geller, 1994)

Then, Cooper (2000) presented a safety culture model, shown in figure 5 that identifies reciprocal or interactive relationships between psychological, situational and behavioral factors of safety culture derived from social cognitive theory and consisted of the following three components: situation, behavior and person (Bandura, 1986). Each component can be measured through a specific method; situation components related to environment and it can be measured through safety management system audit; behavior component can be measured by behavioral based system sampling and lastly the person component can be measured by designing and implementing a safety climate questionnaire (Cooper, 2000).

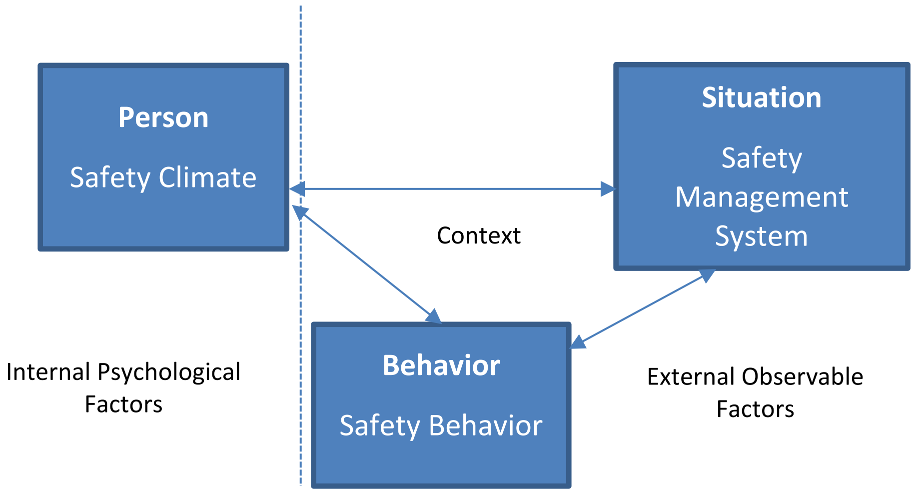

Figure 5 Reciprocal Safety Culture Model (Cooper, 2000)

2.4.3 Construction Sites Safety Culture Reciprocal Models

The basic model of safety culture that is tailored specifically for construction sites is not yet developed due to the complexity of construction process and its various components or sub-organizations like contractor, subcontractor and owner of a particular project (Fang and Wu, 2013). Fang and Wu (2013) argued that the reciprocal models of safety culture developed by prominent researchers in the field like Bandura (1986), Geller (1994) and Cooper (2000) models are not suitable for construction industries because their generic nature approach and lacking of technical and characteristics of constructions' organization.

Choudhry et al. (2007) developed a combining framework of safety culture based on Cooper's (2000) model with a difference where it focuses only on safety culture in construction sites. Choudhry's et al. model merged three related safety measurement tools into Cooper model which are Behavior Based System (BBS), safety climate and safety system audit. This elaboration and addition for such measurement tools enables the assessment of safety culture component individually or as a whole. A great advantage in Choudhry's et al. model is the reflection of project condition as a whole in the term of "environment/situation" which takes into account organization's environment as well.

Choudhry et al. (2007) model, shown in figure 6 exhibits a great effort in implementing Cooper's (2000) safety culture reciprocal model in the context of construction sites. However, there is a criticism that Choudhry's et al. model ignores the role of top management as a significant and necessary component in managing the construction project. This criticism supports Zohar (1980) finding that top management is a significant safety climate component in any type of industrial or manufacturing company.

Pellicer and Molenaar (2009) emphasizes that training is an important safety climate dimension in all hazardous environment including the construction sites. They argued that Choudhry's et al. (2007) model should give more focus on training issue by classifying training based on the workers' job type like, for example, training of supervisors who manage the work place and training of technicians who perform the actual work. Each job type requires different training courses and this issue is needed to be addressed further in Choudhry's et al. safety culture model (Pellicer and Molenaar, 2009).

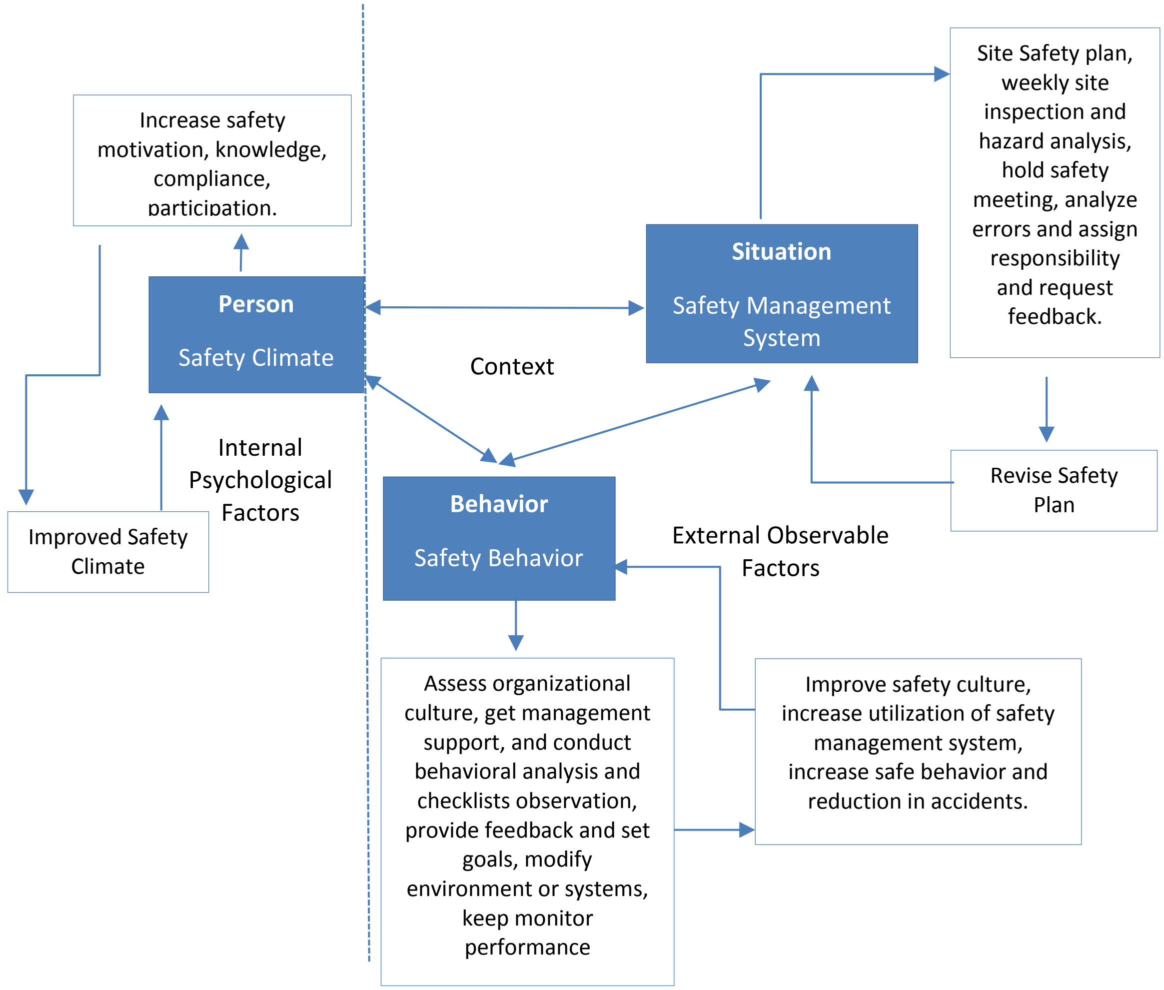

Figure 6 Safety Culture Reciprocal Model in Construction Sites (Choudhry et al., 2007)

Furthermore, Carvajal and Pellicer (2006) mentioned the importance of using the cyclic approach in dealing with daily working requirements because of the ability to correct unsafe behavioral mistakes if they occur along with the continuous improvement and feedback cycle. Chinda & Mohamed (2008) argued that previous models of safety culture have a lack of consistency and alignment between organization goals and organization daily operational work (enabler) in regards to achieving optimum safety performance. Thus, more investigation is needed regarding this matter.

Building upon Choudhry's et al. (2007) model, Safety Culture Interaction (SCI) model was proposed by Fang and Wu (2013) specifically for construction sites as a continual improvement of the reciprocal safety culture models created firstly by Bandura (1986) and then developed by Cooper (2000). They divided the construction project into three components shown in their model as owner safety culture component, subcontractor safety culture component and contractor safety culture component (Fang and Wu, 2013).

Each component mentioned in Fang and Wu's (2013) Safety Culture Interaction (SCI) model is evaluated based on two layers of approach. The first layer is studying the current practices and performances of the management in each component and the second layer is concerning workers aspect in each component as well. The safety culture interaction model for construction sites is provided below in figure 7 for more illustration. Furthermore, this two layered evaluation mechanism is a continuation and development of reciprocal models of safety culture including the assessment of environment, behavior and person in each component along with their interactions using the two layers approach (Fang and Wu, 2013).

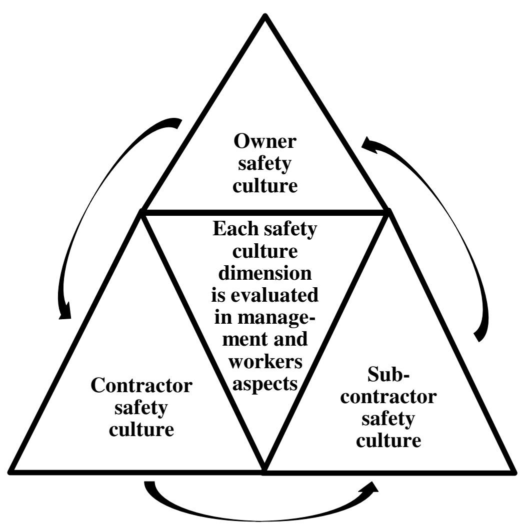

Figure 7 Safety Culture Interaction (SCI) Model (Fang and Wu, 2013)

2.4.4 Nation Specific Safety Culture Models

Beside the discussed safety culture models including multifactor analysis models and reciprocal models, there are few models designed to capture the current assessment of safety culture in a specific nation or country. For example, these countries include Australia, Hong Kong, Malaysian and China with the concern of modeling the current status of their safety culture in the construction industry (Ismail et al., 2012; Biggs et al., 2013).

Moreover, Ismail et al. (2012) did several studies to investigate and measure behavioral aspects related to safety culture in Malaysian construction sites using Choudhry's et al. (2007) model. They used a safety climate questionnaire approach and found out that the main constructs that control safety behaviors in which they are embedded in organizational safety culture include leadership, management commitment, training for safety excellence and resources utilization. Nevertheless, Ismail et al. study results support Zohar (1980) findings regarding that management commitment and attitude toward safety are critical in creating an excellent safety climate. Eventually, a good safety climate results in a better safety culture because it is considered to be the psychological component of safety culture. Despite this, it is not enough to improve safety climate only in order to achieve excellent safety culture, however, all safety culture components including psychology, behavior, and situation are going to be enhanced if safety climate is improved because of the mutual interactions property of safety culture components

2.4.5 Theoretical Safety Culture Models

Many safety culture investigations studies are explanatory studies. These studies aim to find out the factors affecting safety culture by employing surveys in order to point out the constructs as well as sub-constructs safety culture measurement depend on in a particular field. Various safety culture and safety climate studies were lacking in explaining the conceptual and theoretical outlines of the safety culture significant to constructs in regards to their role in forming worker safety performance.

Fogarty and Shaw (2010) investigated the relationships and the mechanisms that link between significant safety climate constructs and behaviors of workers. They distributed safety climate questionnaires to 308 aircraft maintenance workers and they aimed to find out the effects of workers' perceptions on four constructs, personal attitudes toward safety, group norms, management attitudes toward safety and workplace pressures. Fogarty and Shaw study employed the Theory of Planned Behavior (TPB) developed by Ajzen (1991) to investigate workers' safety behavior. They investigated the relationships between the preceding safety climate constructs in relation to two different components, intentions to perform safety behavior and safety violations (Fogarty and Shaw, 2010; Ajzen, 1991). Path analysis was employed using Analysis of Moment Structures (AMOS) software in order to evaluate the relationships among latent variables using confirmatory factor analysis and structural equation modeling.

The Theory of Planned Behavior (TPB) developed by Ajzen (1991) was employed by Fogarty and Shaw (2010) to guide the relationships of the variables and pathway analysis structure of their model. The findings showed very reliable r-squared and goodness-of-fit statistical values for all projected hypotheses (Fogarty and Shaw, 2010). The originated model accounted for 50% variance in violations of safety behaviors by individuals and also accounted for 47% of variance in workers' individual intention to violate safety (Fogarty and Shaw, 2010).

According to the literature, classification of individual unsafe behaviors and actions can be implemented for the purpose of more conceptualization of such behaviors. The classification of unsafe behaviors is referred to include two main concepts, errors and violations (Wiegmann et al., 2004). Reason (1990) as well as Wiegmann and Shappell (2001) discussed that violation behavior is the unsafe act done by a worker deliberately to violate the rules of safety while doing job responsibilities. On the other hand, errors in safety behaviors occur when an unintentional mistake is performed by a worker while working on job-required tasks (Reason, 1990; Wiegmann and Shappell, 2001).

2.5 Factors Affecting Safety Culture in Construction Sites

Many factors affecting safety culture in construction sites have been mentioned in the literature. Given that construction sites environment are the focus of this study, it is necessary to determine the specific factors concerning safety culture related to this field. Construction site safety culture factors can be grouped into two categories, organizational and cultural (social). Figure 8 below illustrates the classifications of factors that affect safety culture in construction industry.

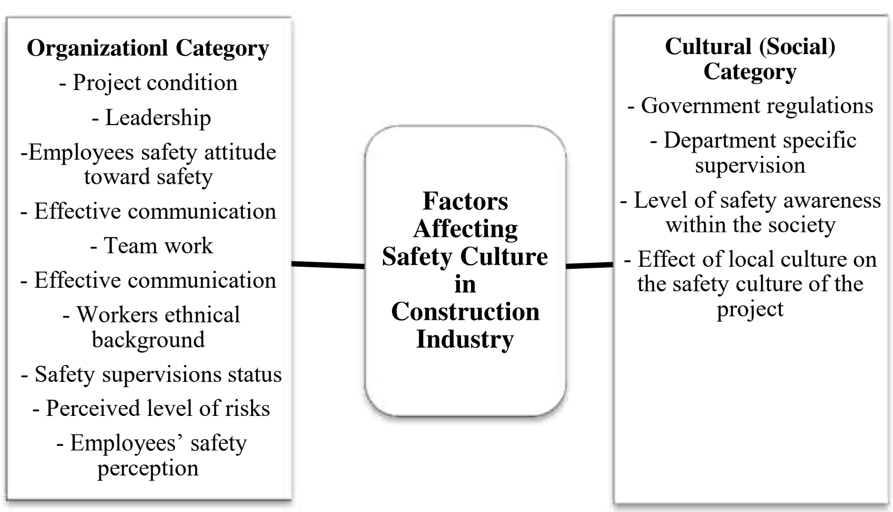

Figure 8 Classification of Safety Culture Factors in Construction Industry

First, the organizational category includes project condition, leadership, employees safety attitude toward safety, effective communication, team work, effective communication, workers ethnical background, safety supervisions status, perceived level of risks and employees' safety perception (Mohamed, 2002). Second, the cultural (social) category includes government regulations, department specific supervision, level of safety awareness within the society and the effect of local culture on the safety culture of the project (Mohamed, 2002).

Ismail et al. (2012) did a study including empirical research with surveys to figure out the factors influencing the implementation of excellent safety management system for construction sites. They found that the most significant factor was personal awareness and communication (Ismail et al., 2012). Moreover, they stated that there is an urgent need for management support for safety issues and supervision in order to let the workers well informed about safety procedures and importance of adherence to safety (Ismail et al., 2012).

Furthermore, several factors of safety culture in construction sites have been mentioned in the literature including working environment, equipment and facilities condition, safety training, management support, reward for good safety outcome, punishing negative safety behavior, management commitment and safety polices (Mohamed, 2002). Nevertheless, several risk factors were identified, including poor safety culture and communication to be associated with generating unsafe work environment (Ismail et al., 2012).

The importance of safety culture is emphasized substantially in the literature by focusing on the roles of safety training and safety supervision in enhancing safety culture (Chi and Han, 2013).Chi and Han (2013) investigated the relationships of risk factors within construction accidents through empirical and statistical analysis of more than nine thousands accidents that had occurred in the United States construction industry from 2002 to 2011. They aimed to assist managers to better know about the nature of accident occurrences in construction in order to rearrange their priorities and to better prevent accidents and enhance the safety-working environment (Chi and Han, 2013). Nonetheless, Chi and Han (2013) summarized that unsafe acts and conditions can be effectively controlled and directed by improving safe performance which is related to human factor and also improving safety conditions which are related to environment.

It is discussed that construction site environments are classified as a labor-intensive industry, and includes workers and supervisors from diverse ethnical backgrounds. This will raise the need to investigate the safety culture in construction sites due to the high variability in perceiving safety regulation and instructions by workers who are performing dangerous and high risk jobs in the environment that has the highest number of injuries and loss of life compared to other working environments (Ismail et al., 2012; Choudhry et al., 2009; Choudhry et al., 2007). Table 6 below summarizes the factors affecting safety culture in the construction industry.

Table 6 Factors Affecting Safety Culture in Construction Sites

Reference	Safety Culture Factors Affecting Construction Work
Mohamed, (2002)	Organizational category includes project condition, leadership, employees' safety attitude toward safety, effective communication, team work, effective communication, workers ethnical background, safety supervisions status, perceived level of risks and employees' safety perception. Cultural (social) category includes government regulations, department specific supervision, and level of safety awareness within the society and effect of local culture on the safety culture of the project. Working environment, equipment and facilities condition, safety training, management support, reward for good safety outcome, punishing negative safety behavior, management commitment and safety polices.
Ismail et al. (2012)	The most significant factor was personal awareness and communication. They found that there is an urgent need for management support for safety issues and supervision.

Reference	Safety Culture Factors Affecting Construction Work
Chi and Han (2013)	Safety training and safety supervision has been emphasized substantially in the literature. Unsafe acts and conditions can be effectively controlled and directed by improving safe act which is related to human factor and also improving safety condition which is related to environment.
Ismail et al. (2012) Choudhry et al. (2007) (2009)	Construction sites environment is classified as a labor intensive industry which includes workers and supervisors from diverse ethnical backgrounds. This will raise the need to investigate the safety culture in construction sites due to the high variability in perceiving safety regulation and instructions.

2.6 Overview of the Construction Industry in Saudi Arabia

Saudi Arabia has the largest construction industry in the gulf region (US-SABC, 2011). Additionally, the growth in the construction sector is dramatically increasing due to a huge demand for varying types of construction projects, such as industrial, commercial and residential buildings (Venture Middle East, 2011). The Saudi government's role in the construction industry is crucial due to the substantial funding which has been estimated to be more than $137 billion in the period between 2008 and 2009, despite this period of time being accompanied by the world's economic financial crises (US-SABC, 2011). Furthermore, the Saudi government plans to invest more than $400 billion for a mega project implementation in the next five years (US-SABC, 2011).

2.6.1 Safety Status of the Construction Sites in Saudi Arabia

Lack of safety culture is the primary cause of injuries and accidents in workplaces, especially in high-risk industries like construction (Choudhry et al., 2007; Cooper, 2000). Although construction sector in Saudi Arabia is the largest in the gulf region, the current safety level considered to be poor (Alasmari et al., 2012). Since the 1990s, few studies were implemented to measure safety performance in Saudi Arabia and some researchers used lagging indicators such like number of accidents and injuries to quantify safety level of performance. It has been found in the literature that measuring safety performance can be either proactive as the leading indicator measures or reactive as the lagging indicator measures. Various prominent scholars support the use of proactive indicators like safety climate measurement which is correspondent of safety culture rather than focusing on reactive measure such like number of accidents or injuries occurred (Mohamed, 2002; Cooper and Phillips,2004).

The safety performance in the construction industry in Saudi Arabia was examined by several scholars during the past two decades. Jannadi and Sudairi (1995) did a study to examine safety performance in construction sites through surveying and by observing 16 different construction companies including large, medium and small firms. They found safety levels to be excellent for large companies yet, it was just acceptable for medium and fair for small companies. Alamoudi (1997) found that all participants' safety level were poor and unsatisfied, however, Alasmari (2010) indicated that large firms have a good level of safety but poor for small and medium firms. Generally, previous published and unpublished studies of investigating safety performance in Saudi Arabia agreed that there is a significant decline in safety culture, which can be considered as the main cause of accidents and injuries on the construction sites (Alasmari et al., 2012).

General Organization of Social Insurance (GOSI) in Saudi Arabia publishes reports about number of injuries and death in accordance to each industry type annually (GOSI, 2014). Compared with other industries in the last 5 years, the construction sector has the highest number of injuries published by GOSI in Saudi Arabia. Moreover, from 2004 to 2010, the number of injuries increased dramatically from 15,357 to 43,308 which is considered more than 150 percentage increase (GOSI, 2014).

Another study was conducted by Alasmari et al. (2012) to compare safety performance level among countries including Unites States, United Kingdom, Australia, United Arab Emirates, Kuwait, Bahrain, Jordan, and Saudi Arabia. The study focused on the total number of employees, and the rate of injuries and death occurrences among each 100,000 employee scale. It was concluded that the highest numbers of injuries and deaths occurred in Saudi Arabia with 3,117 per 100,000 workers for injuries and 28 death occurrences per 100,000 workers in 2008.

2.7 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) was formed by Ajzen (1991) to demonstrate how employees' behaviors are explained in regards to employees' psychological perception. TPB incorporates the intention concept as the root cause that generates human actions. The intention to perform the work is directed by many factors including attitude regarding a behavior, perceived behavioral control and subjective norms (Ajzen, 1991). The primary modules of Ajzen's TPB is illustrated in figure 9 below.

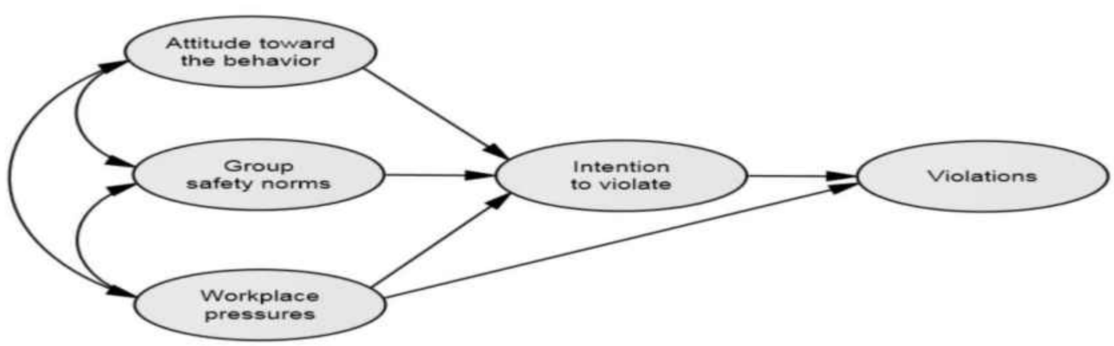

Figure 9 Theory of Planned Behavior (Ajzen, 1991)

Prediction of individual intentions can be determined with a reliable degree of accuracy through the employment of TPB using the three constructs that affected intention module including attitude regarding a behavior, perceived behavioral control and subjective norms

(Ajzen, 1991). The individual behavior variations, then, can be explained through the previous process of predicting intention because intention will generate the behavior (Ajzen, 2005).

The theoretical hypothesis of TPB is that individuals have different attitudes in regards to whether a certain behavior seems rational or realistic. The individual behavior is the yield of three components which are attitude regarding a behavior, perceived behavioral control and subjective norms. The perceived behavioral control component defined as external factors that are beyond employee's control in which the job content appeared to them to be more difficult or easier to perform (Fogarty and Shaw, 2010). Such external factors include management or work pressure, regulations and personnel absence.

The perceived behavioral control component is a direct interpreter of Individual behavior as well as the intention component in the theory of planned behavior. The subjective norms component is related to the behaviors and beliefs of influential people that impacted the shape and formation of other opinions and behaviors (Fogarty and Shaw, 2010). In workplace context, subjective norms might include coworker or manager beliefs and behaviors effect on the individuals' own view of norms because if an individual thinks the manager or supervisor do not consider safety a priority, then this individual will eventually be affected by their approach significantly (Fogarty and Shaw, 2010).

Intention concept was introduced by Ajzen (1991) to reinforce the relationships between attitudes and behaviors due to the fact that attitudes are not always converted to actual behaviors. This is because there are reasons that prevent this conversion, like what Ajzen (1991) proposed, including subjective norms, perceived behavioral control and intention (Fogarty and Shaw, 2010). As intention is the product of three components discussed above, then actual safety behavior can be considered as a product of intention component (Fogarty and Shaw, 2010).

The Theory of Planned Behavior (TPB) is applicable to analyzing safety behaviors of individuals specifically for a construction site context in order to demonstrate how safety behavior of an employee is formed and maintained. A safety helmet, for example, is an essential safety tool for construction workers due to its protection of their head if an accident occurs. The use of helmet is a standard safety rule in construction sites but some workers are not using them and this is classified as unsafe behavior. By analyzing this example using TPB, workers who neglected or refused wearing the helmets have negative attitudes toward this safety standard and thus other coworkers will be affected from these behaviors.

Ultimately, the construction workers will perceive the safety helmet as a disturbing tool due to the hot weather and obstruction of head movement that may result, even though they know that the helmet might save their life. This can be classified as a group norm effect according to the Theory of Planned Behavior. The pervious mentioned hypothetical examples explains how workers eventually form a specific intention regarding wearing a safety helmet in which will determine the behavior of helmet usage along with considering other external factors like management or work pressure (Ajzen, 1991).

2.8 Assessing Safety Culture

It has been found in the literature that measuring safety performance can be either a proactive measure described as leading indicators or reactive measure described as lagging indicators. Various prominent scholars support the use of proactive indicators like safety climate measurement, which is correspondent to safety culture rather than focusing on reactive measures such like number of accidents or injuries occurred (Choudhry et al., 2007; Mohamed, 2002; Cooper and Phillips, 2004; Flin et al., 2000).

Measuring safety culture through safety climate is considered to be a proactive measure that is predictive and can serve as a feed forward type of control rather than being feedback, lagging, or inactive measure (Flin et al., 2000). Safety culture as a term was left flexible for openness and discussion to encompass the culture dynamic changing nature. However, in the literature, there is a lack of guidance on how safety culture can be evaluated and measured effectively (Choudhry et al., 2007).

Many researchers conducted safety climate studies in order to find the safety culture status in a selected population (Zohar, 1980; Flin et al., 2000; Mohamed, 2002; Cooper and Phillips, 2004; Mearns et al., 2003; Fogarty and Shaw, 2010; Choudhry et al., 2009). Safety climate encompasses many different aspects of safety culture by measuring its reflection on policies, procedures related to safety, employees' safety perception and priorities coming from daily tasks (Lopez et al., 2013). Safety climate can be considered as a psychosomatic or intangible subject that measures the state of safety culture at a point of time (Wiegmann, et al., 2004).

However, Cooper (2000) claimed that measuring only safety climate has a tendency to overlook other aspects of the reciprocal model like situational which related to environmental aspect and behavioral aspect as well. There is a great challenge on how to measure safety culture effectively in construction sites and, until now, researchers remain at the beginning of long road before measuring safety culture effectively can be achieved in a meaningful way that benefits all parties working on construction sites.

Grote and Kunzler (2000) used a socio technical model of safety culture to link safety management system and safety culture to general organizational structure. Choudhry et al.

(2007) believed the model is schematic and has a subjective tendency in evaluating safety culture. Psychological, situational and behavioral aspects of safety culture in Cooper (2000) model can be measured by combination of qualitative and quantitative methods (Cooper, 2000). It is suggested that psychological aspect can be measured through safety climate questionnaire; behavioral aspect can be assessed and measured by developing checklists as part of Behavioral Based System concept (BBS); situational aspects can be measured through safety management system audit or inspection (Cooper, 2000).

The dynamic reciprocal relationships among the three components of safety culture in Cooper (2000) and Choudhry et al. (2007) models (situation, person and behavior) can contribute effectively to identify unsafe issues that may cause accidents or injuries within all organizational levels. The triangulation approach in measuring safety culture using safety culture reciprocal models allows multi-level analysis and leads to a better measurement of the reciprocal interactions among model components.

Reciprocal interactions among psychological, environment and behavior components of Cooper's (2000) and Choudhry's et al. (2007) models are the unit of study and development in relation to measuring safety culture effectively. In order to understand the reciprocal interactions between psychological, environmental and behavioral components and its correspondents like safety climate, safety management systems and safety behaviors, analysis on which each element is dependent on the other within a given context must be conducted and investigated. Table 7 below provides summaries of previous safety culture and safety climate studies attempting to measure safety culture or climate. The table clarifies the basic elements in the research methodology used by pervious researchers in the literature including number of questionnaire items, intended population, type of analysis and the dimensions of safety culture or climate studied.

Table 7 Summaries of the Number of Questions, Surveyed Population, Type of Analysis and Dimensions of Safety Culture and Safety Climate of Previous Studies

Reference	No. of Questions/ Instrument	Population	Type of Analysis	Safety Culture/Climate Dimensions
Mohamed (2002)	82, questionnaires administered through interview and site visit after getting permission.	Construction workers in 10 different construction companies in Australia. 68 respondents.	Path Analysis, Structural Equation Modeling (SEM).	Management commitment, communication, workers participation, attitude, capability and skills, management positive monitoring, safety rules and procedure, supportive environment, work pressure, competence, workers involvement, safe work behavior and hazard analysis.
Cooper & Phillips (2004)	50 items developed based on Zohar (1980) survey, questionnaires mailed to the plant workers.	Manufacturing plant personnel, 374 respondents (69% response rate).	Multiple regression analysis.	Management attitude and actions toward safety level of risk, safety training, safety status and reward system, safety enforcement and committee.
Fang et al. (2006)	110, questionnaire administered through site visit with translation of languages based on the population.	54 sites of leading construction company along with its subcontractors in Hong Kong. 4719 respondents.	Explanatory Factor Analysis (EFA), logistic regression.	Management commitment, safety attitudes, safety consultation, training, supervisors and peers roles, risk taking , safety resources, work risk and safety procedures evaluation, workers involvement and competence.

Reference	No. of Questions/ Instrument	Population	Type of Analysis	Safety Culture/Climate Dimensions
Teo & Feng (2009)	10, questionnaires sent by post.	Construction companies in Singapore, 28 respondents (7% response rate).	EFA, Analysis of variance (ANOVA).	Safety commitment, risk management, safety procedures and standards, Accountability, safety behavior, safety compliance, competence and safety value.
Choudhry et al. (2007)	42, questionnaire distributed through site visit of 22 construction sites.	Hong Kong 22 different construction sites, 1120 respondents.	EFA, multiple linear regression.	Management commitment, employees' involvement, safety rules and procedures, work practices, safety values.
Molenaar et al. (2009)	54, questionnaires mailed to the construction companies.	4 construction national companies in Colorado, USA. 237 respondents.	SEM.	Safety commitment, subcontractor involvement, safety accountability, safety values, safety incentives, safety disincentives.
Mohamed et al. (2009)	50 with 3 open ended question for behavior analysis, questionnaires administered through interviews.	Pakistani construction sites including all kind of jobs. 140 respondents.	EFA, logistic regression analysis.	Work environment, awareness and beliefs, risk assessment, safety training, management commitment, peer supports, safety values.
Fogarty & Shaw (2009)	40 items, questions administered through visit.	Aircraft maintenance personnel in Australian military bases, 308 respondents.	Path Analysis.	Workplace pressure, management attitude, group norms, workers attitude, intention to violate and violation.

Reference	No. of Questions/ Instrument	Population	Type of Analysis	Safety Culture/Climate Dimensions
Ismail et al. (2012)	28, questionnaires administered through conducting interviews	Construction workers and managers to find out the most influential factors, 275 respondents.	Descriptive statistics.	Recourses, management, personal, relationships, safety awareness, leadership, safety motivation and work practices and procedure.
Chen et al. (2013)	36, questionnaires questions administered through visit and interview.	Construction manager in Taiwan, 364 respondents.	EFA, Confirmatory Factor Analysis (CFA), SEM.	Human errors, Safety resources and applications, safety equipment and training, site culture and external factors, safety inspection and audits and risk assessment and analysis.
Casey et al. (2015)	10, questionnaires collected through sites visits.	Oil and gas mining organization in Australia, 562 respondents.	Descriptive statistics, SEM.	Supervisor safety support, supervisor production pressure, safety compliance and willingness to report errors.
Hon et al. (2014)	54, questionnaires mailed to the construction companies.	Repair, maintenance, minor alteration, and additions, construction workers in Hong Kong, 396 respondents	Descriptive statistics, SEM.	Management commitment, safety rules, safety responsibility, near misses and injuries, safety participation, safety compliance.
Huang et al. (2006)	21, questionnaires mailed to the participated companies.	Manufacturing, service, construction and transportation workers at United States, 2680 respondents.	Descriptive statistics, CFA, SEM.	Management commitment, safety training, injuries incidents, employees safety control, post injury administration, return to work polices, safety climate, safety performance.

Reference	No. of Questions/ Instrument	Population	Type of Analysis	Safety Culture/Climate Dimensions
Wu et al. (2015)	26, hand-out and mailed version of questionnaire used.	Chinese leadership and staff from the construction industry, 450 respondents.	Descriptive statistics, EFA, SEM.	Supervision, reward systems, social security, work pressure, communication, leadership, safety management system, training, safety procedures' awareness, emotional state, risk assessment.
Alrefaie (2013)	44, questionnaires administered in person through site visits.	24 Jordanian companies to investigate factors that affect safety performance, 324 respondents.	CFA, SEM.	Management commitments, interrelationships, continuous improvement, blaming culture, employee empowerment, safety activates, safety management system, reward system, safety reporting system, supervisor, teamwork, safety awareness, safety behavior safety values.
Vinodk-umar and Bhasi (2010)	35, questionnaires administered in person.	Indian factories personnel producing different kinds of chemical products, 1566 respondents.	Descriptive statistics, CFA, SEM.	Management commitment, safety training, workers involvement, safety communication and feedback, safety rules and procedures, safety promotion policies, safety knowledge, safety motivation and compliance and safety participation.

2.9 New Perspectives of Measuring Safety

Safety performance measurement should be implemented in such a way that focuses on the daily operations and activities in the construction sites not just restricted by investigating accident records or accident causes where failures have occurred. Hollnagel (2014) identified two concepts of safety perspectives, which are Safety I and Safety II based on a long and extensive research study on the history, and development of safety concept starting from 1769 to 2014.

According to Hollnagel (2014), the focus of safety management should not be only on the failure outcomes although our highest aim is to have zero accidents and fatalities. In order to reach that goal, the safety personnel and experts should focus on the positive or success outcomes in which the accidents were avoided in these outcomes and from that improving the safety management practices.

Safety success outcomes or incidents have higher probabilities of occurrences compared with probabilities of safety failures occurrences (Hollnagel, 2014). Hence, safety experts and personnel will manage safety better if they focus on daily operations and activities that produce acceptable and positive safety outcomes (Hollnagel, 2014). The reason to focus on the positive outcomes in evaluating safety performance is the fact that we want to avoid hazards and thus the efforts should be spent analyzing and studying the incidents and circumstances in which hazards were avoided and controlled rather than just studying cases in which there is a failure in the system which has a small probability of happening, compared with the successful safety outcomes (Hollnagel, 2014).

Safety I concept studies the few incidents of failure that might go wrong, while Safety II concept studies the large number of incidents that have successful outcomes without accidents or hazards happened (Hollnagel, 2014). More importantly, Safety I concept is reactive approach which only responds or acts when an accident occur or if there is unacceptable clear level of risk. However, the concept of Safety II is considered to be proactive in which it is continuously looking for any potential development of hazards and risks not only when there is evidence of actual proof of harm shown (Hollnagel, 2014).

In regards to the attitude toward human factor in both Safety I and Safety II perspectives, humans are primarily perceived as liability or hazard in the view of Safety I concept. Conversely, Safety II concept considers the human as a necessary resource for system to be flexible and reliable. Moreover, Safety I perspective believes that accidents are caused by failure of individuals and breakdown of machines in which it focuses only in investigating the causes or factors that make the accident happened (Hollnagel, 2014).

In contrast, Safety II believes that incidents and its related consequences happened regardless to the outcomes either successful or failure outcomes (Hollnagel, 2014). The purpose of accidents investigation in safety II perspective is to understand first how a set of events goes right to form the basis of understanding and explains how these same set of events go wrong and produces a failure outcome.

The considerations of Hollnagel (2014) about Safety I and Safety II concepts have direct influence on safety culture research. Hollnagel's (2014) Safety I and Safety II impacts on safety culture research can be seen in such a way that goes in parallel with the concept of measuring safety culture to predict safety performance as proactive measure rather than measuring safety only with reactive approach using accidents records and traditional accidents investigation when they occurred (Cooper and Phillips, 2004; Cooper, 2000; Mohamed, 2002). Safety culture is considered as a leading indicator, reliable and excellent predictor of safety performance in organizations and importantly it supports the safety II approach (Choudhry et al., 2007; Mohamed, 2002; Flin et al., 2000). Safety II perspective emphasizes that we should take care of the things that go right in every day actions rather than only investigating the safety level from reactive way when accident or failure outcomes occur as described in Safety I perspective.

2.10 Discussion of Future Research

Safety culture previous studied models established for high accident rates industries were deigned to focus on assigning accountabilities to blame individuals rather than investigating safety issues from holistic point of view. However, there is a considerable necessity to give more priority for measuring safety culture from a systematic and holistic view including individual components as a part of measurement. There is a great tendency to adopt the belief that safety failures are caused by individuals or organizational members rather than looking to the broader view of why things go wrong and therefore why harmful consequences occur. It is important to detect the main factors that contribute to organizational safety failure in order to establish the organizational structure that prevents individual safety failures and reengineer the system to be more reliable. There are substantial opportunities for future researchers to reengineer and design multifaceted systems of organizational safety culture by including specific country culture along with corporate culture to better assess organizational lapses in maintaining good safety culture.

Operations and activities performed every day when things are producing good safety level or outcomes should be studied more in order to improve safety level or performance. Safety culture is inherited in the people mind and psychology and it is going to be reflected in their daily actions and behaviors. Hollnagel's (2014) Safety II considerations, which focus on the things that go right in the system not just the failures outcomes, are in alignment with safety culture concept. Safety culture concept supports the Safety II approach developed by Hollnagel (2014) because it predicts proactively the safety performance's good characteristics of the individuals working in construction sites that influence management, processes and values in continuous manner regardless of the occurrences of failure safety outcomes of the investigated construction sites. There is a future opportunity to conduct research using safety culture and the Safety II concept in order to improve safety level in organizations as well as to investigate the actual relationships between the two perspectives.

Nevertheless, there are major limitations regarding the implementation of the reciprocal safety culture models. One important object that needs to be included in the reciprocal safety culture models is the impact of the national culture which, if incorporated, will give more insights about safety culture differences among diverse countries. It is crucial to search for the most dominant elements that may have an effect on safety culture improvement and maintainability.

2.11 Remarks on the Literature Review

Accidents related to human errors have destructive impacts on the safety and wellbeing of the work environment. These impacts include extreme costs of handling unsafe issues, economic vulnerabilities and loss of life. The construction industry is known to have one of the highest injury and accident rates compared to other workplaces. Investigations and enhancement of the current safety practices and processes in construction sites are urgently needed to promote safety performance. Safety culture reflects the safety practices and management in the organizations and it has been considered to impact worker behaviors positively or negatively. Measuring safety climate and safety culture considered to be a measure that is predictive and can serve as a feed forward type of control rather than being merely a feedback, lagging or inactive measure (Flin et al., 2000).

Safety culture becomes a popular term due to its ability to capture all of the important aspects of safety practices, including safety management system, safety perception and safety behaviors. Safety culture is inversely correlated with accidents and injuries at the construction sites. It has been mentioned that management commitment along with safety polices have direct influences on safety climate and safety culture (Lopez et al., 2013). Importantly, it has been generally agreed that management commitment factor has the strongest influence on safety culture as an outcome (Ismail et al., 2012; Choudhry et al., 2009; Cooper, 2000; Wiegmann, et al., 2004; Mearns et al., 2003). Safety culture concept was introduced in both forms, including general basic concept and in relation to construction sites environment. Safety culture is the main factor that influences employees' attitudes and behaviors in respect to organization ongoing safety performance and it is essentially connected to organizational culture and as a result it attracted a wide range of industries (Choudhry et al., 2007).

This study provided a comprehensive discussion by conducting an extensive literature review about important issues affecting the formation of safety culture, positive safety culture indicators, cultural diversity impact, level of aggregation and subcultural existence in organizational context. It is worth emphasizing that culture can be formed when there is an agreement on norms and values shared including traditions, regional background, behavioral accepted actions and philosophy of thinking (Choudhry et al., 2007; Cooper, 2000). When there is no agreement on the mentioned dimensions of culture, no form of culture will result. There is considerable necessity to make sure that a studied sample of people who are working together are truly having a related culture especially from the social environment before proceeding to apply a safety culture research (Schein, 2010).

Safety climate is an important aspect of safety culture because it measures the perception of employees regarding safety polices and values from psychological perspective. By employing a safety climate survey, the status of the safety level in the time in which study is conducted can be obtained (Cooper, 2000). Linking safety climate with time is essential because safety climate is changing in nature because employees and management are changing as well. There are a group of main indicators of positive safety culture including management support, personnel involvement, continuous improvement, correction of unaccepted attitudes and behaviors, safety incentives, and training, as well as safety accountability (Vecchio-Sudus and Griffiths, 2004; Molenaar et al., 2009).

Safety culture is a crucial component to reengineer the concept of organizational culture if it is properly integrated with all aspects of organizational functions and processes. As a result, this integration will prevent individual accidents and injuries. The safety culture component was limited in this study by focusing on measuring safety culture in a specific environment. Safety culture should be assessed using a safety climate questionnaire, which is considered to be a reliable measure of safety culture. However, safety management system and workers behaviors should be assessed and investigated based on safety culture reciprocal models (Geller, 1994; Cooper, 2000; Choudhry et al., 2007; Fang and Wu, 2013).

This Research provides a synthesized classification of the current existing models of safety culture based on a thorough literature review. In recent decades, a range of safety culture reciprocal models have been developed including multifactor analysis models, reciprocal safety culture models, construction sites safety culture reciprocal models, nation-specific safety culture models and theoretical safety culture model (Bandura, 1986; Schien 1991; Geller, 1994; Cooper, 2000; Choudhry et al., 2007; Fogarty and Shaw, 2010; Fang & Wu, 2013). Furthermore, there is an unresolved debate about whether an organization is a culture by itself or has a specific culture related to it. Therefore, it is not a surprise that there is no accepted or universal model of safety culture that exists in the literature (Choudhry et al., 2007).

The reciprocal associations among situation, person and behavior components of safety culture reciprocal models can effectively be used as the diagnostic assessment model to detect unsafe problems that may arise in the organization (Geller, 1994; Cooper, 2000; Choudhry et al., 2007; Fang and Wu, 2013). The triangulation method is used by evaluating safety culture through the use of safety culture reciprocal models and was recommended by scholars due to its ability to permit several levels of analysis (Cooper, 2000). This lead to better assessment of safety culture because it captures the reciprocal interactions among safety culture components. In order to realize the reciprocal relations between psychological, environmental and behavioral components and its correspondents like safety climate, safety management system and safety related behaviors, and examinations on which each component is interacting or depending on the other components in a certain setting must be applied and investigated.

Factors affecting safety culture in construction industry can be grouped into two categories that are organizational and social. Organizational factors are related to project situation, management style in safety administration, safety attitudes, communication, group norms, workers ethnical diversity, safety enforcement and control. The social category includes all the factors coming from outside of the organization including government rules, society safety awareness and the impacts of local culture on the safety culture in the construction site.

Safety I and safety II concepts developed by Hollnagel (2014) have a significant impact on safety culture research in such a manner that goes in similar direction with the notion of assessing safety culture as an active measure of safety performance and this approach of dealing with safety is supported by the literature (Cooper and Phillips, 2004; Cooper, 2000; Mohamed, 2002). Safety culture is known to be as a leading sign, dependable and excellent interpreter of safety performance in organizations and it supports the Safety II approach significantly (Choudhry et al., 2007; Mohamed, 2002; Flin et al., 2000; Hollnagel, 2014). Safety II perspective is the important focus that highlights the events that go as planned in every day actions instead of only inspecting the safety level from a reactive view when accidents or failure outcomes arise as described in the Safety I perspective (Hollnagel, 2014).

CHAPTER 3: METHODS AND PROCEDURES

3.1 Introduction

This study focuses on assessing safety culture among construction personnel who work in the middle management level of governmental construction sites in Saudi Arabia. Construction personnel targeted in this research are engineers, supervisors, project managers, safety engineers and middle managers in construction projects. This research explored whether the dominant safety culture would have an influence on personnel safety motivation and their safety performance. Furthermore, this study aims to find out whether safety motivation for construction safety mediates the relationship between safety culture and safety performance in the construction environment.

Measuring safety performance is implemented on the basis of workers' behavior to make errors, as well as their own attitude toward violations. Therefore, this study focuses on answering the following questions:

Q1: What is the impact of safety culture on personnel motivation to construction safety in governmental mega construction sites at Saudi Arabia?

Q2: What is the effect of current safety culture on construction personnel error behaviors?

Q3: What is the effect of existing safety culture on construction personnel own attitude toward violations?

Q4: Does personnel safety motivation to construction safety in Saudi Arabia mediate the relationship between safety culture and construction personnel error behavior?

Q5: Does personnel safety motivation to construction safety in Saudi Arabia mediate the relationship between safety culture and construction personnel own attitude toward violations?

In order to evaluate the relationships between safety culture, personnel safety motivation to construction safety, construction personnel error behavior and construction personnel's own attitude toward violations, a proposed model is presented to illustrate the generated study hypotheses as well as their relationships. Figure 10 shown below, depicts the proposed study model of assessing construction personnel safety culture including engineers, supervisors, safety officers and projects manager. Safety culture assessment model serves as a predictor of safety performance in governmental construction mega projects at Saudi Arabia. Also, the proposed model tests the mediation role of personnel safety motivation to construction safety between safety culture and safety performance as illustrated in figure 10 below.

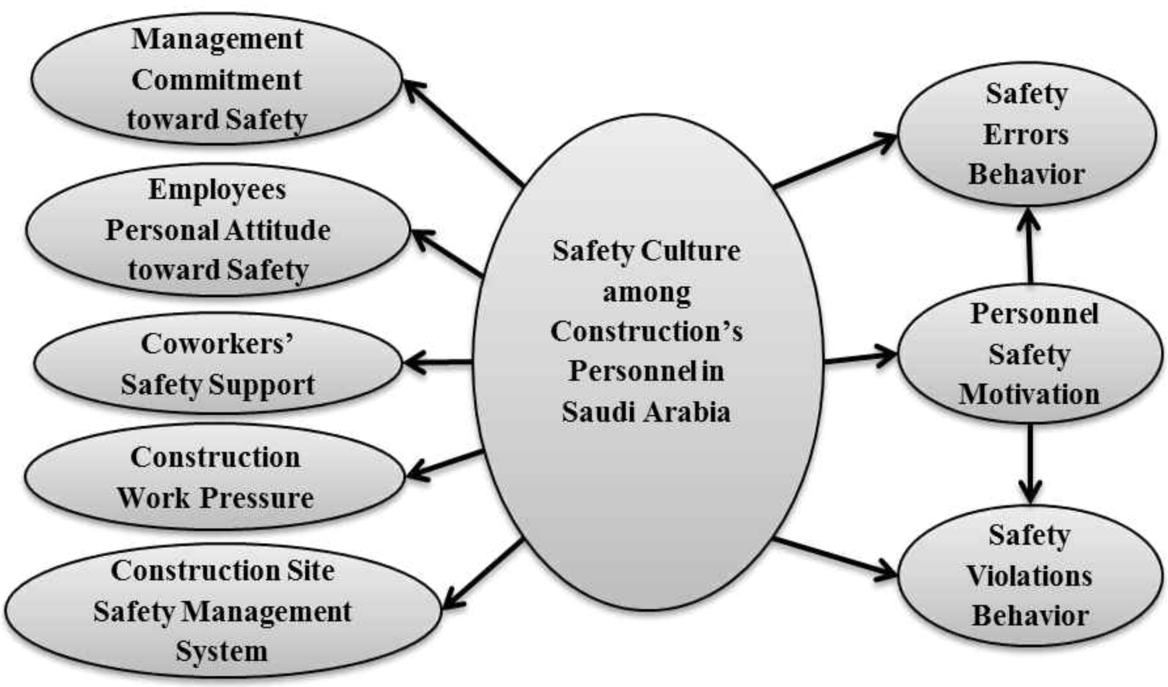

Figure 10 Conceptual Proposed Study Model of Safety Culture Assessment

All the variables in this quantitative study were measured using survey questionnaires. The survey questions of this research were collected from previous studies in which they were used. Thus, all the questions used in this research questionnaire were validated and used by prominent scholars in the field of safety culture. In this research, confirmatory factor analysis (CFA) and the structural equation modeling (SEM) are used to validate and analyze the study of latent factors along with the relationships between the research constructs.

3.2 Survey Instrument

Assessing safety culture from only accidents records is not reliable enough for determining whether the assessed organization has strong or weak safety culture. The bias of reported information and the discrepancy of reporting by individuals lead to not depending only on previous accident reports to assess safety culture (Helmreich and Merritt, 2001). Helmreich and Merritt (2001) argued that companies with low incidents or near miss rates, or just have a single safety accident, cannot be considered to have either poor or good safety culture because, most likely, accidents are outlier events that cannot be used for thorough assessment. Therefore, evaluation of safety culture components from theoretical background is performed in this study using survey questionnaire including the investigation of person, behavior, and environment components based on reciprocal safety culture models (Cooper, 2000; Fang and Wu, 2013; Choudhry et al., 2007; Molenaar et al.,2009).

Survey instruments are widely used to evaluate safety culture in many industries including construction, manufacturing, nuclear plants, and transportation (Mohamed, 2002). It is considered as the most useful and optimal method to gather information from the workforces who are working in hazardous industries in terms of time and cost especially in large size firms. This study used questions from five different surveys to measure safety culture, personnel safety motivation to construction safety, worker error behaviors and worker's own attitude toward violations.

Demographic information was included and collected in the beginning of the survey. The demographic information questions consisted of nationality, language, age, education, working experience in construction field, work position in the company and, lastly, frequency of safety training. The reliability of all factors was measured using the internal consistency estimation as an index of each factor. Moreover, Cronbach's alpha minimum value of 0.70 or above is needed to ensure adequate reliability. All the five surveys used in this research have different reliability measures beginning from 0.70 to 0.94. In this research, a new safety culture measurement instrument was developed. The developed survey utilized the strongest parts of the adopted five questionnaires.

The reliability measure gives a clear insight whether a set of items are related to one latent construct or not. All the survey questions used in this study have a theoretical underpinning related to safety culture reciprocal models discussed in the literature review section. Therefore, all the factors extracted in this study either have been tested before in previous research, or have been used in previous safety culture models with theoretical and statistical justifications that show a clear evidence of their applicability to construction safety culture.

The safety culture in construction sites component was captured through several five main factors including 1) management commitment toward safety, 2) employees personal attitude toward safety, 3) coworkers safety support, 4) construction work pressure and 5) construction site safety management system. There are three different types of surveys used to measure safety culture factors. Three of the five safety culture components mentioned are measured using Seo et al. (2004) survey including management commitment toward safety, coworkers safety support and construction work pressure. In regards to workers personal attitude toward safety component, it is measured using a survey from Hall (2006) study. Lastly, construction site safety management system factor is measured using Molenaar et al. (2009) survey in which the questions were created specifically for assessing safety culture in construction companies. The total number of questions combined to measure safety culture in construction site was 46. A 5-point Likert scale was used ranging from 1 strongly disagree, 2 disagree, 3 neutral, 4 agree to 5 strongly agree. The survey was tailored to measure several characteristics of safety culture in construction sites.

The forth survey used in this study adopted from the Vinodkumar and Bhasi (2010) study in which it was designed to measure workers safety motivation to follow safety rules. The survey is used in previous research to measure the level of motivation and importance the employees place regarding following safety procedures and policies. Safety motivation factor contains five questions to measure the level of worker's safety priorities and motivation to follow construction safety using a five point Likert scale ranging from 1 (strongly disagree), to 5 (strongly agree). Safety motivation factor is hypothesized in this study to mediate the relationships between construction safety culture and personnel safety performance through analyzing personnel behaviors including error and individual attitude toward violation behaviors.

Workers attitude toward violations is measured using Fogarty and Shaw (2010) survey questions. The adopted survey has nine questions relating workers attitude to their own violation behavior. However, only five questions were selected due to similarities amongst questions and to avoid repeated or unclear questions. Thus, five questions are selected to measure workers' attitudes toward violations including rare and common violations. Moreover, there are some changes on the language terms of the survey to be better suited and easier to understand by the construction personnel, as they are the targeted population of this study.

Lastly, the fifth survey adopted in this study is measuring worker's error behavior using Seo et al. (2004) unsafe behavior construct. Four questions are selected in which they are related to skills, decision-making and error perceptions by workers. The survey consisted of four questions used to measure personnel error in grain industry. However, due to the generality of the questions it can be applied to construction industry as well. Moreover, five point Likert scale is used for answering these questions.

3.3 Study Variables

Study variables in this research are the factors assessing safety culture, personnel motivation to construction safety, personnel error behavior and personnel own attitude toward violation. Three different surveys were used to measure safety culture construct with a total of 46 questions. These surveys adopted from Seo et al. (2004), Hall (2006) and Molenaar et al. (2009) studies. Safety culture was assessed based on five main factors which are considered as latent variables including 1) management commitment toward safety, 2) employee's personal attitude toward safety, 3) coworkers safety support, 4) construction work pressure and 5) construction site safety management systems.

Safety culture is the exogenous variable, which affects personnel safety motivation to construction safety, personnel's error behavior and personnel's own attitude toward violation behavior. Personnel's safety motivations to construction safety is the mediating variable between safety culture and employee's error behavior as well as employee's own attitude toward violations. Furthermore, demographic variables such as working experience in construction field and work position in the company, as well as frequency of safety training are collected to add another dimension in the study analysis. Table 8 below summarizes the description of all study variables in which they are consisted of exogenous variables, mediating variables and endogenous variables. Also, control or demographic variables are presented in the last section of table 8.

Eight latent variables are evaluated in this quantitative research. Safety culture is an exogenous, or dependent variable, that consists of five factors including management's commitment toward safety, employee's personal attitude toward safety, coworkers safety support, construction work pressure and construction site safety management systems. Personnel safety motivation to construction safety is the mediating variable between safety culture and the dual scales of safety performance. The dual safety performance measures are personnel error behavior and personnel's attitude toward violation in which they are considered to be endogenous variables. The following sections elaborate each latent variable of this study.

3.3.1 Management Commitment toward Safety

Management's commitment toward safety is the first component of safety culture in the study's conceptualized model. It is referred to management support and level of commitment, as well as dedication to safety as perceived by construction workers. It has been generally agreed and mentioned in the literature by prominent researchers that management support and commitment to safety is the most important aspect in measuring safety climate and this is a subcomponent of safety culture (Zohar, 1980; Hall, 2006; Fogarty and Shaw, 2010; Seo et al., 2004; Choudhry et al., 2007). Therefore, safety culture cannot be determined without measuring the level of importance and support management put on safety.

Management commitment toward safety is measured through nine questions adopted from Seo et al. (2004) survey. Cronbach‘s alpha reliability score of this factor is 0.84 as mentioned in Seo et al. (2004) study. However, two identical items in the survey were deleted. Also, supervisor support is considered to be a part of management's commitment and therefore two questions related to supervisor's support are added in management commitment toward safety factor in order to observe the level of consistency and support of safety between levels of management.

The questions of management commitment toward safety construct focused on how safety management commitment and support is actually realized by construction personnel. Also, it includes the evaluation of company's top management attitudes regarding safety essential works and how the management is supporting and dealing with safety issues raised in every day operations, either positively or negatively. For example, "Management motivates workers to report every incident about work safety to supervisors or upper management."

3.3.2 Employees Personal Attitude toward Safety

Employees' personal attitude toward safety is defined as the perception of each person regarding safety values and expectations (Cooper, 2000; Fogarty and Shaw, 2010). In this study, attitude is a term related to how a worker feels regarding safety as a value and as an approach. Therefore, it is expected that people would have different attitudes due to the diversity types of personalities as well as their backgrounds (Cooper, 2000). Also, attitude, as a result, would have an effect on the behaviors and actions of people because it is a reflection of their current values and inner beliefs (Cox and Cox, 1991; Cooper, 2000; Ekval, 1996).

Hall (2006) discussed that a behavior has a subjective tendency to be judged as a negative or a positive behavior. This behavior judgment is performed based on each individual attitude and evaluation is shaped from strong beliefs and values. Employee's personal attitudes toward safety construct consists of questions that are intended to measure individual's evaluation of work hazards, safety equipment practices, workers inner commitment to safety values, workers feelings and opinions regarding the urgency to follow safety regulations and their attitude toward errors and violations in following safety rules. For example, "It is most likely to have accident in a work place where there are no work safety rules."

Employees' personal attitude toward safety is one of the components of predicting safety culture in the study-conceptualized model. It can be considered as a partial measure of safety culture that is necessarily needed to determine the overall safety culture status based on theoretical model of safety culture (Geller 1994; Cooper 2000; Choudhry et al., 2007; Fang and Wu, 2013). Workers attitude regarding safety as a construct is measured by using Hall (2006) risk survey, and this latent factor contained seven questions. In regards to the reliability of this construct adopted from Hall (2006) survey, construct theoretical development and questions can be considered adequately reliable to be adopted and supported according to literature.

3.3.3 Coworkers Safety Support

Coworkers' safety support is one of the components of safety culture, in which it is defined as the accepted or familiar way to do a particular task within a group of people or social environment (Fogarty and Shaw, 2010; Helmreich and Merritt, 2001). The presence of coworkers influence is evident on workers attitude in organizations and it is believed that it would have an impact on workers safety behaviors as well as their safety culture. Organizations tend to have a dynamic, changing culture (Helmreich and Merritt, 2001). This argument is justified due to the existence of subcultures in organizations based on different individuals' characteristics including age, nationality, work experiences, educational level and work position.

The beliefs and behaviors of group members are most likely to influence the attitudes of individuals (Fogarty and Shaw, 2010). Individuals throughout group member interactions interpret events, regulations, policies and procedures. Negative norms or irregular versions of formal rules are more likely to be developed by group members (Helmreich and Merritt, 2001; Galler, 1994; Wiegmann et al., 2004; Zohar, 1980).

Coworkers safety support construct consists of six questions selected from Seo et al. (2004) coworkers support factor that have the reliability of Cronbach's alpha score of more than 0.70. However, one item is edited to suit the cultural environment of Saudi Arabia. Also, coworkers support latent variables, which allow for the measuring of peer's safety priority level, as well as their safety commitment level perceived. Therefore, coworkers' safety support construct has six questions in total. For example, "My colleagues attach importance to assessing working incidents that may cause hazardous accidents."

3.3.4 Construction Work Pressure

Construction work pressure as perceived by construction workers is the forth component of safety culture. It is defined as the apparent workers' understanding regarding the difficulty or easiness to follow safety rules and procedures under time and cost pressure. This view regarding safety adherence and implementation is shaped by workers experiences as well as workers expectations about obstacles to follow safety procedures. Construction work pressure construct is intended to measure the availability of construction safety tools as well as the appropriateness of applying safety procedures when the workers are under pressure to finish the work in a specific timeframe or cost (Hinze, 2007).

Fogarty and Shaw (2010) argued that workers might want to perform the work according to safety rules and procedure but however their actual performance may be impacted by external factor such as pressure to complete a task. Therefore, safety level will be affected negatively. In construction sites environment, work pressure can be caused by shortage of time, lack of required employees, absence of necessary tools and, lastly, a lack of money, which causes contactors to be under pressure to receive their payments. Although work pressure in construction work may seemed to be coming from management only, the project owner as a customer, coworkers and each workers self-made expectations can exert pressure on personnel safety performance (Hinze, 2007). Therefore, sources of construction work pressure should be identified and realized to improve personnel safety culture (Hinze, 2007).

Construction work pressures as a latent factor is measured through six questions to observe several issues including time, pressure as seen by workers, extreme amount of construction work, balance between assigned workload and workers ability to follow safety, obstacles in execution safety procedures, workers proficiency in following safety rules and the availability of necessary safety tools within construction sites. Questions are adopted from Seo et al. (2004) work pressure construct in which it includes seven questions with a reliability Cronbach‘s alpha score of more than 0.80.

However, some of the wording in the questions are altered to suit the nature of construction work. Moreover, there are a couple of identical questions in need of removal. In addition, workers proficiency in following safety regulation is in need of measurement. Therefore, after dropping two items from the survey, one item is included to observe the competency of workers to follow safety and another item is included also to observe the availability and accessibility of safety needed tools provided by construction site management. Finally, construction work pressure as a latent factor has, in total, seven questions. For example, “In my workplace, cut corners and risky attitudes are common because of heavy workload.”

3.3.5 Construction Site Safety Management System

Construction site safety management system is a critical technical component that needs to be measured in order to evaluate safety culture in the construction field. This latent factor includes assessing four important construction safety management components including safety rewards or incentives, safety enforcement and disincentives for unsafe behavior, subcontractors safety compliance and safety system accountability and commitment. All the questions used in this construct are adopted from Molenaar et al. (2009) study in which they developed a comprehensive survey to measure safety culture specifically for construction companies. Molenaar et al. (2009) survey was fitted to their safety culture study model through factor analysis using several iterations until the fitting of their model was satisfied. They developed the questions based on theoretical background from prominent models of safety culture created previously in the literature. Also, statistical analysis was used through doing explanatory factor analysis in which they reduce their original number of questions in their survey from 54 to 19 questions only through several iterations that have the highest correlation on safety culture (Molenaar et al., 2009).

The first subcomponent of construction safety management system is safety rewards or incentives. The questions of safety incentives and rewards includes the amount of safety feedback or reports received by management or from management, workers understanding of feeling appreciated and thanked when they do the work in a safe manner, how frequent incentives for safety are introduced and, lastly, how valuable the safety rewards and incentives given by management are, as perceived by construction personnel (Molenaar et al., 2009). There are four questions to measure safety management rewards and incentives. For example, “as a general understanding, do employees think that they will be acknowledged and thanked when they perform the work in safe manner?”

The second subcomponent of construction safety management system is safety enforcement and disincentives of unsafe behaviors. It is defined as how the safety management ensures that unsafe work will be punished consistently regardless of accidents occurrence. Also, it is related to safety performance tracking and the enforcement of necessary corrective actions if unsafe behavior or violation occurred. This subcomponent contains three questions measuring consistency of corrective actions for unsafe act, the general understanding that unsafe behavior will not be tolerated as perceived by workers and lastly the degree level of safety rule enforcement occurred when violation happened but no accidents resulted (Hartshorn, 1998; Molenaar et al., 2009). For example, “To what levels are safety procedures imposed when violations occur but no accident results.”

Subcontractors’ safety compliance is the third subcomponents of construction safety management system factor. Subcontractors are having an integral role in achieving good safety level in any large construction company (Hinze, 2007; Molenaar et al., 2009). It is defined as subcontractors’ commitment to safety programs and their effective participation in complying with safety procedures. Hence, measuring subcontractors’ safety compliance is implemented using two questions that include the level of importance subcontractors think about safety application and the frequency of hired subcontractors’ attendance to safety meeting as well as safety training sessions (Molenaar et al., 2009). For example, "Subcontractors in the construction project often attend safety training and meeting."

Lastly, the fourth subcomponent intended to measure safety management system in construction sites is the established practices of safety accountability and commitment within the safety management system. It is defined as how management applies construction safety programs effectively in which hazards analysis and prevention is being implemented along with conducting behavior modification for any unsafe behaviors that may be noticed (Molenaar et al., 2009). Also, safety accountability and commitment is an integral part of the safety management system. It is intended to measure the effectiveness of safety by determining safety responsibilities and level of importance workers think about safety in practical way through different level of construction safety management (Molenaar et al., 2009). There are five questions adopted to measure safety commitment and established safety accountabilities in the construction safety management system. For example, "I feel safety management in my company actions convey a sincere commitment to safety."

Construction safety management system is the fifth component used for measuring safety culture in construction site. In total, it contains 17 questions to measure the different critical aspects of construction safety management systems in practical way. It is critical to make appropriate attention toward the technical aspects of the work nature and details before beginning measuring its safety level. For this reason, this component is very important in measuring safety culture in construction sites due to its technical relation to the nature of work in construction field. Nevertheless, all the questions adopted for this construct designed solely to suit the nature of safety work in construction environment.

3.3.6 Personnel Safety Motivation

In this study, personnel safety motivation as a latent factor in the conceptual model is used as a mediator variable between safety culture in the construction environment and workers safety performance through measuring workers error behavior and workers attitude toward violation behavior. Safety motivation variables address the role of communication and positive feedback between management and workers to encourage safety practices and also to increase workers attachment to perform the work in a safe manner. Moreover, it is expected in this study that safety culture will have an effect on personnel safety motivation because if the culture of safety is high then safety motivation is going to be the same and the opposite is true as well.

This is justified by the argument that safety culture encompasses individuals' values and beliefs regarding safety as well as the consequences of them being seen as actual behaviors. Therefore, safety culture relates to safety motivation and safety adherence since the motivation feeling comes from internal values and morale of the people shaped by the existing culture (Choudhry et al., 2007; Mohamed, 2002; Zohar, 1980).

Personnel safety motivation is measured using five questions adopted from Vinodkumar and Bhasi (2010) safety motivation construct in which it has an internal consistency reliability score of 0.72. Vinodkumar and Bhasi (2010) used safety motivation as a mediator between safety management practices and safety performance and they found significant relationships between safety climate metrics and safety motivation, including safety communication and management commitment. Safety motivation questions mainly focus on the level of priority and importance each workers feels about safety as an engraved value affected by safety culture. For example, "Do I feel it is crucial that management improve safety program continuously?"

3.3.7 Personnel Error Behavior

Personnel error is the first factor that measures safety performance of construction personnel beside personnel own attitude toward violation behavior construct. Safety performance was measured in this study using both variables of workers' errors and their attitude toward violation behaviors. This construct is measured using Seo et al. (2004) unsafe behavior factor to capture the reasons of error behavior including decision, skills or communication errors that consequently lead to unsafe error behavior (Wiegmann and Shappell, 2001). There are four questions selected to measure personnel misconduct behavior from Seo et al. (2004) survey. The questions are focusing on measuring workers decision making ability to follow safety rules consistently, the skills workers need to have to work safely and lastly the workers wiliness to perform work in safe manner if there is a pressure or ambiguity regarding work specification which is called perceptional error. For example, "I do not have any hesitation to follow safety procedures and policy when performing a construction task."

3.3.8 Personnel Own Attitude toward Violation Behavior

Personnel attitude toward violation is the second factor that measures safety performance of construction personnel beside workers error behavior construct. It is defined as the way workers think about safety violation by performing construction work in less time without constraining themselves to follow safety standards and procedures especially under time or cost pressure. Also, it reflects workers will to report any safety violation to management if their peers performed it. Five questions selected from Fogarty and Shaw (2010) to measure personnel attitude toward violations including common and infrequent violation behavior. The questions focus on the willful attitude of workers to violate safety regulation and their responsibility to perform work safely even with the existing pressure of time and cost. For example, “I am aware of my responsibility for safety work in my company to perform work as safe as possible.”

Table 8 Summary of the Study Variables

Study variables	Dimensions	Variables Descriptions
Safety Culture *Exogenous Variables*	Management Commitment toward Safety	Management's support, level of commitment and dedication to safety as perceived by construction workers.
		Evaluation of company's top management attitudes regarding safety essential works.
		How management is supporting and dealing with safety issues rising in every day operations either positively or negatively.
	Employees Attitudes toward Safety	Perception of each worker regarding safety values and expectations, workers feelings and opinions regarding the urgency to follow safety regulations.
		Individual's evaluation of work hazards, safety equipment usage and workers inner commitment to safety values.
	Coworkers Safety Support	Accepted or familiar way to do a particular task within a group of people or social environment.
		Existence of subcultures in organizations based on different individuals characteristics that influence safety adherence.
		Peers safety priority influence as well as their safety commitment influence perceived between each other.
	Construction Work Pressure	Apparent understanding of workers regarding the difficulty or easiness to follow safety rules and procedures.
		Time and cost pressures as seen from workers view, extreme amount of construction work, balance between allotted workload and workers ability to follow safety rules.
		Obstacles in execution safety procedures, workers proficiency in following safety procedures and the availability of necessary safety tools within construction sites.
	Construction Safety Management System	Amount of safety feedback or reports received to or from management, workers understanding of being appreciated and thanked when working in a safe manner, frequency of safety incentives and values of safety rewards.
		Consistency of corrective actions for unsafe act, general understanding that unsafe behavior is not tolerated and the degree of safety rules enforcement when violation happened but no accidents resulted.

Study variables	Dimensions	Variables Descriptions
Safety Culture *Exogenous Variables*	Construction Safety Management System	Importance subcontractors placed on safety and the frequency their attendance to safety meeting and training.
		Management safety system accountability application in construction safety program, hazards analysis and prevention implementation and behavior modification for unsafe behaviors.
Personnel Safety Motivation *Mediating Variable*		The levels of priority and importance personnel feel about safety as an engraved value affected by safety culture. Personnel encouragement to perform safety practices and personnel level of attachment to perform the work in safe manner.
Personnel Safety Performance *Endogenous Variables*	Error Behavior	Error in personnel decision making ability to follow safety rules, employees skills errors to do construction work safely and workers willingness to perform work safely if there is misperception or pressure in doing the work.
	Violation Behavior	The way personnel think about safety violation behavior and performing construction work in less time without following safety standards. Also, it reflects personnel own well to report or discuss safety violation if it was performed by their peers.
Demographic Variables	Nationality	Open ended answer by the respondent.
	Language	Open ended answer by the respondent.
	Age	Under 26, 26-31, 31-35-36-42 and older than 42.
	Education	None, High School, Collage, Bachelor, Master and PhD.
	Work Experience	Fewer than 5 years, 6-10, 11-15, 16-20 and more than 21 years.
	Work Position	Project Manager, Engineer, Safety Officer and Supervisor.
	Frequency of safety Training	Never, 1 to 3 times, 3 to 7 times, more than 7 times.

3.4 Procedures

Since the study takes place with the governmental mega construction projects in Saudi Arabia, a written approval must be obtained before any form of data collection or survey deployment can be initiated. Along with the survey, the first page attached is an explanation letter addressing the study goals and purposes as well as stressing the considerations of participants' confidentiality right. Moreover, participation in this study is optional for all construction personnel including supervisors, engineers, site managers and safety officials. In this study, all the information provided by the study participants are collected anonymously to make them comfortable in the selection of their responses both truthfully, as well as ensuring their protection from harm and the preservation of their right of privacy.

Survey distributions in construction sites are not an easy task, especially if there is a need for accurate and reliable data collection. There are three methods of data collection employed in this study, electronic, in-person and delegation method. The electronic method is implemented through the dispersal of emails to construction project managers and engineers to complete the surveys electronically by themselves. Each email contains information about study objectives and a link to the study's questionnaire. In-person method of data collection involves site visiting and distributing the surveys by conducting meetings and interviews with construction personnel either in a group setting or individually. Lastly, the delegation method of data collection involves asking one of the influential personnel in the construction project to distribute the survey to the construction site personnel and return them back upon completion.

All the three methods are applied to increase the number of responses and also to suit all construction personnel circumstances and needs to get the required information in an optimum and accurate manner.

3.4.1 Human Participation in the Study

This study involves the employment of a survey instrument to get the responses of construction personnel in large government construction projects in Saudi Arabia. Due to the needs for participations of people, it is crucial to acquire the approval from the Institutional Review Board (IRB) before the implementation of data gathering using the survey tool. The cover letter of the questionnaire contains a participation invitation as well as an informed consent that is needed and must be obtained from each participant before beginning the survey questions.

Survey completion was voluntary to all construction personnel who participated in the study and all participants were informed that they had the right not to complete the survey at any time of their participation. The survey study guaranteed privacy of all contributed information given by participants through collecting data anonymously to ensure the right of participants by not having any risk or harm while volunteering in this study. It is the researcher's responsibility to ensure that all participants of the study do not have any kind of harmful experience and to maintain their right of privacy.

All the reordered responses must be secured and confidential. Therefore, any identifiable personal information was not intended to be collected in the survey such as, personal name and Job ID number. Finally, all the collected demographic information including work experiences, job position, frequency of safety training and education were anonymous and general in which it cannot ever be related to a specific individual.

3.5 Study Population and Sample Size

The study population was the construction personnel who are currently working as middle managers in government mega construction projects in Saudi Arabia. A written authorization letter was obtained to access the governmental construction sites in order to begin the data collection process through survey distribution. This study intended to collect information from all construction workforce including engineers, supervisors, site managers and safety officers. There are several arguments that have existed in regard to the needed population or sample size to assure that statistical analysis of the study model is valid. There is a claim that a sample size of 200 cases is considered to be reliable enough to generate a valid model as the issue of the power analysis of the model is unlikely to occur (Kline, 2011; Xiong et al., 2015). However, it is reported in the literature that researchers using structural equation modeling (SEM) approach used sample sizes less than 200 cases (Xiong et al., 2015; Bagozzi and Yi, 2012). Kline (2011) and Bentler and Chou (1987) stated that the estimation of sample size using structural equation modeling should be done in regards to the number of observed parameters or variables. Bentler & Chou (1987) stated that sample size should be at least 5 times the number of parameters or observed variables in the SEM model with more favorability to be 10 times the number of estimated parameters (Kline, 2011). Other researchers argued that SEM model must have a population sample size more than 100 to be valid (Bagozzi and Yi, 2012).

Xiong et al. (2015) did a study in which they reviewed 84 SEM models previously published in the literature in the area of construction engineering and management. They found that more than 30 percent of the reviewed SEM models had a sample size of less than 100, and more than 70 percent have a sample size of less than 200 (Xiong et al., 2015). Moreover on Xiong et al. (2015) study, they found that more than 85 percent of the implemented SEM models in construction engineering management field have a sample size less than 5 to 1 ratio representing required number of sample size in respect to the number of questionnaire items.

The sample size has a substantial impact in making statistical interpretations about a studied population sample. Leedy and Ormrod (2013) stated the logical assumption that whenever the sample size can be larger, that better study results could be gained, as well. The ideal sample size obtained for the current study will depends on the population size of construction workers in Saudi Arabia. According to GOSI in Saudi Arabia (2014), the number of personnel working in constructions sites at Saudi Arabia is 2,174,962 workers. Therefore, by using confidence interval level as 95% and 50% level of variability, the ideal sample size for this study should be 384 and it is considered to be large compared with the minimum required sample size of 200 (Kline, 2011). It is beneficial for the researcher to consider all the sampling sizes appropriate methods to make the SEM model valid. The exploration of the acceptable sampling methods enables the researcher to have multiple options to decide which sampling method is better to be employed. This based on the available resources and the timespan of the statistical analysis of the projected research.

3.6 Statistical Analysis

The statistical procedures in this study comprised of descriptive statistics, confirmatory factor analysis (CFA) for the proposed model and structural equation modeling (SEM) to analyze the relationships between model factors, as well as to test the study hypotheses. Each method of the statistical analysis used in this study is elaborated in the following sections.

3.6.1 Descriptive Statistics

Descriptive statistics are used to analyze the participant information based on the provided demographical data. The researcher can get many insights through analyzing the participant responses based on each demographical variable by calculating frequency of each demographic variable including minimum value, maximum value, mean value and standard deviation value. Demographic information includes educations, safety training, age, work position and work experiences. Data check is a part of descriptive statistics and it is performed by checking outliers data, missing data, doing normality check, linearity check and homoscedasticity test to check for any potential analysis weaknesses that can be improved upon, which may have negative effects on the study reliability and validity.

While conducting descriptive statistics in the study, it is important to check for multicollinearity issues due to its common occurrence in survey research (Kline, 2011). Multicollinearity problems are shown in the correlation matrix of the study variables which indicates that at least one independent variable or more are highly correlated with one or more independent variables. As a result, this means that they are both measuring the same concept (Brown, 2006).

Correlation matrix check is crucial in the study to make sure adequate correlation is present between study variables (Brown, 2006; Kline, 2011; Schumacker and Lomax, 2004). A correlation of more than a 0.85 is a sign of multicollinearity problem (Brown, 2006; Kline, 2011). Multicollinearity for each latent factor is checked and identified using Spearman's correlation matrix due to the ordinal experimental nature of the collected data (Brown, 2006; Kline, 2011; Schumacker and Lomax, 2004).

3.6.2 Confirmatory Factor Analysis

Schumacker and Lomax (2004) defined confirmatory factor analysis (CFA) as a type of statistical factor analysis, which tests whether a group of items belong to a specific factor or construct. CFA is applied in this study to validate the proposed study measurement model related to the defined study variables with their connected measurable items for each latent factor. CFA as a factor analysis technique, determines the validity for each latent variable by investigating if a set of items related to each latent factor is really measuring what is aimed to be evaluated and quantified (Brown, 2006; Harrington, 2009; Schumacker and Lomax, 2004).

Confirmatory factor analysis is a powerful tool to test goodness of fit of the study model. Many methods have been mentioned in the literature regarding goodness of fit assessment. However, there is a consensus that validating each construct or latent factor individually would be the most reliable way to assess any possible weaknesses in model fit (Hooper et al., 2008). The statistical procedures of CFA require an existing and strong hypothetical study model for evaluating and validating the goodness of fit of model parameters for each latent variable (Brown, 2006; Harrington, 2009).

The measurement of model goodness of fit indicates the degree to which the hypothesized model fits the actual data collected. Many researchers argued that a single or a few measures of goodness of fit is not effective enough to judge the model fitness of the collected data (Brown, 2006; Harrington, 2009; Hooper et al., 2008). Hence, four measures of goodness of fit are adopted in this study because it is recommended to use a reasonable number of goodness of fit criteria to be able to assess the model fitness to the collected data accurately. In this research, four fit indices are adopted to assess the proposed study model fitness to the data. The goodness of fit indices used in this study are the following 1) chi-square statistical index, 2) comparative fit index (CFI), 3) Tucker-Lewis index (TLI) and 4) root mean square error of approximation (RMSEA).

Chi-squared as goodness of fit index intends to compare the examined model with an excellent fit hypothetical model to assess the ratio of fitness between them. It measures how the model is appropriately fitting the collected data (Brown, 2006; Harrington, 2009; Schumacker and Lomax, 2004). It is preferable to have a lower value of Chi-squared index because it shows a better model fitness to the data. Sample size has a dominant role in Chi-squared index value due to its proportional relationship with sample size. Nevertheless, former scholars mentioned that a value between two and three of chi-square over the degree of freedom ratio indicates a satisfactory model fitting.

Moreover, comparative fit index (CFI) and Tucker-Lewis index (TLI) are used to measure model fitness to the data. Comparative fit index (CFI) measures model fitting through the comparison between the created study model, with another independent model in which all of its variables are not correlated to test model assumptions discrepancy. The third measure of model goodness of fit is Tucker-Lewis index (TLI) and its working mechanism and acceptable output follows the basis of CFI index and both of them having a lesser amount of sensitivity to sample size compared to chi-squared index. It is recommended to have both CFI and TLI indexes as greater than 0.90 and less than 0.95 but not less than 0.90. However, CFI and TLI values can be greater than 0.95, which is considered to be an excellent fitting value. Nevertheless, if both values of CFI or TLI are less than 0.90, then there is a necessary need for model reconstruction (Brown, 2006; Harrington, 2009; Kline, 2011; Schumacker and Lomax, 2004).

Lastly, the root mean square error of approximation (RMSEA) index is the fourth goodness of fit measure adopted using confirmatory factor analysis. RMSEA intends to evaluate model complexity to rather measure the close fit of population data to the study model (Brown, 2006). Whenever the RMSEA has a lower value, the better model fitting is resulted due to fewer fit running approximations. Generally, RMSEA value is acceptable if it is less than 0.05 and it indicates an excellent level of model goodness of fit (Harrington, 2009; Kline, 2011). Furthermore, the range of RMSEA index values between 0.05 and 0.08 is a signal of a sufficient fit as well. Finally, if the model has RMSEA value of 0.10 or more, then the model is not fitting the data and it is considered to have a poor goodness of fit (Brown, 2006; Harrington, 2009; Kline, 2011; Schumacker and Lomax, 2004).

3.6.3 Structural Equation Modeling

Structural equation modeling (SEM) is referred to a set of statistical techniques used for testing a conceptual proposed study model. The SEM approach enables the researchers to conduct a wide range of statistical methods including confirmatory factor analysis, path analysis and multiple regression analysis (Kline, 2011; Schumacker and Lomax, 2004). The main purpose of structural equation modeling (SEM) approach is to find out the degree to which the hypothesized model for a research study is maintained and supported by sampling data from intended population. Therefore, it is a method for investigating model validity and hypothetical assumptions with the use of empirical data.

The main use of the SEM approach is to test the proposed hypotheses of the study model because it is known to be described as the “second generation” multivariate exploration technique and is widely applied in theoretical studies, as well as empirical justifications in many disciplines including construction industry (Xiong et al., 2015). Furthermore, SEM as a statistical method determines the relationships and directional influence either to be direct or indirect effect between the model’s latent variables in which each one of them has a set of observed variables in the conceptualized study model (Schumacker and Lomax, 2004).

Structural equation modeling (SEM) has been commonly, and successfully, employed in most of survey research in behavioral and social sciences due to its ability to improve and validate the latent constructs or the unobserved variables in the measurement models effectively

(Schumacker & Lomax, 2004; Byrne, 2013; Kline, 2011). Moreover, SEM methodology mainly consisted of two parts, the measurement model and the structural model (Schumacker and Lomax, 2004). The measurement model explains how well the various numbers of measure latent variables observed or exogenous variables including some measurement properties like reliability and validity for each latent construct (Schumacker and Lomax, 2004). Additionally, the structural model associates latent variables with each other to measure the relationships between them, such as the direct and indirect effects, as well as the explained and unexplained variances accounted for in each latent variable (Molenaar et al., 2000; Schumacker and Lomax, 2004). These two parts of SEM are linked together using system of regression equations (Schumacker and Lomax, 2004).

SEM incorporates path analysis technique to develop the structural model of the study along with the measurement model as well (Molenaar et al., 2000). Latent variables are represented as oval shapes graphically and they cannot be measured or observed directly. Rather, they are inferred from other observed or measurable variables which are represented graphically as square shapes. Nevertheless, structural equation modeling has been considered as the most suitable statistical technique for analyzing the relationships between latent or unobserved constructs through a set of observed variables related to each latent factor (Byrne, 2013; Schumacker and Lomax, 2004).

The purpose to using structural equation modeling in this research area for evaluating personnel safety culture in construction sites is to test the proposed structural model of safety culture after validating the measurement model using confirmatory factor analysis. SEM methodology examines the relationships between latent factors of the study model extracted by doing an extensive literature review to investigate the study hypotheses statements. The latent factors in this study include construction safety culture as an exogenous variable, construction personnel safety motivation as a mediating variable, and safety performance for both endogenous variables, including personnel errors behavior, as well as personnel attitude toward violation behaviors within the construction environment. Therefore, SEM is the core statistical methodology and the framework that guided this study for testing and evaluating the latent factors in the safety culture hypothesized model.

CHAPTER 4: FINDINGS

4.1 Overview

The results of the study are presented in this chapter based on the detailed methodology addressed in the preceding chapter. Four kinds of statistical analysis are applied in this study to analyze the collected data. These are descriptive statistics, multicollinearity check, confirmatory factor analysis and structural equation modeling. At the beginning, descriptive statistics was used to analyze the frequency of demographic variables. Data from participants who did not complete all the survey questions were excluded because of the missing data in their responses. Then, multicollinearity check was implemented by conducting a Spearman's rho correlation matrix for each latent variable to detect any signs of multicollinearity problems.

Structural equation modeling (SEM) was used in this study to examine the effect of safety culture on safety performance including errors and violation behaviors within the construction sites. Moreover, SEM was used to investigate the mediating influence of safety motivation for construction safety between safety culture and safety performance in construction fields. Validating the measurement model is considered to be the initial first step when conducting structural equation modeling (Kline, 2011; Schumacker and Lomax, 2004). In order to properly validate the measurement model using SEM, confirmatory factor analysis must be applied for each unobserved or latent variable in the study.

Applying confirmatory factor analysis (CFA) for each latent factor will validate each construct along with its indicators or observed variables. Then, when the validation of all latent constructs in the research model is conducted separately for each latent factor, CFA is applied in aggregated manner for all latent variables together in order to validate the whole measurement model. Each measurement model analyzed has an internal consistency score that is calculated and assessed using Cronbach's alpha index.

When the validation of the measurement models is finalized, the structural model is established containing all endogenous and exogenous variables to evaluate the influences between safety culture and safety motivation for construction safety, then construction personnel error behaviors and their attitude toward violation. The measurement model and structural model needs revision if there is a poor model fit or weak relations among study variables. The revision process of the original model can improve the model overall fit and eliminate the sources of inappropriate fitting. The following sections describe the revision process of the original model including the measurement model and the structural model. Finally, testing the hypotheses of the study was implemented in accordance to the results obtained from conducting structural equation modeling.

4.2 Survey Statistics

The research population is the construction personnel who work in government construction sites in Saudi Arabia. This study targeted the middle management level in these construction sites due to the nature of questions assessing the safety management system and management commitment to safety. Taibah University located in Madinah was the host organization of this research. This study was hosted by a government institution in Saudi Arabia to facilitate the data collection and to give the study the needed authority to have an access to government construction sites.

In order to maximize the response rate, three methods of data collection have been employed in this study including electronic, in-person and delegation method. The main method was the electronic method, which was facilitated by the host organization in Saudi Arabia. The electronic method included a web based survey using (https://ucf.qualtrics.com) that was sent to construction personnel working in government construction sites. Also, the in-person method of data collection was implemented through visiting construction sites and conducting meetings and interviews with construction personnel either in-group or individually. The third method involved the delegation of data collection by asking one of the influential personnel in the construction projects to distribute the survey. Using the three distribution methods as indicated above, the survey was distributed to 866 construction personnel in governmental construction sites. An overall of 434 respondents completed all survey questions. Thus, the survey response rate used in this study was 50.11%.

4.2.1 Demographic Variables

Demographic variables in this study are the control variables collected from the participating construction personnel to deliver a broader look into the research outcomes. Eight control variables are collected from participating construction personnel including nationality, language, age, education, work experience within theconstruction field, work position in the company, and frequency of safety training.

Nationality was the first demographic variable collected. The nationality information was an open-ended question answered by the survey respondent to accommodate all nationalities. Most of the participants are from Saudi Arabia. A total of 387 participants (89.2%) were from Saudi Arabia. The remaining participants whom they constitute less than 11% of the respondents were from twelve different countries including Egypt, Kuwait, Iraq, Jordan, Britain, Syria, Slovakia, Palestine, Morocco, Tunis, Sudan and Yemen. Table 9 shows the frequency of respondents' nationalities along with the percentage each nationality constitutes from the total number of participants.

Table 9 Statistics of participants' nationalities

Nationality	Frequency	Percent	Cumulative Percent
Saudi	387	89.2%	89.2%
Egyptian	15	3.5%	92.6%
Kuwaiti	2	0.5%	93.1%
Iraqi	1	0.2%	93.3%
Jordanian	9	2.1%	95.4%
British	1	0.2%	95.6%
Syrian	6	1.4%	97.0%
Slovakian	1	0.2%	97.2%
Palestinian	1	0.2%	97.5%
Moroccan	2	0.5%	97.9%
Tunisian	1	0.2%	98.2%
Sudanese	5	1.2%	99.3%
Yemeni	3	0.7%	100.0%
Total	434	100.0	

The second and third demographic variables are the language and gender of participants. Because the study conducted in Saudi Arabia, most of the participants' language is Arabic. A total of 418 participants (96.3%) indicated that their mother language is Arabic. The remaining participants indicated that their mother languages are English (2.8% of the participants) and less than 1% indicated that they speak other languages including German and Gujarati language. In regard to the gender of the participants, 99.1% of the survey respondents were male. That is justified by the nature of the construction work environment as well as the culture of Saudi Arabia. Table 10 and table 11 show the response count and percentage of both language and gender of the construction personnel participated in this study.

Table 10 Language demographic variable descriptive statistics

Language	Response Count	Percentage	Cumulative Percent
Arabic	418	96.3%	96.3%
English	12	2.8%	99.1%
Other	4	0.9%	100%

Table 11 Statistics of participants' gender

Gender	Response Count	Percentage	Cumulative Percent
Male	430	99.1%	99.1%
Female	4	0.9%	100.0%

Age is the fourth demographic variable in the study. Most of the respondents were in the age category from 26 to 30 years with a total number of responses of 134 (30.9%). Also, a total of 120 participants (27.6%) were in the age category from 31 to 35 years. Age category from 36 to 40 years had a total of 67 respondents (15.4%) and the numbers of participants who are older than 40 years old came to 88 respondents (20.3%). Lastly, the numbers of participants who are younger than 26 years old is very small, with 25 participants (5.8%) and that is justified because the study targeted middle managers, which usually they have several years of experience and are expected to have an age that is older than 26 years. Table 12 shows the response count and percentage of the age category of the construction personnel participated in this study.

Table 12 Statistics of participants' age

Age	Response Count	Percentage	Cumulative Percent
Under 26 years	25	5.8	5.8
26-30 years	134	30.9	36.6
31-35 years	120	27.6	64.3
36-40 years	67	15.4	79.7
More than 40 years	88	20.3	100.0

The fifth demographic variable is the education level. Most of the participants indicated that they have a bachelor degree with a total number of 278 participants (64.1%). Moreover, 89 participants indicated they have a master degree constituting 20.5% of the total sample size. A total of 28 participants (6.5%) indicated they have a PhD degree and 25 participants indicated they have a diploma (5.8%). The rest of participants indicated they have a high school-level education, with ta otal number of 13 participants (3%). Only 1 participant (0.2%) did not complete high school. Table 13 shows the response count and percentage of the education level of the construction personnel participated in this study.

Table 13 Statistics of participants' education level

Education Level	Response Count	Percentage	Cumulative Percent
Unfinished High School	1	0.2%	.2%
High School	13	3.0%	3.2%
Diploma	25	5.8%	9.0%
Bachelor	278	64.1%	73.0%
Master	89	20.5%	93.5%
PhD	28	6.5%	100.0%

The sixth control variable in this research is the position of the participants in the construction field. There were 77 Project managers (17.7%), 199 engineers (45.9%), 57 safety engineers (13.1%), and 68 supervisors (15.7%). Other participants including consultants and administrative personnel were 33 participants (7.6%). Table 14 shows the response count and percentage of the position of the construction personnel participated in this study.

Table 14 Statistics of the work position of construction personnel participated in the study

Position	Response Count	Percentage	Cumulative Percent
Project Manager	77	17.7%	17.7%
Engineer	199	45.9%	63.6%
Safety Engineer	57	13.1%	76.7%
Supervisor	68	15.7%	92.4%
Other	33	7.6%	100.0%

The survey of this study collected information about the participants' years of experience in the construction field. A total of 164 participants (37.8%) had less than 5 years of experience, 128 of participants (29.5%) had 6 to 10 years of experience, 46 of participants (10.6%) had 11 to 15 years of experience and 31 of respondents (7.1%) had 16 to 20 years of experience in construction field. Lastly, 65 respondents (15%) of construction personnel participated in this study had more than 21 years of experience. Table 15 shows the response count and percentage of the years of experiences of the construction personnel participated in this study.

Table 15 Statistics of the years of experience of construction personnel participated in the study

Years of experience	Response Count	Percentage	Cumulative Percent
Less than 5 years	164	37.8%	37.8%
6-10 years	128	29.5%	67.3%
11-15 years	46	10.6%	77.9%
16-20 years	31	7.1%	85.0%
More than 21 years	65	15.0%	100.0%
Total	434	100.0%	100.0%

The last demographic variable collected in study is the frequency of safety training of the participants in these construction sites. A total number of 211 participants (48.6%) indicated that they had safety training more than one time, but less than four times. Also, 134 of respondents (30.9%) indicated they had safety training more than four times. On the other hand, 89 of participants (20.5%) indicated that they never had safety training. Table 16 shows the response count and percentage of the frequency of safety training of the construction personnel participated in this study.

Table 16 Statistics of the frequency of safety training of construction personnel participants

Frequency of Safety Training	Response Count	Percentage	Cumulative Percent
Never	89	20.5%	20.5%
1-4 times	211	48.6%	69.1%
More than 4 times	134	30.9%	100.0%
Total	434	100.0%	100.0%

4.2.2 Multicollinearity Test

The second stage of descriptive statistics in this research is to test all the latent factors for multicollinearity issue due to its common occurrence in survey and social research (Kline, 2011; Schumacker and Lomax, 2004). Multicollinearity issue has an adverse effect on the statistical analysis (Kline, 2011). Therefore, it is always recommended to check for multicollinearity during the early stages of statistical analysis to ensure accurate results (Schumacker and Lomax, 2004).

Multicollinearity is detected by analyzing the correlation matrix of the study's latent variables. Specifically, multicollinearity occurs when at least one of the variables or more is highly correlated with other variables in a latent construct, implying that they are both assessing a similar variable (Brown, 2006). Therefore, inspecting the correlation matrix is vital in this study to confirm that adequate correlations are presented between the observed variables for each latent construct (Brown, 2006; Schumacker and Lomax, 2004).

Testing and identifying possible multicollinearity problems for each latent variable was performed using Spearman's correlation matrix because all collected data in this research is ordinal in nature (Brown, 2006; Kline, 2011; Schumacker and Lomax, 2004). If the correlation is more than 0.80 between any two variables, it is considered an indication of multicollinearity problem (Brown, 2006; Kline, 2011). Therefore, 0.80 correlation level or more between two variables in a latent factor was used in this study as an elimination rule of one of the correlated observed variables to resolve the multicollinearity issue.

Spearman's correlation matrix was implemented for all five factors of safety culture, including management commitment toward safety, employee personal attitude toward safety, coworkers safety support, construction work pressure and construction sites safety management system. Furthermore, Spearman's correlation matrix also applies for personnel safety motivation, personnel error behaviors and personnel attitudes toward violations in construction sites. The following subsections describe the multicollinearity check for each latent variable in this research.

4.2.2.1 Management Commitment toward Safety

The first factor of safety culture in this research is management's commitment toward safety. It refers to management's devotion and level of commitment and support to safety as observed by construction personnel. Management's commitment latent factor consisted of nine observed variables addressing 1) administration's commitment to safety, 2) top management attitudes regarding safety, and 3) the way management deals with daily operational safety concerns. The correlation check for multicollinearity was performed using Spearman's correlation matrix to all nine observed variables of management's commitment latent variable. The results of the Spearman's rho correlation matrix for all the indicators of management's commitment latent factor are shown in Appendix C. All correlations between the nine indicators of management commitment are significant at 0.05 level. Moreover, the highest correlation among them was 0.668 in which indicates that all of the correlations are less than the cutoff point of multicollinearity which is 0.80. Therefore, multicollinearity issues do not exist among all observed variable of management commitment.

4.2.2.2 Employee Personal Attitudes toward Safety

The second dimension of safety culture in this research is employee attitudes toward safety, which discusses the view of each construction site's middle manager about safety values and beliefs. Employee attitudes toward safety includes, seven observed variables to measure personnel evaluation of safety risks, employees internal obligations, and their feeling and opinions concerning the urgent need to maintain and follow safety rules and regulations. The correlation check for multicollinearity was executed using Spearman's correlation matrix to all seven observed variables of employee attitudes toward safety as a latent variable. The result of the Spearman's rho correlation matrix for employee attitude toward safety latent factor is shown in Appendix C. All correlations between the seven indicators of employee attitudes are significant at 0.05 levels. Furthermore, the maximum correlation among them was 0.593, which shows that all the correlations are less than the cutoff point of multicollinearity at 0.80. Therefore, multicollinearity issues do not exist among all observed variable of employee personal attitudes toward safety construct.

4.2.2.3 Coworkers Safety Support

Coworkers' safety support is the third component of safety culture in this study, which refers to the influence of the presence of coworkers as a group norm on employee safety attitudes in an organization (Helmreich and Merritt, 2001). Coworkers' safety support as a latent construct contains six observed variables to measure the priority of safety placed by coworkers as a group norm as well as their commitment to follow safety procedures. The correlation check for multicollinearity was implemented using Spearman's correlation matrix to all six indicators of coworkers safety support. Appendix C shows the result of the Spearman's rho correlation matrix for coworkers' safety support latent factor. All correlations among the six indicators of coworkers safety support are significant at 0.05 levels except only three pairs. Furthermore, all the correlations among the six variables are less than the cutoff point of multicollinearity, which is 0.80. The maximum correlation among them was 0.709, where it is still under the cutoff point of multicollinearity problem. Therefore, multicollinearity issues do not exist among all observed variables of coworkers safety support construct.

4.2.2.4 Construction Workplace Pressure

The fourth dimension of safety culture is workplace pressure in which it measures personnel perception and experience about following safety regulations under scheduling or budget pressure (Hinze, 2007). Construction workplace pressure as a latent construct contains seven observed variables to measure construction work under time and cost pressure. Construction work pressure construct measures the tradeoff between workers choice and their past practices to follow safety rules or ignore them, easiness to acquire safety equipment and apply safety procedure when time and budget pressure are present on construction sites.

The correlation check for multicollinearity issue was implemented using Spearman's correlation matrix to all seven observed variables of construction workplace pressure as a latent variable. Spearman's rho correlation matrix for workplace pressure construct is shown on Appendix C. All the correlations among the seven observed variable of workplace pressure are significant at 0.05 level excluding four pairs between indicator WP7 with WP1, WP2, WP4, and WP5. This suggests further investigation when doing confirmatory factor analysis in the next step to assess the possibility of eliminating indicator WP7. Nevertheless, all the correlations among the seven variables are less than the cutoff point of multicollinearity which is 0.80. The maximum correlation among them was 0.455 and therefore, multicollinearity issues do not exist among all observed variables of construction workplace pressure construct.

4.2.2.5 Construction Sites Safety Management System

The fifth component of safety culture is construction safety management systems, which evaluates the effectiveness and performance of the existed safety management system in the construction field. Specifically, safety management system as a latent variable consisted of 17 indicators to measure safety execution, safety incentive system, safety behavior modifications for unsafe performance and safety compliance for subcontractors as well as safety accountability system in the construction fields.

The correlation check for multicollinearity issue was implemented using Spearman's correlation matrix to all seventeen observed variables of construction safety management systems latent variable. Spearman's rho correlation matrix results for safety management systems construct is shown on Appendix C. All the correlations among the seventeen observed variable of safety management systems are significant at 0.05 levels. Furthermore, all the correlations among the seventeen variables are less than the cutoff point of multicollinearity, which is 0.80. The maximum correlation among them was 0.70 and is less than the limiting correlation sign of 0.80. Therefore, multicollinearity issue did not occur among all observed variables of safety management systems latent factor.

4.2.2.6 Personnel Safety Motivation

Personnel safety motivation for construction safety is the mediating latent variable between safety culture and safety performance in the construction field. Five observed variables assessed the motivational level of construction personnel to follow safety rules. The correlation check for multicollinearity was performed using Spearman's correlation matrix to all five observed variables of safety management mediating latent variable. Appendix C displays the result of the Spearman's rho correlation matrix for the five variables of safety motivation. All correlations among the five indicators of safety motivation are significant at 0.05 level. Moreover, the highest correlation among them was 0.743 and this indicates that all of the correlations are less than the cutoff point of multicollinearity which is 0.80. Therefore, multicollinearity issues do not exist among all observed variables of safety motivation.

4.2.2.7 Personnel Error Behavior

Personnel error behaviors include four observed variables assessed construction personnel error behavior in regards to workers ability to follow safety norms consistently. The correlation check for multicollinearity was performed using Spearman's correlation matrix to all four observed variables of error behavior endogenous latent variable. Appendix C shows the result of the Spearman's rho correlation matrix for the four variables of error behavior. All correlations among the four observed variables of error behavior latent factor are significant at 0.05 level. Moreover, the highest correlation among them was 0.686, and this indicates that all of the correlations are less than the cutoff point of multicollinearity at 0.80. Therefore, multicollinearity issues do not exist among all observed variables of errors behavior endogenous latent factor.

4.2.2.8 Personnel Attitudes toward Violation Behavior

Personnel attitudes toward violation behavior includes five observed variables assessed construction personnel common violation practices and their attitude regarding bending safety procedures in an intentional manner. The correlation check for multicollinearity was completed using Spearman's correlation matrix to all five observed variables of personnel attitudes toward violation behavior endogenous variable. The results of the obtained Spearman's rho correlation matrix for all the five variables of personnel attitudes toward violation behaviors are shown on Appendix C. Most of the correlations among the five observed variables of personnel attitudes toward violation behavior latent factor are significant at 0.05 level. Additionally, the highest correlation among them was 0.595, which indicates that all of the correlations are less than the cutoff point of multicollinearity at 0.80. Therefore, multicollinearity issues do not exist among all observed variable of personnel attitudes toward violations behavior endogenous latent variable.

4.3 Validating Measurement Model Using Confirmatory Factor Analysis

Validating the measurement model of this study is a critical step to make the model ready for the application of structural equation modeling. Confirmatory factor analysis is applied before structural equation modeling to validate and to confirm the reliability of the measurement model. CFA is implemented in this study to validate the proposed study measurement model related to the defined study of latent variables with their connected measurable items for each latent factor. CFA as a factor analysis method, determines the validity for each latent variable by investigating whether or not a set of items related to each latent factor is really measuring what is being evaluated and quantified (Brown, 2006; Harrington, 2009; Schumacker and Lomax, 2004).

Therefore, CFA is carried out to validate the reliability of each measurement model related to each latent factor in the study.

Model specification needs to be implemented first in order to apply confirmatory factor analysis (Harrington, 2009; Schumacker and Lomax, 2004). This means the latent factors should be specified along with their indicators as well as the relationships between the latent variables in the model based on a theoretical foundation. There are several indicators related to each latent variable representing a construct. The factor loading score characterizes the relationships between the latent variable and the observed variables. Factor loading as a regression score quantifies the relation between the observed variable and its latent variable to know how strong or weak the relationship is between them. Moreover, factor loading explains how much the latent factor is represented by the measurable variable and, therefore, the higher the factor loading the better the relationship between the latent factor and its observed variable.

The entire latent factors in this research are first order latent variables except safety culture latent factor. The first order factor means that the latent factors are directly connected to the observed variables. Safety culture is a second order latent factor meaning it is connected to other latent factors. Safety culture is conceptualized by five factors and it is analyzed as a second order construct based on theoretical framework. Each specified hypothetical model is illustrated by a figure for each latent construct.

After specifying all the latent variables along with its indicators in the measurement model, the confirmatory factor analysis requires the identification of the specified measurement model. The identification process is applied using AMOS 23 software to investigate the possibility for parameters estimation in the specified model from the resulting covariance matrix.

This research selected maximum likelihood estimation method (ML) to report estimates of statistical data with a standardized solution.

The next stage in doing CFA after model specification and identification is testing the measurement model in order to assess goodness of fit through statistical indices. Testing the model goodness of fit is performed using AMOS 23 software to test all specified and identified measurement models and calculate goodness of fit indicators for all of them. The goodness of fit calculations are used to find out the degree to which the theorized measurement model fits the collected data. The goodness of fit for each measurement model was assessed through four indices, chi-square statistical index, comparative fit index (CFI), Tucker-Lewis index (TLI) and, lastly, root mean square error of approximation (RMSEA) index.

Confirmatory factor analysis considers the modifications to the specified model as a final improvement step if it has a poor model fit result. The process of model modification includes enhancing the model fitness of the generic model to an acceptable level. First, all factor loadings in each latent construct must be checked to have a statistically significant effect. Also, each factor loading should have a critical ratio value of ± 1.96 or higher (Schumacker and Lomax, 2004). Any observed variable that is not statistically significant is removed to increase the model fit indices. Secondly, the modification indices of the measurement model are reviewed since they provide model fit enhancement through suggesting covariance between error terms in the model. Reviewing and editing the model using modification indices should decrease the chi-square statistical index value and enhance model fitness measurement parameters.

Modification indices are generated using AMOS 23 for each generic measurement model with the aim to increase model overall fit. Covariance connections are added between error terms to the generic model based on the suggestion form modification indices to improve model fit.

Finally, checking the standardized residual matrix is performed to find out if there is any correlation or covariance term that is not represented well enough by the study model. Observed variables with high errors or residuals are removed because they are not well captured by the model.

In order to ensure the reliability for each measurement model, the calculation of the internal consistency of each latent construct is performed to confirm the validity of its related measurement model. The score of Cronbach's alpha is calculated for all measurement models separately to confirm the reliability of each latent variable. It is recommended to have a Cranach's alpha value of 0.70 or higher for each measurement model to assure a satisfactory reliability level.

In this research, confirmatory factor analysis was applied for all variables, including the exogenous and endogenous variables. CFA measures the validity and reliability for each latent factor as a measurement model by implementing the maximum likelihood estimation method. Furthermore, safety culture in construction sites is the exogenous latent second order factor in which it consists of five first order factors including 1) management commitment toward safety, 2) employees attitudes toward safety, 3) coworkers safety support, 4) construction workplace pressure and 5) construction sites safety management system.

Each of the five factors or constructs of safety culture was validated and checked for adequate reliability using confirmatory factor analysis. In addition, the endogenous variables in this research are personnel safety motivation, personnel error behavior and personnel attitudes toward violations. Each of the endogenous variables or constructs are validated and checked for adequate reliability using confirmatory factor analysis.

4.3.1 Exogenous Variables

Safety culture in construction sites is the exogenous second order latent variable in this research. In the following subsections, CFA is conducted for all exogenous variables to validate safety culture hypothetical measurement model of each latent factor. Construction safety culture is conceptualized by five key first order factors including management's commitment toward safety, employee attitudes toward safety, coworkers' safety support, construction workplace pressure, and construction sites safety management system.

4.3.1.1 Management Commitment toward Safety

Management's commitment toward safety consists of nine observed variables discussing management support to safety in construction field. Participants' responses were recorded based on a five point Likert scale ranging from strongly disagree to strongly agree. A CFA was carried out to confirm the measurement model of management commitment. The factor loading is defined as the standardized regression score that explains the level of relation between the observed variable and its latent factor. Observed variables with small factor loadings, specifically smaller than 0.5, are eliminated from the measurement model except if the study investigator thinks it is necessary to keep them with the condition that they are not going to affect the fitness of the model in a negative manner.

When doing a CFA, first factor loadings and critical ratios for each observed variable are checked in, where each one of them represents management commitment construct. The critical ratio value determines the significance of the regression between the latent variable and the observed variable. Any factor loading whose critical ratio is higher than 1.96 is considered significant at the 0.05 level. All factor loadings of management commitment indicators are higher than 0.5 except for MC6 which has a negative factor loading of -0.44 that is slightly less than -0.5. Due to the importance a researcher feels regarding MC6 indicator concerning the negative relationship with management commitment, it was kept in the initial validation. A special attention was given to this indicator when validating the whole measurement model with all latent factors. The remaining indicators are all statistically significant and have critical ratio higher than 1.96, as well as they all have factor loadings above 0.5. Figure 10 illustrates the generic measurement model of the management commitment toward safety construct.

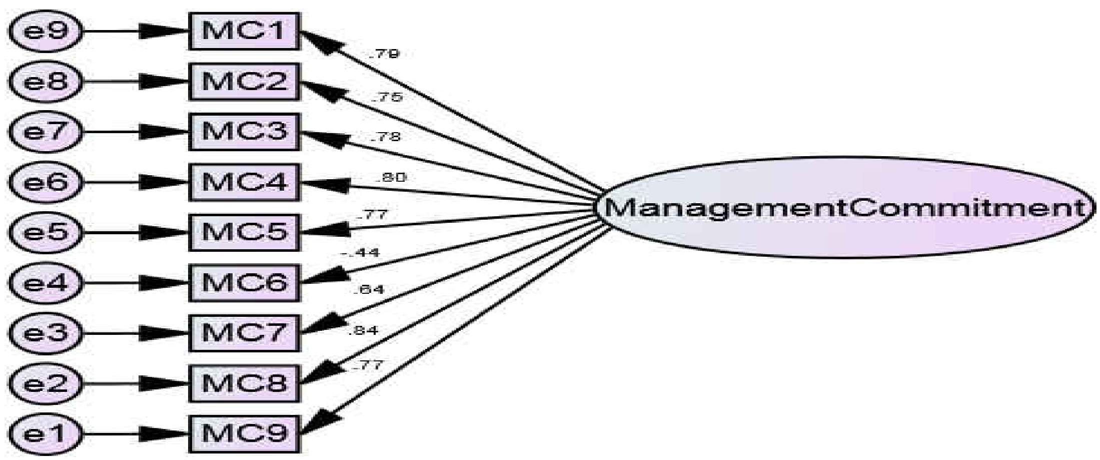

Figure 11 Generic Measurement Model for Management Commitment toward Safety

After keeping all the indicators of management commitment toward safety as shown in the generic model, the measurement model was evaluated to check model fit indices. Management commitment toward safety generic measurement model fit was within a satisfactory range. However, chances to improve model fit require implementation if there is a space of model fitness improvement through the release of parameters in accordance to the output of modification indices performed by AMOS 23 software. By allowing parameters to be freely connected using covariance matrix, chi- square index is going to be improved and decreased at least with the same current value (Schumacker and Lomax, 2004). From the modification indices produced by AMOS 23, an error covariance term between e2 and e3 are added to improve model fit. Figure 12 illustrates the revised management commitment toward safety measurement model.

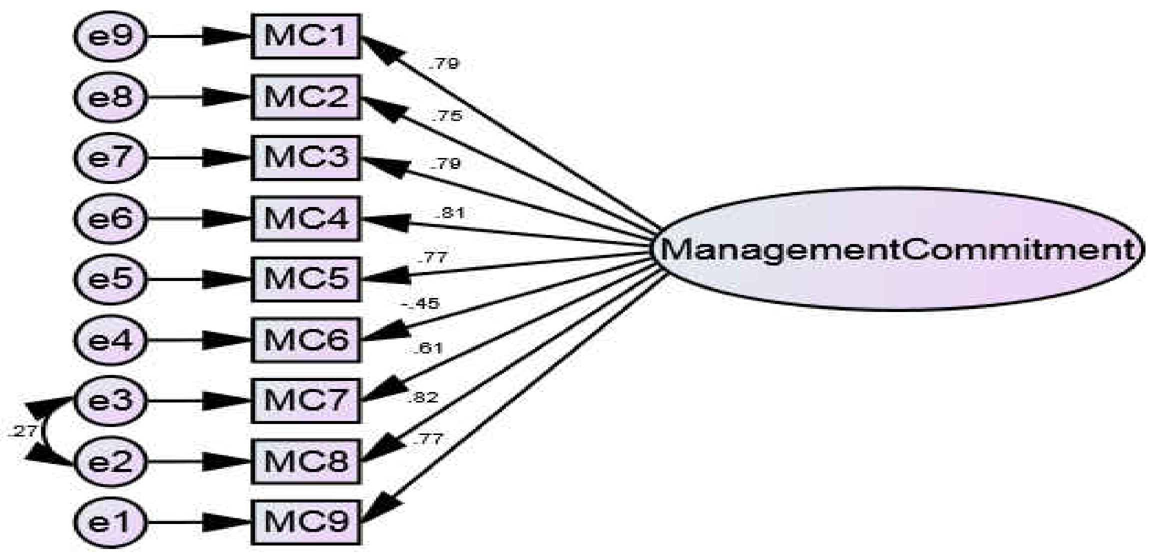

Figure 12 Revised Measurement Model for Management Commitment toward Safety

The revised measurement model of management commitment toward safety consisted of nine indicators similar to the initial model. Each observed variable has a factor loading range from - 0.45 to 0.82. One pair of errors is correlated to improve model fit between e2 and e3 as shown in figure 12. In the revised model, the nine standardized regression scores are significant at 0.05 level because their critical ratios are all above 1.96. Table 17 demonstrates the estimated parameters of the generic and revised management commitment toward safety measurement model. MC6 Item is not removed because although it has a weak factor loading that is less than 0.5, MC6 was kept in the revised model because it was significant and did not affect model fit and validity. MC6 indicator signals the need of more investigation to decide whether to keep it or delete it when validating the whole safety culture and safety behavior model in which all latent variables of the research are included.

Table 17 Parameter Estimates for Management Commitment toward Safety Measurement Model

	Generic Model				Revised Model			
	Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
MC 9 <--- MC	1.00				1.00			
MC 8 <--- MC	1.216	0.065	18.671	***	1.199	0.066	18.195	***
MC 7 <--- MC	0.891	0.065	13.660	***	.853	0.066	12.861	***
MC 6 <--- MC	-0.684	0.075	-9.091	***	-.693	0.076	-9.175	***
MC 5 <--- MC	1.170	0.069	16.918	***	1.177	0.070	16.913	***
MC 4 <--- MC	1.138	0.064	17.714	***	1.146	0.065	17.722	***
MC 3 <--- MC	1.005	0.058	17.228	***	1.012	0.059	17.252	***
MC 2 <--- MC	0.951	0.059	16.252	***	.958	0.059	16.277	***
MC 1 <--- MC	1.332	0.077	17.295	***	1.337	0.077	17.247	***

Lastly, evaluating model fit indices were performed to validate the final revised measurement model. This study used four fit indices to test model fit as mentioned in the previous chapter discussing methods and procedures of this research. Table 18 illustrates the model fit indices checked for the generic and revised management commitment measurement model. Specifically, chi-square, comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA) are the model fit indices used to evaluate the measurement of model fit.

Table 18 Model Fit Indices for Management Commitment toward Safety Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	82.162	57.381
Degrees of Freedom (df)	>=0	27	26
Chi- Square statistic/df	<=5	3.043	2.207
Tucker-Lewis index (TLI)	> 0.90	0.966	0.980
Comparative fit index (CFI)	> 0.90	0.975	0.986
Goodness of fit index (GFI)	> 0.90	0.959	0.972
Root mean square error of approx (RMSEA)	< 0.05 -0.08	0.069	0.053
Probability (p- close)	> 0.05	0.034	0.376

Table 18 above shows the indices of goodness of fit for both the revised and generic models of management commitment. It can be seen that the revised model has improved in model fit. The revised model has a lower Chi- Square statistic value and this confirms that a better model fit was reached in the revised model. However, the generic model had an acceptable model fit indices but the revised model had an even a better fit level in all fit indices adopted in this study.

In order to measure the internal consistency of the management commitment toward safety revised measurement model, Cronbach's alpha score was calculated. The calculated score of Cronbach's alpha for management commitment latent factor was 0.837, which is higher than the suggested level of 0.70 concluding that management commitment latent variable is a reliable construct.

4.3.1.2 Employees Personal Attitude toward Safety

Employees' personal attitude toward safety consists of seven observed variables discussing the view of the construction middle management personnel about safety main values and beliefs. Participants' responses were recorded based on a five point Likert scale ranging from strongly disagrees to strongly agree. A CFA was carried out to confirm the measurement model of employee attitudes toward safety. Observed variables with small factor loadings, specifically smaller than 0.5, are eliminated from the measurement model except if the study investigator thinks that it is necessary to keep them without affecting the fitness of the measurement model.

When applying a CFA on employees' attitudes toward safety construct, first, factor loadings and critical ratios for each observed variable were checked in which each one of them represents the employee attitudes construct. In the generic model of employee attitudes toward safety, all factor loadings of employees attitudes toward safety indicators are higher than 0.5 except for EA6 and EA7 which they have weak factor loadings of 0.30 and 0.34 respectively. Due to the weak factor loading of EA6 and EA7 indicators, elimination was recommended from the measurement model. The remaining indicators are all statistically significant and have critical ratio higher than 1.96, as well as they all have factor loadings above 0.5. Figure 13 illustrates the generic measurement model of employee attitudes toward safety construct.

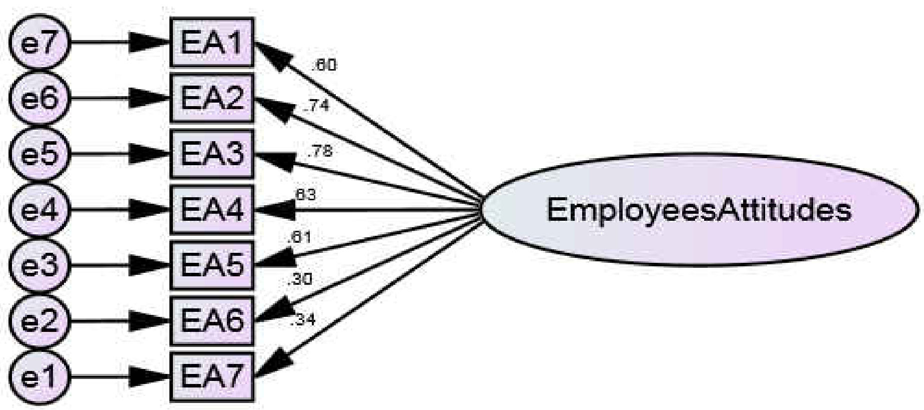

Figure 13 Generic Measurement Model for Employee Attitudes toward Safety Construct

After eliminating E6 and E7 indicators from employee attitudes toward safety generic model, the measurement model was assessed to check model fit indices. Employee attitudes toward safety generic measurement model fit was not yet within a satisfactory limit. Hence, improving model fit was required by freeing parameters in accordance to the output of modification indices performed by AMOS 23 software. From the modification indices produced by AMOS 23, an error covariance term between e4 and e5 was added to improve model fit. Figure 14 illustrates the revised employee attitudes toward safety measurement model.

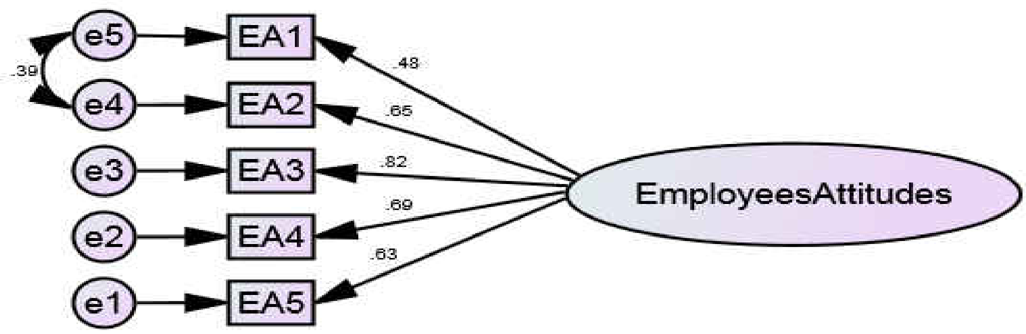

Figure 14 Revised Measurement Model for Employee Attitudes toward Safety

The revised measurement model of employee attitudes toward safety consisted of five observed variables after eliminating EA6 and EA7 indicators. Each observed variable has a factor loading ranged from 0.48 to 0.82. One pair of errors is correlated to improve model fit between e4 and e5 as shown in figure 14. In the revised model, the five standardized regression score are significant at 0.05 level because their critical ratios all above 1.96. Table 19 demonstrates the estimated parameters of the generic and revised employees' attitudes toward safety measurement model. EA1 Item is not removed because although it has a weak factor loading (0.48) that is slightly less than 0.5, but EA1 is kept in the revised model because it is still significant and not affecting model fit and validity. EA1 indicator raised the need of more investigation to decide whether to keep it or delete it when validating the whole safety culture and safety behavior model in which all latent variables of the research are included.

Table 19 Parameter Estimates for Employee Attitudes toward Safety Measurement Model

	Generic Model				Revised Model			
	Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
EA 7 <--- EA	1.000				Deleted			
EA 6 <--- EA	0.949	0.210	4.526	***	Deleted			
EA 5 <--- EA	2.514	0.406	6.191	***	1.309	0.158	8.305	***
EA 4 <--- EA	2.630	0.420	6.261	***	1.449	0.167	8.672	***
EA 3 <--- EA	2.734	0.418	6.545	***	1.456	0.162	9.010	***
EA 2 <--- EA	2.675	0.413	6.484	***	1.183	0.111	10.623	***
EA 1 <--- EA	2.479	0.401	6.178	***	1.00			

Lastly, assessing model fit indices are performed to validate the final revised measurement model. Table 20 shows the model fit indices checked for the generic and revised employees' attitudes toward safety measurement model. It can be seen that the revised model has improved dramatically in model fit. The revised model has a considerable lower Chi- Square statistic value, which confirms that the revised model is in acceptable data fit range in all fit indices. Moreover, RMSEA fit index was improved greatly in the revised model form 0.148 to 0.79 which increased model overall fit.

Table 20 Model Fit Indices for Employee Attitudes toward Safety Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	146.288	16.01
Degrees of Freedom (df)	>=0	14	4
Chi- Square statistic/df	<=5	10.449	4
Tucker-Lewis index (TLI)	> 0.90	0.758	0.954
Comparative fit index (CFI)	> 0.90	0.838	0.982
Goodness of fit index (GFI)	> 0.90	0.904	0.985
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.148	0.079
Probability (p- close)	> 0.05	0.00	0.069

Finally, measuring the internal consistency of the employee attitudes toward safety revised measurement construct is implemented using Cronbach's alpha score to ensure a valid reliability level. The calculated score of Cronbach's alpha for the employee attitudes toward safety latent factor was 0.797, which is higher than the recommended level of 0.70 concluding that employee attitude toward safety latent variables is a reliable construct.

<u>4.3.1.3 Coworkers Safety Support</u>

Coworkers' safety support consists of six observed variables discussing the view of coworkers' safety influence as a group norm on individual safety values and beliefs specifically in construction field. Participants' responses were recorded based on a five point Likert scale ranging from strongly disagree to strongly agree. A confirmatory factor analysis was conducted to verify the measurement model of coworkers' safety support. Observed variables with weak factor loadings, specifically less than 0.5, were eliminated from the measurement model except if the researcher believes that it is important to keep them.

When applying a CFA on coworkers' safety support construct, first, factor loading and critical ratio for each observed variable were checked. In the generic model of coworkers' safety support, all factor loadings of employee attitudes toward safety indicators were higher than 0.5 except for CS3 and CS4 which they have weak factor loading of -0.24 and 0.03 respectively. Moreover, CS4 indicator was not significant at 0.05 level because it had a critical ratio less than 1.96. Therefore, due to the weak factor loading of CS3 and CS4 observed variables as well as the insignificance of CS4 indicator, they were suggested to be eliminated from coworkers' safety support measurement model. The remaining indicators are all statistically significant with critical ratios higher than 1.96 and they have factor loadings above 0.5. Figure 15 illustrates the generic measurement model of the coworkers' safety support construct.

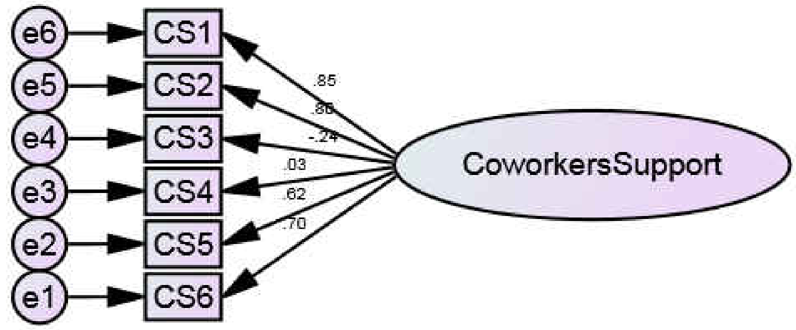

Figure 15 Generic Measurement Model for Coworkers' Safety Support Construct

After eliminating CS3 and CS4 indicators from coworkers' safety support generic model, the measurement model was evaluated to check model fit indices. Coworkers' safety support generic measurement model fit was not yet within an acceptable range. Hence, improving model fit was needed by AMOS 23 software using the method of releasing parameters in accordance to the modification indices. Using the modification indices created by AMOS 23, an error covariance term between e1 and e2 was included to improve model fit. Figure 16 demonstrates the revised coworkers' safety support measurement model.

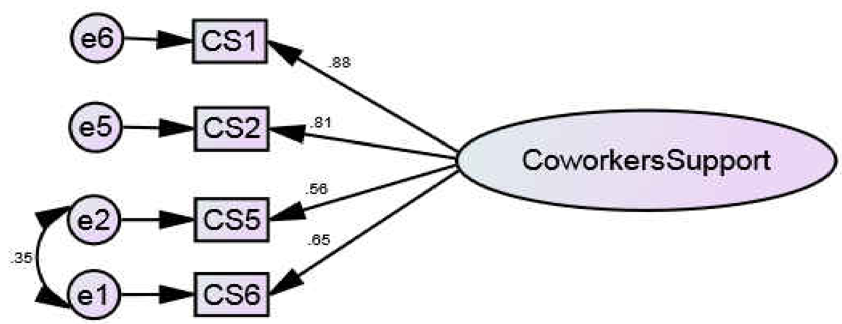

Figure 16 Revised Measurement Model for Coworkers' Safety Support

The revised measurement model of coworkers' safety support consisted of four indicators after eliminating CS3 and CS4 observed variables. Each observed variable has a factor loading range from 0.56 to 0.88. One pair of errors is interrelated to improve model fit between e1 and e2 as shown in figure 16. In the revised model, CS1, CS2, CS5 and CS6 standardized regression scores are significant at 0.05 level because their critical ratios all above 1.96. Table 21 shows the estimated parameters of the generic and revised coworkers' safety support measurement model.

Table 21 Parameter estimates for Coworkers' Safety Support Measurement Model

	Generic Model				Revised Model			
	Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
CS 6 <--- CS	.798	.054	14.755	***	0.714	.054	13.227	***
CS 5 <--- CS	.643	.050	12.876	***	0.555	.050	11.134	***
CS 4 <--- CS	.036	.058	.628	.530	Deleted			
CS 3 <--- CS	-.310	.066	-4.665	***	Deleted			
CS 2 <--- CS	.930	.055	16.918	***	0.901	0.057	15.721	***
CS 1 <--- CS	1.000				1.00			

It is crucial to evaluate model fit indices in order to validate the finalized revised coworkers' safety support measurement model. Table 22 exhibits the model fit indices checked for the generic and revised coworkers' safety support measurement model. Furthermore, it can be seen that the revised model was enhanced effectively in model fit. The entire model fit indices values are within a satisfactory range for the revised model of coworkers' safety support construct. The revised model did have a substantially lower Chi- Square statistic value, which confirms that the revised model reached an acceptable fit value range in all fit indices. Besides, RMSEA fit index was improved significantly in the revised model form 0.209 to 0.0799 which increases model overall fit.

Table 22 Model Fit Indices for coworkers' safety support measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	179.58	4.001
Degrees of Freedom (df)	>=0	9	1
Chi- Square statistic/df	<=5	19.95	4
Tucker-Lewis index (TLI)	> 0.90	0.663	0.973
Comparative fit index (CFI)	> 0.90	0.798	0.996
Goodness of fit index (GFI)	> 0.90	0.889	0.995
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.209	0.0799
Probability (p- close)	> 0.05	0.00	0.163

At the end of the validation process, internal consistency of the coworkers' safety support revised measurement construct should be performed using Cronbach's alpha score to confirm a an effective reliability level. Cronbach's alpha score was calculated for coworkers' safety support latent factor and it was found to be 0.834, which is higher than the suggested level of 0.70. Therefore, it can be concluded that coworkers' safety support latent variable is a reliable construct.

<u>4.3.1.4 Construction Workplace Pressure</u>

Construction workplace pressure consists of seven observed variables discussing the opinions and experiences of construction middle managers regarding the effects of work pressure on following safety rules in construction environment. Participants' responses were recorded based on a five point Likert scale ranging from strongly disagrees to strongly agree. A confirmatory factor analysis was applied to verify the measurement model of construction workplace pressure. Observed variables with weak factor loadings, specifically less than 0.5, were removed from the measurement model except if the researcher believes that it is imperative to include them.

When conducting confirmatory factor analysis on construction workplace pressure construct, first, factor loading and critical ratio for each observed variable were checked. In the generic model of construction workplace pressure, all factor loadings of workplace pressure indicators were higher than 0.5 except for WP2 and WP7 which they had weak factor loadings of 0.43 and -0.21 respectively. Therefore, because WP2 and WP7 observed variables had weak factor loadings in the generic model, they were recommended for removal from the construction workplace pressure measurement model. The remaining indicators were all statistically significant with critical ratios higher than 1.96 and they have factor loadings above 0.5. Figure 17 shows the generic measurement model of the construction workplace pressure construct.

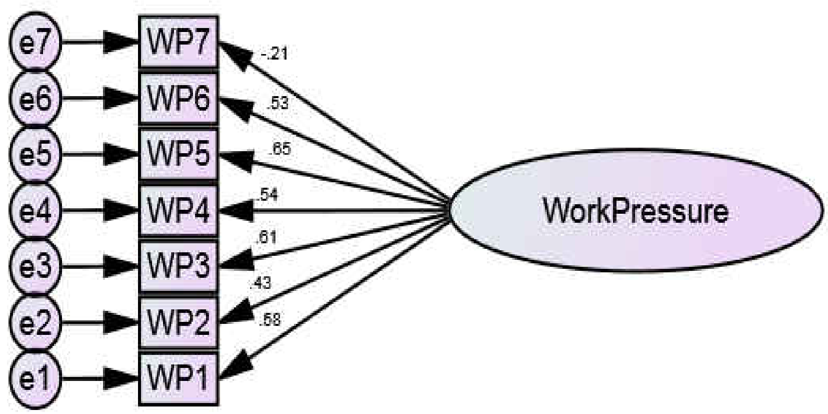

Figure 17 Generic Measurement Model for Construction Workplace Pressure Construct

After removing WP2 and WP7 observed variables from construction workplace pressure generic model, the measurement model was assessed to check model fit indices. Construction workplace pressure generic measurement model fit indices were within an acceptable range. In order to be sure that the model reached the best fit level, modification indices of construction workplace pressure generated by AMOS 23 software needed to be checked. After the examination of the modification indices, no error correlation was suggested and, therefore, it can be concluded that the model fit of construction workplace pressure measurement model reached the best fit after eliminating WP2 and WP7 indicators. Figure 18 exhibits the revised construction workplace pressure measurement model.

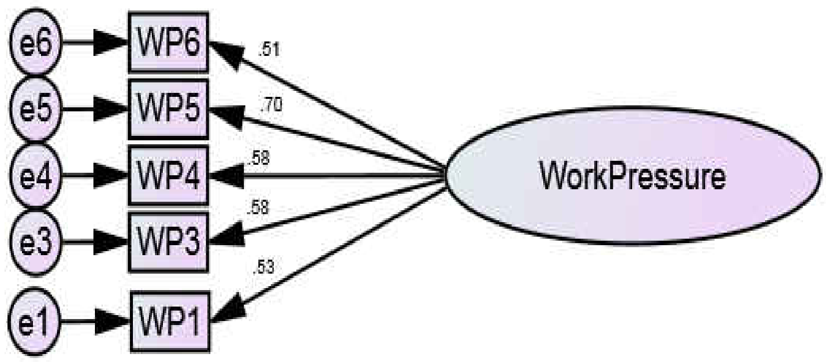

Figure 18 Revised Measurement Model for Construction Workplace Pressure

The revised measurement model of construction workplace pressure consisted of five indicators after eliminating WP2 and WP7 observed variables. Each observed variable had a factor loading ranged from 0.51 to 0.70. In the revised model, WP1, WP3, WP4, WP5 and WP6 standardized regression scores were significant at 0.05 level since their critical ratios all above 1.96. Table 23 illustrates the estimated parameters of the generic and revised construction workplace pressure measurement model.

Table 23 Parameter estimates for construction workplace pressure Measurement Model

	Generic Model				Revised Model			
	Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
WP 1 <--- WP	1.000				1.00			
WP 2 <--- WP	.627	.091	6.916	***	Deleted			
WP 3 <--- WP	.953	.108	8.792	***	.984	.124	7.918	***
WP 4 <--- WP	.826	.102	8.114	***	.978	.123	7.955	***
WP 5 <--- WP	1.007	.111	9.041	***	1.196	.140	8.544	***
WP 6 <--- WP	.806	.100	8.026	***	.840	.115	7.310	***
WP 7 <--- WP	-.333	.093	-3.582	***	Deleted			

It is essential to assess model fit indices in order to validate the confirmed revised construction workplace pressure measurement model. Table 24 displays the model fit indices tested for the generic and revised construction workplace pressure measurement model. Additionally, it can be observed that the revised model was enhanced effectively in model fit. The entire model fit indice values were in the recommended range for the revised model of construction workplace pressure construct. The revised model developed had an extensive lower Chi- Square statistic value, which confirms that the revised model fit indices were in acceptable fit range. Lastly, Comparative fit index (CFI) was improved the most in the revised model form 0.882 to 0.965 which increased model overall fitness.

Table 24 Model Fit Indices for Construction Workplace Pressure Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	70.6	17.58
Degrees of Freedom (df)	>=0	14	5
Chi- Square statistic/df	<=5	5.04	3.5
Tucker-Lewis index (TLI)	> 0.90	0.823	0.931
Comparative fit index (CFI)	> 0.90	0.882	0.965
Goodness of fit index (GFI)	> 0.90	0.954	0.983
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.097	0.076
Probability (p- close)	> 0.05	0.00	0.110

The last step in the validation process using CFA was to calculate the internal consistency of the construction workplace pressure revised measurement construct. Internal consistency was calculated using Cronbach's alpha score to check the reliability level of the revised model. Cronbach's alpha score was calculated for construction workplace pressure latent factor and it was 0.717 which is greater than the proposed level of 0.70. Thus, it can be determined that construction workplace pressure latent variable is a reliable construct.

4.3.1.5 Construction Site Safety Management System

The construction site safety management system consists of seventeen observed variables discussing the efficiency and attainment of the current safety management system in the construction sites. Similar to previous latent exogenous variables, participants' answers were recorded based on a five point Likert scale ranging from strongly disagree to strongly agree. A CFA was conducted to verify the measurement model of safety management system. Observed variables with poor factor loadings, specifically less than 0.5, were removed from the measurement model except if there is a legitimate reason to keep them specified by the researcher.

When applying a CFA on safety management system construct, first, factor loadings and critical ratios for each observed variable were tested. In the generic model of safety management system, all factor loadings of safety management system indicators were greater than 0.5 except for SMS14 and SMS5, which they had, factor loading of 0.39 and 0.45 respectively. Therefore, due to the weak factor loadings of SMS14 observed variable, it was suggested to be excluded from safety management system measurement model. For SMS5, it was suggested to be kept, due to the importance of the indicator and also its factor loading was slightly less than the cutoff point of 0.5. However, more investigation is needed for SMS5 indicator when validating the whole study model including all the latent variables. The remaining observed variables were all statistically significant at 0.05 level with critical ratios higher than 1.96 and they have factor loadings above 0.5. Figure 19 below shows the generic measurement model for the safety management system construct.

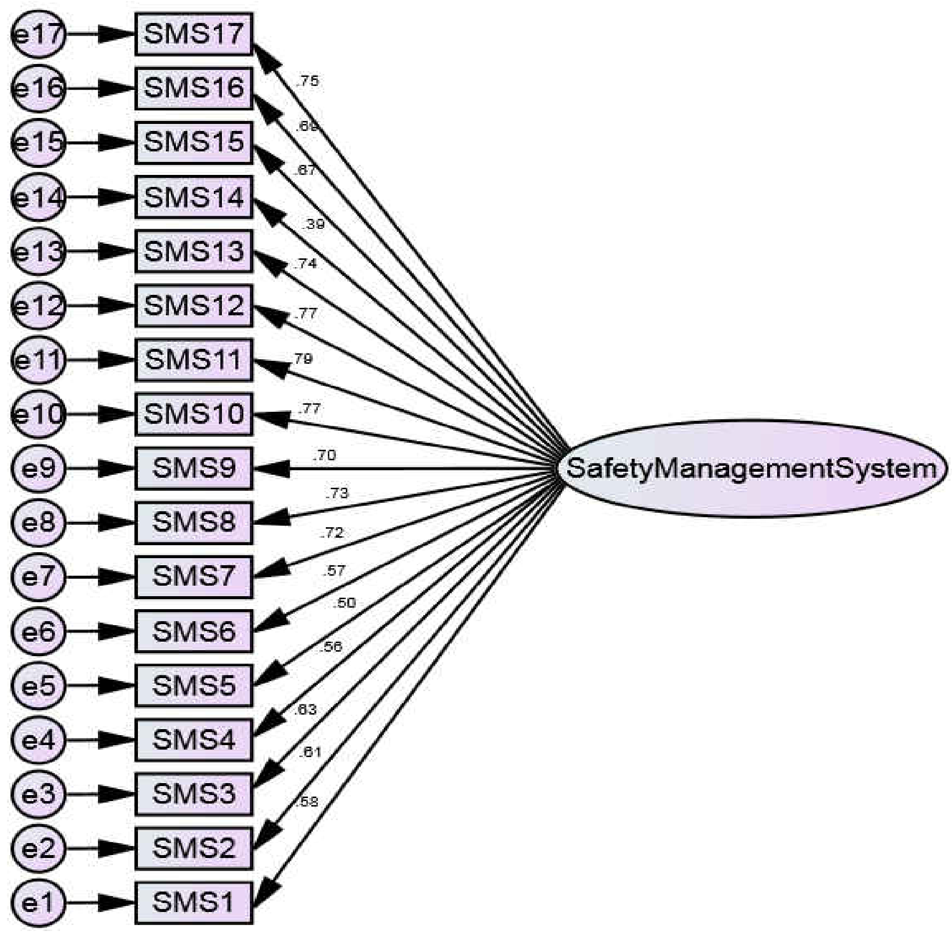

Figure 19 Generic Measurement Model for Safety Management System Construct

After eliminating the SMS14 indicator from the safety management system generic model, the measurement model was assessed to check model fit indices. Safety management system generic measurement model fit was not yet within an acceptable range. Hence, improving model fit was needed by AMOS 23 software using the modification indices method of parameters release. From the modification indices created by AMOS 23, error covariance terms between e2 and e3, e3 and e4, e4 and e5, e4 and e6, e5 and e6, e5 and e8, e6 and e7, e7 and e8, e10 and e11, e13 and e15, e15 and e17 and e16 with e17 were added to improve model fit. Figure 20 exhibits the revised safety management system measurement model.

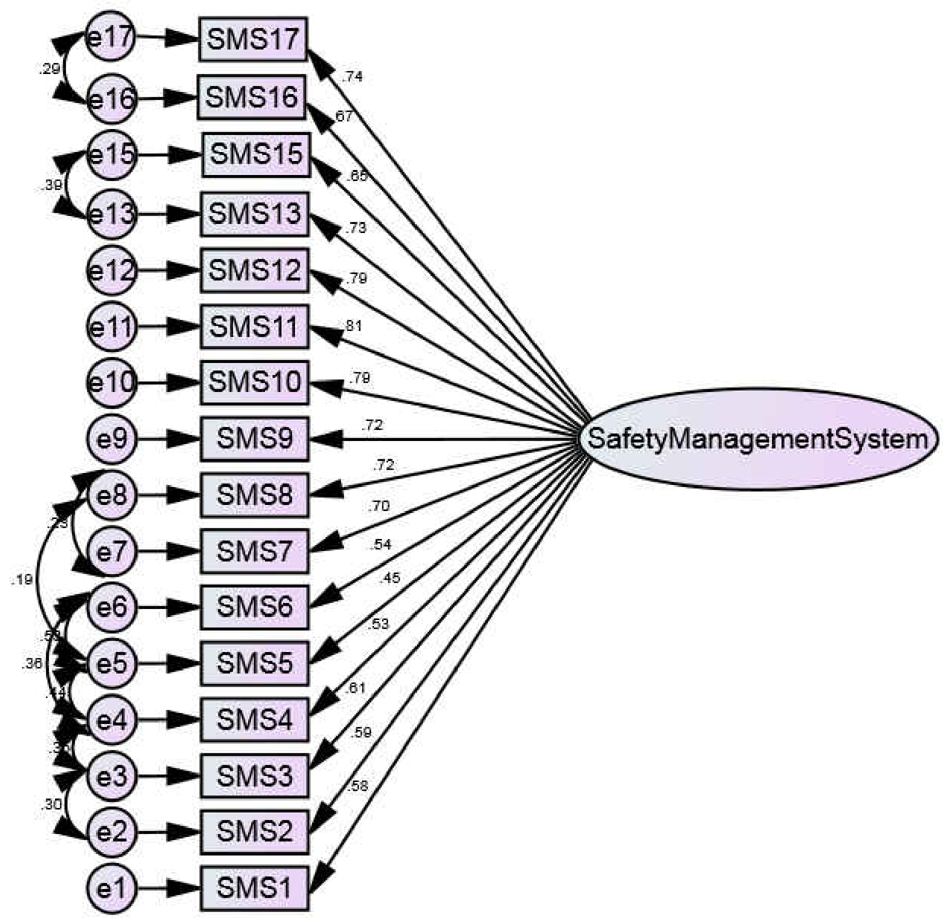

Figure 20 Revised Measurement Model for Safety Management System

The revised measurement model of construction sites safety management system consisted of sixteen indicators after eliminating SMS14 observed variable. Each observed variable had a factor loading range from 0.45 to 0.81. Several pairs of errors were correlated with each other as presented in figure 20 to increase model fit based on the modification indices created by AMOS 23. In the revised model, all standardized regression values were significant at 0.05 level because their critical ratios were above 1.96. Table 25 illustrates the estimated parameters of the generic and revised construction sites safety management system measurement model.

Table 25 Parameter Estimates for Safety Management System Measurement Model

			Generic Model				Revised Model			
			Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
SMS 1	<---	SMS	1.000				1.000			
SMS 2	<---	SMS	1.183	.113	10.506	***	1.154	.113	10.242	***
SMS 3	<---	SMS	1.300	.121	10.790	***	1.248	.118	10.534	***
SMS 4	<---	SMS	1.156	.116	9.939	***	1.063	.113	9.394	***
SMS 5	<---	SMS	.995	.110	9.027	***	.889	.108	8.259	***
SMS 6	<---	SMS	1.077	.107	10.021	***	1.013	.107	9.491	***
SMS 7	<---	SMS	1.333	.113	11.820	***	1.300	.113	11.525	***
SMS 8	<---	SMS	1.344	.112	11.988	***	1.312	.112	11.726	***
SMS 9	<---	SMS	1.315	.112	11.694	***	1.342	.114	11.766	***
SMS 10	<---	SMS	1.505	.121	12.408	***	1.551	.124	12.545	***
SMS 11	<---	SMS	1.498	.119	12.592	***	1.540	.121	12.705	***
SMS 12	<---	SMS	1.402	.113	12.426	***	1.425	.114	12.460	***
SMS 13	<---	SMS	1.480	.122	12.121	***	1.451	.122	11.869	***
SMS 14	<---	SMS	.665	.091	7.309	***	Deleted			
SMS 15	<---	SMS	1.221	.108	11.339	***	1.176	.107	10.952	***
SMS 16	<---	SMS	1.231	.107	11.487	***	1.196	.107	11.158	***
SMS 17	<---	SMS	1.280	.105	12.204	***	1.268	.105	12.029	***

It is imperative to evaluate model fit indices in order to verify the validity of the final revised safety management system measurement model. Table 26 shows the model fit values tested for both the generic and revised safety management system measurement model. Also, it can be stated that the revised model was improved excellently in model fit. The entire model fit indices numbers are within the recommended range for the revised model of safety management system construct. The revised model had a considerable decrease in Chi- Square statistic value, which indicated that the revised model reached an acceptable fit range in all fit measures.

Further, RMSEA and p-close fit indices are improved substantially in the revised model form 0.124 to 0.068 for RMSEA index and from 0.00 to 0.05 for p-close index which increase model overall fitness.

Table 26 Model Fit Indices for Safety Management System Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	915.2	292.875
Degrees of Freedom (df)	>=0	119	95
Chi- Square statistic/df	<=5	7.69	3.08
Tucker-Lewis index (TLI)	> 0.90	0.778	0.937
Comparative fit index (CFI)	> 0.90	0.805	0.95
Goodness of fit index (GFI)	> 0.90	0.765	0.920
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.124	0.068
Probability (p- close)	> 0.05	0.00	0.05

The final step of the validation process is to calculate Cronbach's alpha score to measure the internal consistency of the safety management system revised measurement construct. Cronbach's alpha score reflects the reliability of safety management system latent factor and it is found to be 0.93, and is considered to be an excellent value because it is much higher than the suggested level of 0.70. Therefore, based on Cronbach's alpha score calculated, safety management system latent variable is a reliable construct.

4.3.2 Endogenous Variables

In this research, the endogenous latent variables are personnel motivation to construction safety, construction personnel error behavior and personnel attitudes toward violations behavior. Personnel safety motivation is hypothesized in the study model to mediate the relationship between safety culture in construction sites and construction personnel safety performance. Safety performance is measured by two endogenous latent variable including personnel error behavior and personnel attitudes toward violations behavior. Validating all endogenous variables was conducted using CFA for each factor separately to validate the reliability of each construct.

4.3.2.1 Personnel Safety Motivation

Personnel safety motivation is the mediating variable in the research model. Safety motivation mediating construct consists of five observed variables related to measuring safety motivation of construction personnel in following safety procedures as an important individual's priorities and values. Like previous variables, the answers of participants were recorded based on a five point Likert scale ranging from strongly disagree to strongly agree. A confirmatory factor analysis was carried out to confirm the measurement model of personnel safety motivation. Indicators with small factor loadings, specifically smaller than 0.5, are eliminated from the measurement model.

When applying a confirmatory factor analysis on personnel safety motivation construct, first, factor loadings and critical ratios for each observed variable are tested. In the generic model of personnel safety motivation, all the factor loadings of personnel safety motivation indicators are greater than 0.5 and also they are all statistically significant at 0.05 level and have critical ratio higher than 1.96. Figure 21 below demonstrates the generic measurement model of personnel safety motivation construct.

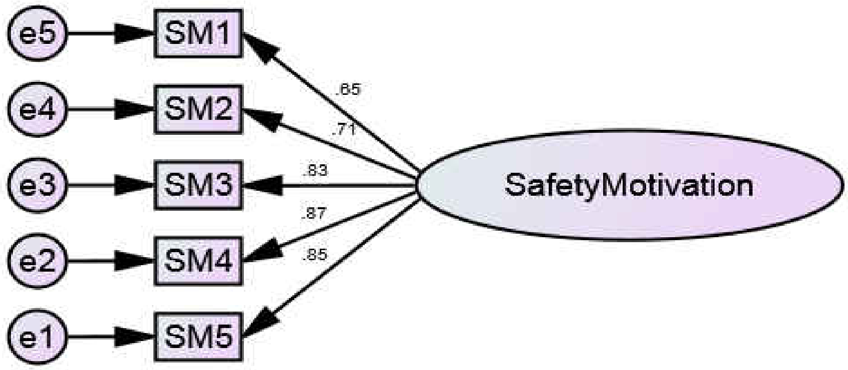

Figure 21 Generic Measurement Model for Personnel Safety Motivation

After keeping all the indicators of personnel safety motivation generic model, the measurement model was reviewed to check model fit indices. Personnel safety motivation generic measurement model fit was within the recommended model fit range for all indices except for RMSEA index and p close index as well. Thus, improve model fit should be implemented to make all the fit indices within the allowable range. Modification indices are calculated using AMOS 23 software in which parameters are allowed to be freely estimated using covariance matrix. From the modification indices produced by AMOS 23, an error covariance connection between e4 and e5 is included to enhance model fit. Figure 22 depicts the revised personnel safety motivation measurement model.

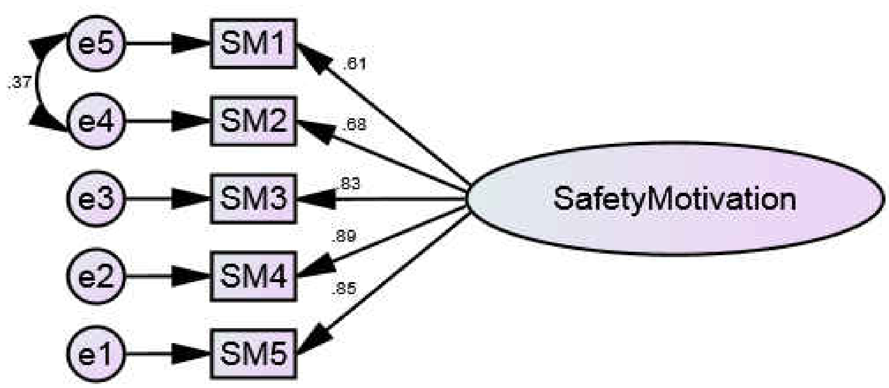

Figure 22 Revised Measurement Model for Personnel Safety Motivation

The revised measurement model of personnel safety motivation consisted of five indicators like the generic model. The entire observed variable have a factor loading range from 0.61 to 0.89. A pair of errors is correlated to improve model fit between e4 and e5 as shown in figure 22. In the revised model, all five standardized regression coefficients are significant at 0.05 level because their critical ratios all above 1.96. Table 27 shows the parameters estimations of both generic and revised personnel safety motivation measurement model.

Table 27 Parameter Estimates for Personnel Safety Motivation Measurement Model

	Generic Model				Revised Model			
	Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
SM 5 <--- SM	1.000				1.000			
SM 4 <--- SM	.995	.045	22.273	***	1.006	.044	22.616	***
SM 3 <--- SM	.975	.047	20.784	***	.973	.047	20.873	***
SM 2 <--- SM	.791	.048	16.572	***	.755	.048	15.613	***
SM 1 <--- SM	.756	.052	14.661	***	.711	.052	13.599	***

The next step is to check model fit values to confirm the validity of the revised personnel safety motivation measurement model. Table 28 shows the model fit values tested for both the generic and revised safety management system measurement model. Also, it can be stated that RMSEA and p close have improved in the model fit from 0.166 to 0.05 for RMSEA and from 0.00 to 0.429 for p-close index, which raised model fit. Moreover, the remaining fit indices improved significantly in the revised model. Therefore, the revised model of personnel safety motivation reached the required model fit aimed because all fit indices are within the recommended values. The revised model decreased Chi- Square statistic value substantially, which is desired because the lower Chi- Square statistic value the better fit is obtained.

Table 28 Model Fit Indices for Personnel Safety Motivation Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	64.91	8.3
Degrees of Freedom (df)	>=0	5	4
Chi- Square statistic/df	<=5	12.983	2.07
Tucker-Lewis index (TLI)	> 0.90	0.904	0.991
Comparative fit index (CFI)	> 0.90	0.952	0.997
Goodness of fit index (GFI)	> 0.90	0.943	0.993
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.166	0.05
Probability (p- close)	> 0.05	0.000	0.429

Finding out the reliability measurement for personnel safety motivation measurement model is the last step in the validation process using CFA method. Cronbach's alpha score is calculated for personnel safety motivation measurement model and it is founded to be 0.889. Therefore, personnel safety motivation factor is excellent and reliable because its Cronbach's alpha calculated value is much greater than the threshold recommended level of 0.70.

4.3.2.2 Personnel Error Behavior

Personnel Error behavior is the first factor to measure safety performance. Error behavior is perceived by four observed variables discussing construction personnel ability to follow safety rules and procedures in a consistent manner. Questions are given to participants on a five point Likert scale ranging from strongly disagree to strongly agree. A CFA was carried out to validate the measurement model of personnel error behavior.

All factor loadings and critical ratios for each observed variable are checked. In the generic model of personnel error behavior, all the factor loadings of error behavior indicators are higher than 0.5 and all critical ratios are statistically significant because their values are higher than 1.96. Figure 23 illustrates the generic measurement model of the personnel error behavior endogenous variable.

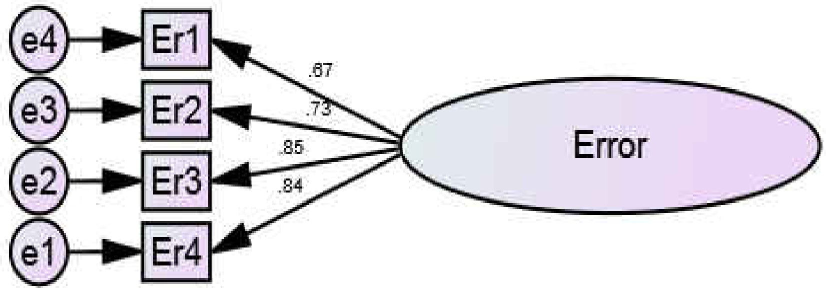

Figure 23 Generic Measurement Model for Personnel Error behavior

Next step toward validation is to check the measurement model fit indices. Personnel error behavior generic measurement model fit was yet not within a satisfactory range although that all the indicators are significant at 0.05 level and have an adequate factor loadings above 0.5. Thus, improving model fit is needed to be executed by releasing parameters in accordance to the output of modification indices created by AMOS 23 software. An error covariance term between e3 and e4 is added based on the modification indices to improve model fit. Figure 24 depicts the revised personnel error behavior measurement model.

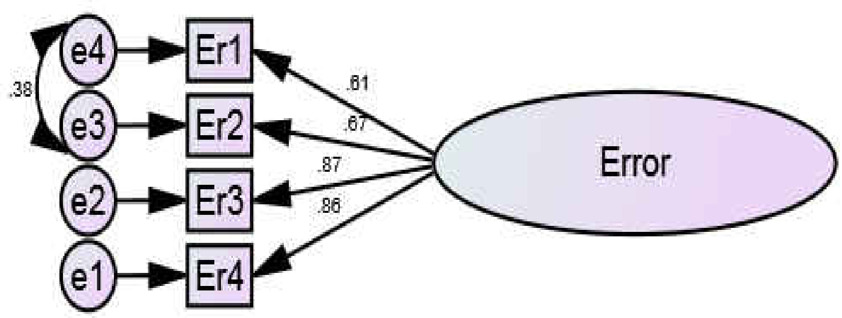

Figure 24 Revised Measurement Model for Personnel Error Behavior

The revised measurement model of personnel error behavior consisted of four observed variables similar to generic model. Each observed variable has a factor loading ranged from 0.61 to 0.87. A pairs of errors is added to enhance model fit between e3 and e4 as presented in figure

24. All the four regression estimations for error behavior construct are significant at 0.05. Table 29 shows the estimated parameters of both the generic and revised personnel error behavior measurement model.

Table 29 Parameter Estimates for Personnel Error Behavior Measurement Model

			Generic Model				Revised Model			
			Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
ER 4	<---	Error	1.000				1.000			
ER 3	<---	Error	1.036	.055	18.734	***	1.041	.058	17.889	***
ER 2	<---	Error	.844	.053	16.006	***	.770	.053	14.597	***
ER 1	<---	Error	.814	.056	14.459	***	.726	.057	12.842	***

Model fit indices were checked to validate the final revised personnel error behavior measurement model. Table 30 displays the model fit indices checked for the generic and revised personnel error behavior measurement model. It can be noticed that the revised model did improved significantly in model fit indices values. The revised model of personnel error behavior had an extensive lower Chi- Square statistic value which indicated that the revised model was enhanced in all fit indices. Additionally, RMSEA fit value was improved considerably from 0.246 to 0.001 in which it became a very satisfying fitting value that increased model overall fit.

Table 30 Model Fit Indices for Personnel Error Behavior Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	54.278	0.872
Degrees of Freedom (df)	>=0	2	1
Chi- Square statistic/df	<=5	27.139	0.872
Tucker-Lewis index (TLI)	> 0.90	0.807	1.001
Comparative fit index (CFI)	> 0.90	0.936	1.00
Goodness of fit index (GFI)	> 0.90	0.939	0.999
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.246	0.001
Probability (p- close)	> 0.05	0.000	0.567

The final step is to calculate the internal consistency using Cronbach's alpha value to verify the reliability of personnel error behavior latent variable. The calculated score of Cronbach's alpha for error behavior is 0.856 which is higher than the recommended level of 0.70 and therefore, personnel error behavior, measurement model is a reliable construct.

4.3.2.3 Personnel Attitudes toward Violation Behavior

Personnel attitude toward violation behavior are the second factor aiming in measuring safety performance in this research. Personnel attitudes toward violation are evaluated by five indicators concerning construction personnel attitudes to do violation through not following safety rules deliberately. Questions are distributed to participants on a five point Likert scale going from strongly disagree to strongly agree. A confirmatory factor analysis was carried out to validate the measurement model of personnel attitudes toward violation behavior.

All factor loadings and critical ratios for each observed variable are checked. In the generic model of personnel attitudes toward violation behavior, all the factor loadings of personnel attitudes toward violation behavior indicators are higher than 0.5 except for VI5 indicator which has a weak factor loading of 0.39. Therefore, VI5 indicator is recommended for removal from the revised model. However, all violation observed variables are statistically significant because they have critical ratios values higher than 1.96 including VI5. Although VI5 observed variable is significant and have a critical ratio higher than 1.96, it is still needed to be removed due to its weak factor loading. Figure 25 demonstrates the generic measurement model of the personnel own attitudes toward violation behavior endogenous variable.

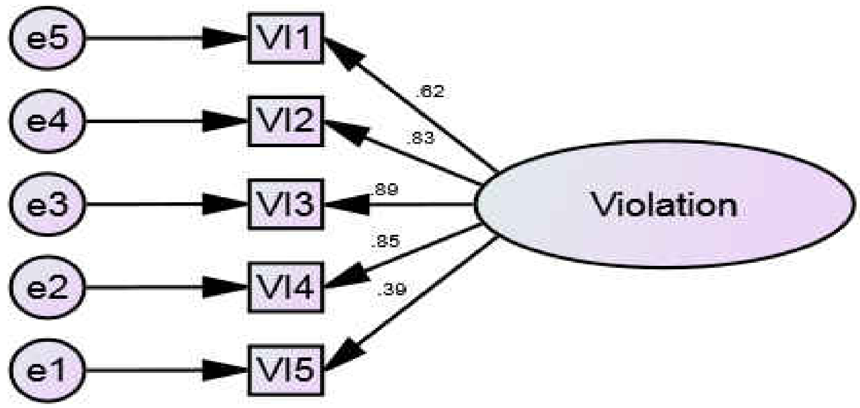

Figure 25 Generic Measurement Model for Personnel Attitudes toward Violation Behavior

To complete the validation process, model fit is checked to make sure the model is within the required fit range for all fit indices. The measurement model of personnel attitudes toward violation behavior was in a good model fit for all fit indices. However, eliminating VI5 observed variable has improved the model fit more significantly which makes the revised model fit much better in all fit values measured. There was no error correlation suggestions from modification indices created by AMOS 23 software because the model was already fit in the generic phase. Figure 26 represents the revised personnel attitudes toward violation behavior measurement model.

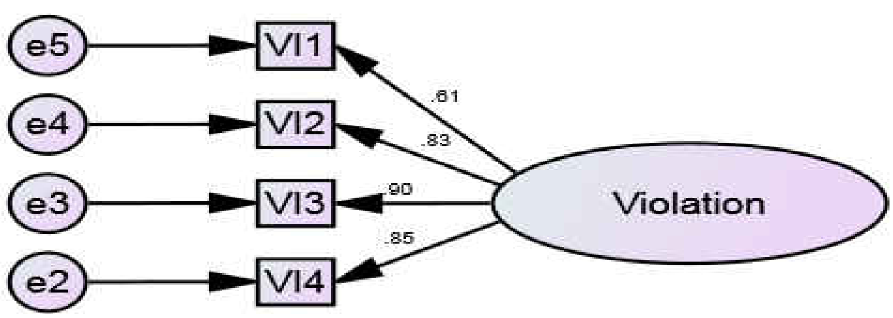

Figure 26 Revised Measurement Model for Personnel Attitudes toward Violation Behavior

After removing VI5 indicator, the revised measurement model of personnel attitudes toward violation behavior consisted of four observed variables. The factor loadings for all observed variables are ranged from 0.61 to 0.90. Personnel attitudes toward violation behavior four regression standardized values are significant at 0.05. Table 31 illustrates the predicted parameters of both the generic and revised personnel attitudes toward violation behavior measurement model.

Table 31 Parameter Estimates for Personnel Attitudes toward Violation Behavior Measurement Model

	Generic Model				Revised Model			
	Estimate	S.E.	C.R.	P	Estimate	S.E.	C.R.	P
VI 5 <--- VI	1.000				Deleted			
VI 4 <--- VI	2.024	.254	7.985	***	1.000			
VI 3 <--- VI	2.058	.255	8.055	***	1.023	.046	22.296	***
VI 2 <--- VI	1.967	.248	7.943	***	.972	.048	20.405	***
VI 1 <--- VI	1.460	.200	7.297	***	.714	.053	13.504	***

Testing the model fit indices is completed to validate the revised personnel attitudes toward violation behavior measurement model. Table 31 shows the model fit indices checked for the generic and revised personnel attitudes toward violation behavior measurement model. The revised model did improve after eliminating VI5, although the generic model was within the satisfactory range in all model fit indices values. For example, RMSEA index is enhanced from 0.066 to 0.019 in which it became a very adequate fitting value that increase model overall fit.

Lastly, internal consistency is calculated for personnel attitudes toward violation behavior measurement model using Cronbach's alpha score to ensure the existence of valid reliability. Cronbach's alpha score for personnel attitudes toward violation behavior construct is 0.871 which is greater than the suggested level of 0.70 and thus, personnel attitudes toward violation behavior measurement model is a reliable construct.

Table 32 Model Fit Indices for Personnel Attitudes toward Violation Behavior Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	14.332	2.326
Degrees of Freedom (df)	>=0	5	2
Chi- Square statistic/df	<=5	2.866	1.163
Tucker-Lewis index (TLI)	> 0.90	0.981	0.999
Comparative fit index (CFI)	> 0.90	0.991	1.00
Goodness of fit index (GFI)	> 0.90	0.987	0.997
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.066	0.019
Probability (p- close)	> 0.05	0.217	0.624

4.3.3 Validating the Study Model of Safety Culture and Safety Performance using CFA

Validating each construct in the research model is a key step toward applying confirmatory factor analysis effectively to all study variables. The previous section of CFA discussed the validation for each measurement model in order to prepare each construct to be validated for a second time but with all other study variables as the study model theorized. After confirming the validity of each measurement model in the study separately in the beginning of doing CFA, the safety culture study model needed to be validated as a whole model including all exogenous and endogenous variables using confirmatory factor analysis.

In the proposed model, safety culture is hypothesized as a second order latent factor that consisted of five dimensions including management commitment toward safety, employee attitudes toward safety, coworkers' safety support, construction workplace pressure and construction sites safety management systems. Personnel safety motivation is the mediating variable in the model between safety culture and safety performance measured through error and violation behavior. Safety motivation construct along with personnel error behavior and personnel attitudes toward violations and all exogenous variables are included in the hypothesized study generic measurement model as shown in figure 27.

CFA is applied to validate safety culture hypothesized study model. In the generic model of safety culture hypothesized study model, all the factor loadings are statistically significant at 0.05 level because their critical ratio are higher than 1.96. However, the generic safety culture hypothesized study model did not have satisfactory fit measures based on TLI and CFI where (TLI=0.855 and CFI=0.863). In contrast, chi square ($\chi 2/df$) and RMSEA are considered to be within a tolerable fit range where (chi square /*degree of freedom*) = 2.33, and RMSEA = 0.056 (PCLOSE= 0.000). Hence, improving model fit is necessary to be implemented using a number of modification trials. Initially, any indicator that has a low factor loading less than 0.50 is removed to enhance model fit. MC6, SMS5, ER1, GB4, VI1 are all excluded from the safety culture hypothesized study measurement model except for VI2 and ER2 which they have factor loadings of 0.43 and 0.46 respectively.

The reason which VI2 and ER2 are not removed because their factor loadings are just slightly under 0.5 and most importantly to follow the rule of recommended lowest number of observed variables that represent a latent variable which should be three indicators (Kline, 2011). If VI2 and ER2 are deleted from the generic model, error and violation constructs will end up with less than three indicators that violate the recommended number of indicator condition mentioned in the literature (Kline, 2011). Although items with low factor loading are deleted, the model fit slightly improved but still the fit is not with an adequate range.

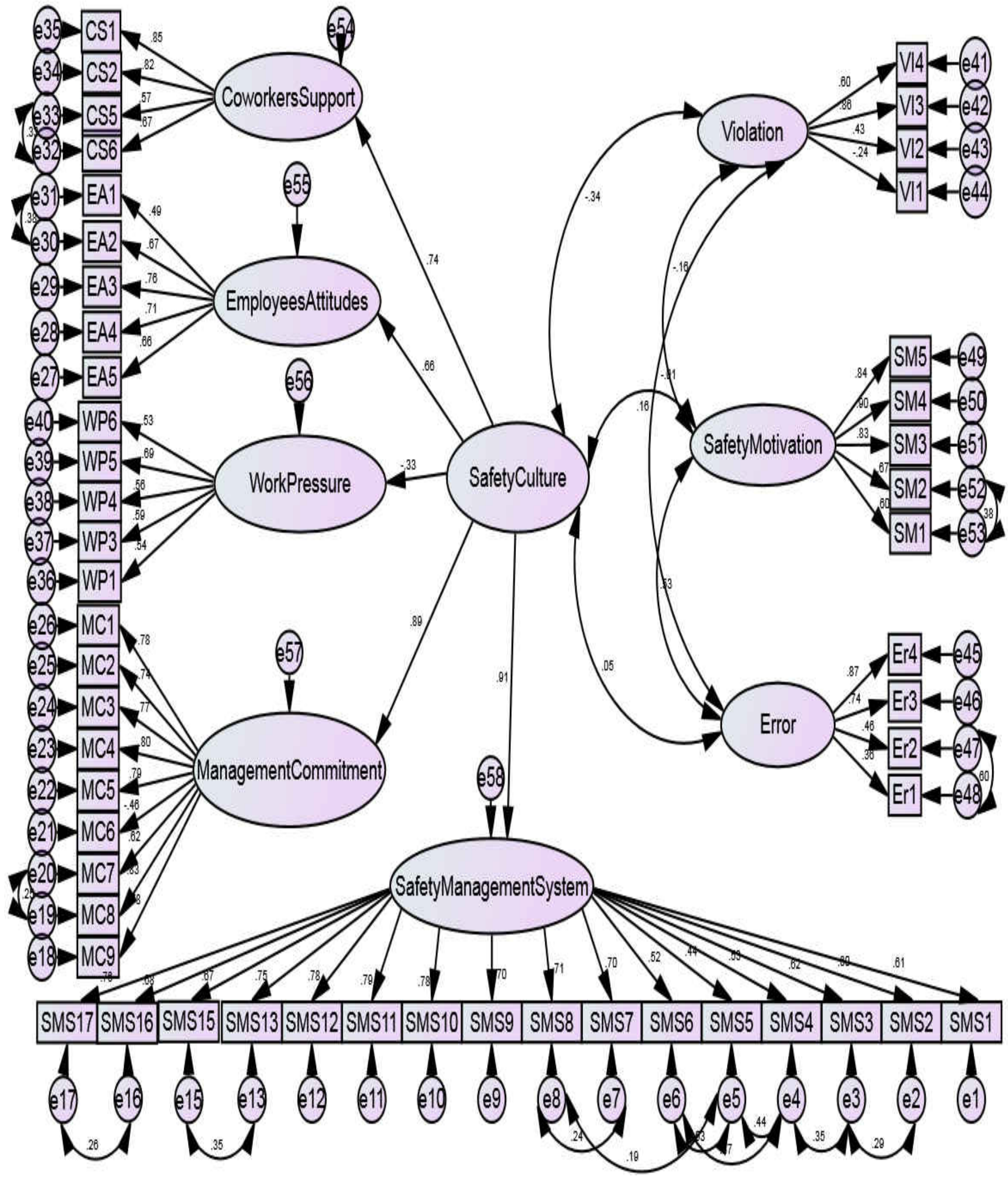

Figure 27 Measurement Model for Hypothesized Study Safety Culture Model

Next, the examination of residuals standardized matrix is performed using AMOS 23 software. Analyzing standardized residuals matrix helped to identify variable covariance terms to find out whether or not these variables are accounted for reasonably by the study model. If the value of standardized residual is more than 1.96 or 2.58, it indicates that the residual is high enough in which make the variable representation not accurate in the model (Schumacker and Lomax, 2004). Some of the indicator signals high residual value but however they are not consistent and when they are removed no significant effect can be seen in the overall model fit. Therefore, they are kept until checking of the modification indices and error correlations suggested in the next step of the analysis. The revised measurement model of safety culture hypothesized study is presented on figure 28.

The model fit indices for the revised safety culture hypothesized study measurement are within a satisfactory fit criteria (chi square /degree of freedom= 1.911, TLI=0.907, CFI=0.0914, RMSEA=0.046 and p-close= 0.988). Table 32 below illustrates the fit indices for both the generic and revised safety culture hypothesized study measurement model. The revised safety culture hypothesized measurement model indicated significant developments in model fit indices values.

Table 33 Model Fit Indices for Safety Culture Hypothesized Study Measurement Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	2919.412	2006.95
Degrees of Freedom (df)	>=0	1249	1050
Chi- Square statistic/df	<=5	2.337	1.911
Tucker-Lewis index (TLI)	> 0.90	0.855	0.907
Comparative fit index (CFI)	> 0.90	0.863	0.914
Goodness of fit index (GFI)	> 0.90	0.791	0.85
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.056	0.046
Probability (p- close)	> 0.05	0.000	0.988

Moreover, the Chi square statistics value is remarkably decreased by almost 1000, which increased the revised model fitness significantly. Lastly, the calculation of internal consistency using Cronbach's alpha of each latent variable is determined as 0.937 for safety culture construct, 0.889 for personnel safety motivation construct, 0.840 for personnel error behavior and 0.891 for personnel attitudes toward violation behavior construct. Therefore, the revised safety culture hypothesized study model is confirmed to be reliable because all the revised model variables' Cronbach's alpha score are higher than 0.70.

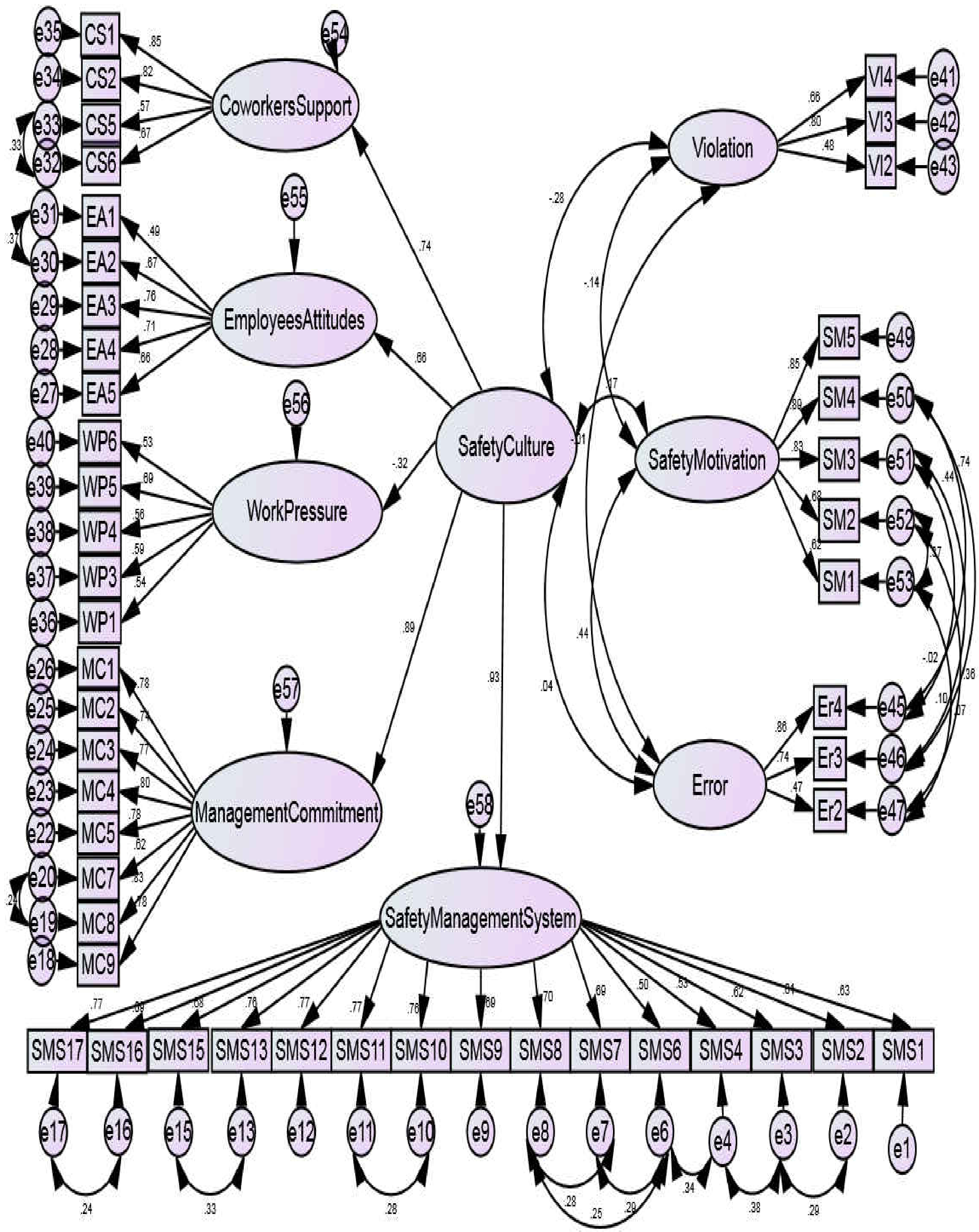

Figure 28 Revised Measurement Model for Hypothesized Study Safety Culture Model

4.4 Structural Equation Modeling

The next step after validating safety culture hypothesized study model using confirmatory factor analysis is to generate the structural model of the study in order to test the research hypotheses. Path analysis was employed with the use of each latent indicator to test the connections between each latent variable as well as the hypotheses of the study. Each latent variable is inputted using its observed variables to form a composite variable aiming to deliver a measuring score for each construct in the research model using AMOS 23 software. Furthermore, the generated composite variables have a number of benefits compared with latent variables because it delivers an enhanced model fitness values (Brown, 2006; Kline, 2011; Schumacker and Lomax, 2004).

All exogenous and endogenous variables in this research are included in the structural model. In the study, the exogenous variable is safety culture in construction sites affecting personnel safety motivation to construction safety and personnel error behaviors as well as their attitudes toward violation behaviors. On the other hand, endogenous variables in this research consist of construction personnel safety motivation, construction personnel error behavior as well as construction personnel attitudes toward violation behaviors. Moreover, personnel safety motivation to construction safety is conceptualized in this study to be the mediating variable that mediates the relationship between safety culture in construction sites and construction personnel error behavior as well as personnel attitudes toward violations behavior.

Building the generic structural model is implemented in accordance to the theoretical background to test the research hypotheses through linking safety culture as the exogenous variable to the endogenous variables including personnel safety motivation to construction safety, construction personnel error behavior and construction personnel attitudes toward violation behaviors. In addition, demographic variables are incorporated in the structural model including age, nationality, education, working experience in construction field, work position in the company, and frequency of safety training to offer more comprehension to the research. Using path analysis, the coefficients of the standardized path are estimated for each connection between the composite variables. Figure 29 demonstrates the generic structural model for the influence of safety culture hypothesized study model on safety performance through error and violation behavior.

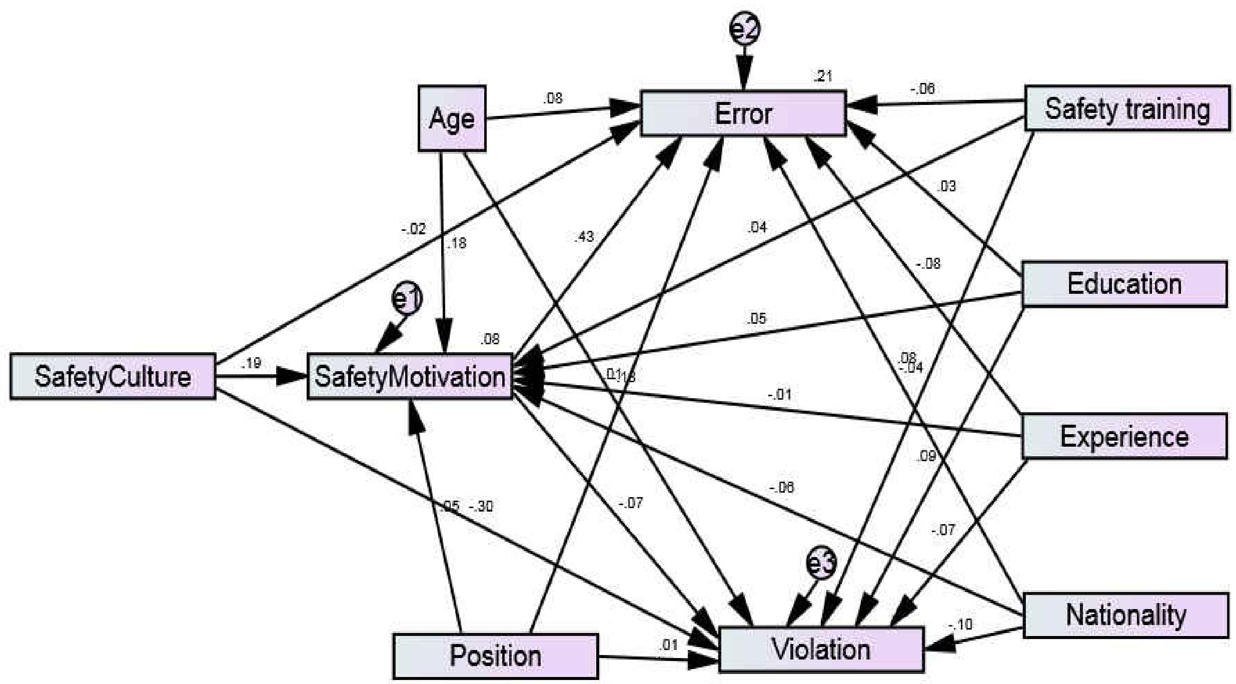

Figure 29 The Generic Structural Model for the Influence of Safety Culture on Safety Performance

Safety culture hypothesized generic structural model for evaluating safety culture impact on safety performance is assessed based on fitting indices to measure goodness of fit. Four measures of goodness of fit are employed to assess safety culture hypothesized generic structural model fit in regards to the collected data. The goodness of fit indices employed are comparative fit index (CFI), chi-square statistical index, root mean square error of approximation (RMSEA) and lastly Tucker-Lewis index (TLI).

In order to validate the generic structural model of safety culture and safety act, searching for the insignificance regression paths should be identified at a 0.05 significance level. Then, any identified regression path that is not significant is removed from the generic model one by one to enhance model fitness. Lastly, the assessments of modification indices are performed to check the value of each fit index. Furthermore, chi-square fit index should be checked when error correlations are suggested through using AMOS 23 software. Nevertheless, chi-square value is expected to decrease when error terms are correlated in the model.

The generic structural model for safety culture influence on safety performance does not adequately fit based on the adopted fit criteria (GFI= 0.847, CFI=0.248, chi square /degree of freedom= 28.5, RMSEA = 0.252and lastly PCLOSE= 0.000). The regression paths or coefficients from safety training, experience and position to safety motivation, error behavior and violation behavior are not significant statistically at 0.05 alpha level. Therefore, safety training, experience and position demographic variables are removed from the structural model. Furthermore, two regression paths from education to error and safety motivation are removed from the model because it was insignificant at 0.05 level. Also, one regression line in the model is eliminated from nationality to safety motivation because it was not significant at 0.05 alpha level as well. Thus, overall two indicators and three regression paths are removed from the revised structural model of safety culture effect on safety performance in construction sites. The revised structural model of hypothesized safety culture effect on safety act is shown on figure 30.

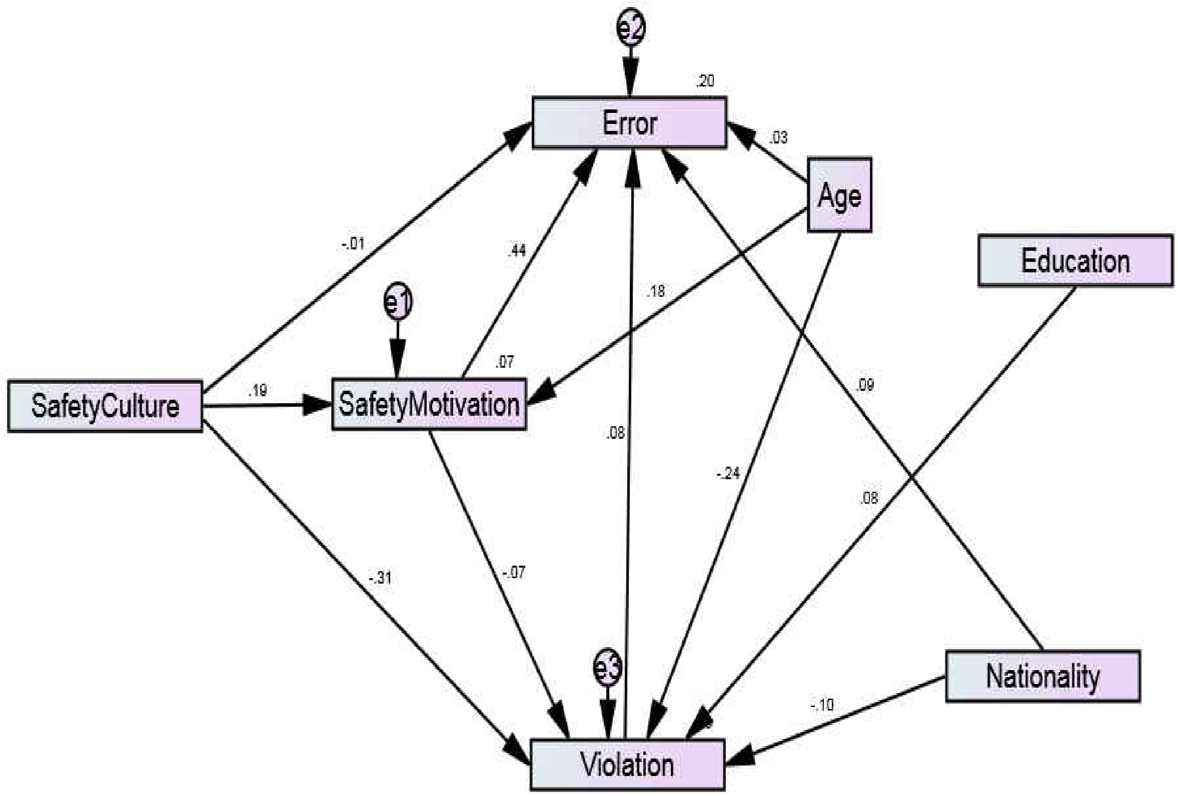

Figure 30 The Revised Structural Model for the Influence of Safety Culture on Safety Performance

The revised structural model for safety culture influence on safety performance has a substantially better fit based on the embraced fit criteria, especially in chi square data index (GFI= 0.989, CFI=0.962, chi square /degree of freedom= 1.896, RMSEA = 0.045 and lastly PCLOSE= 0.543). Table 33 illustrates an assessment of model fit measures between the revised and generic structural model of safety culture effect on safety performance in construction sites. The revised model of safety culture influence on safety performance has improved substantially in model fit indices after eliminating the insignificant regression paths and demographic variables. Moreover, the revised finalized structural model of safety culture effect on safety performance in construction sites is adopted to examine the study hypotheses and evaluate the relationships among construction safety culture, personnel safety motivation to construction safety, construction personnel error behavior and construction personnel attitudes toward violations.

Table 34 Fit Indices for Safety Culture Influence on Safety Performance Structural Model

Fit Index	Fit Criteria	Generic Model	Revised Model
Chi- Square statistic (X^2)	Low	627.45	17.063
Degrees of Freedom (df)	>=0	22	9
Chi- Square statistic/df	<=5	28.52	1.896
Tucker-Lewis index (TLI)	> 0.90	-0.537	0.912
Comparative fit index (CFI)	> 0.90	0.248	0.962
Goodness of fit index (GFI)	> 0.90	0.847	0.989
Root mean square error of approx (RMSEA)	< 0.05-0.08	0.252	0.045
Probability (p- close)	> 0.05	0.000	0.543

The revised structural model indicates that safety culture on construction sites has a significant, positive effect on personnel safety motivation to construction safety (β=0.19, p<0.001). This points to the significant role of safety culture in enhancing personnel safety motivation to construction safety. Furthermore, safety culture in construction sites has a significant, negative influence on personnel attitude toward violations (β= -0.31, p<0.001). This significant relationship between safety culture and construction personnel safety behavior showed the substantial impact of safety culture in decreasing construction personnel attitude toward violations. As construction personnel in Saudi Arabia have thorough and positive awareness about safety culture on construction sites, they are going to be less likely to form attitudes toward safety violations. In contrast, safety culture on construction sites do not have a significant, direct effect on construction personnel error behaviors (β=-0.02, p>0.05). This result states that construction personnel error behavior cannot be directly anticipated from constructions safety culture in Saudi Arabia.

Personnel safety motivation to construction safety is the mediating factor between safety culture personnel error behavior as well as personnel attitudes toward violations behavior in construction sites. Safety motivation to construction safety has a significant statistical effect on personnel error behavior ($\beta=0.43$, $p<0.001$). This emphasizes the vital role of safety motivation in making construction personnel more motivated to follow safety procedures and make fewer errors in doing construction work. On the other hand, personnel safety motivation to construction safety does not have significant influence on construction personnel attitudes toward violations, ($\beta= -0.07$, $p>0.05$) although safety culture directly affects personnel attitudes toward violation. Therefore, personnel safety motivation mediates the relationships between safety culture in construction sites and personnel error behavior. However, personnel safety motivation is not mediating the relationships between safety culture in construction sites and personnel attitudes toward violation behavior.

Analysis on the mediation role of safety motivation on personnel attitudes toward violation is continued for evaluation reasons. The mediation assessment is implemented by the use of bootstrapping statistical method to assess the effect of personnel safety motivation to construction safety as a mediator variable between construction safety culture and safety performance measures including error and violation behaviors. It is found that safety culture has a significant negative direct impact on construction personnel attitude toward violations ($\beta= -0.31$, $p<0.001$). Table 34 and 35 exhibit parameters estimations comparisons between generic and revised safety culture effect on safety performance structural model.

Table 35 Parameters Estimates of the Generic Safety Culture Influence on Safety Performance Structural Model

			Estimate	S.E.	C.R.	P
Safety Motivation	<---	Safety Training	.035	.040	.873	.383
Safety Motivation	<---	Education	.036	.036	.986	.324
Safety Motivation	<---	Experience	-.003	.020	-.136	.892
Safety Motivation	<---	Nationality	-.018	.014	-1.276	.202
Safety Motivation	<---	Position	.027	.024	1.109	.268
Safety Motivation	<---	Age	.090	.023	3.863	***
Safety Motivation	<---	Safety Culture	.184	.046	4.010	***
Error	<---	Safety Motivation	.505	.052	9.652	***
Violation	<---	Safety Motivation	-.069	.045	-1.539	.124
Error	<---	Safety Culture	-.020	.051	-.389	.698
Violation	<---	Safety Culture	-.293	.043	-6.737	***
Error	<---	Education	.031	.039	.781	.435
Error	<---	Nationality	.031	.016	1.971	.049
Violation	<---	Nationality	-.031	.013	-2.331	.020
Error	<---	Position	.005	.026	.187	.851
Violation	<---	Position	.005	.023	.222	.824
Violation	<---	Education	.066	.034	1.963	.050
Error	<---	Safety Training	-.064	.044	-1.465	.143
Error	<---	Age	.049	.026	1.892	.059
Violation	<---	Age	-.091	.022	-4.138	***
Violation	<---	Safety Training	-.033	.037	-.882	.378
Error	<---	Experience	-.040	.022	-1.842	.065
Violation	<---	Experience	-.029	.019	-1.577	.115

*** P value is significant at 0.005 level

Table 36 Parameter Estimates of the Revised Safety Culture Influence on Safety Performance Structural Model

			Estimate	S.E.	C.R.	P
Safety Motivation	<---	Safety Culture	.185	.046	4.007	***
Safety Motivation	<---	Age	.089	.023	3.782	***
Violation	<---	Safety Motivation	-.069	.044	-1.558	.119
Violation	<---	Safety Culture	-.304	.044	-6.987	***
Violation	<---	Nationality	-.032	.013	-2.373	.018
Violation	<---	Education	.064	.034	1.902	.057
Violation	<---	Age	-.122	.022	-5.530	***
Error	<---	Safety Motivation	.510	.052	9.770	***
Error	<---	Safety Culture	-.016	.054	-.297	.766
Error	<---	Nationality	.033	.016	2.118	.034
Error	<---	Age	.018	.027	.662	.508
Error	<---	Violation	.093	.056	1.654	.098

*** P value is significant at 0.005 level

Testing the mediating effect of personnel safety motivation to construction safety between safety culture and personnel error behavior is performed first. The direct influence of safety culture on personnel error behavior is not statistically significant (β= -0.01, p>0.05) at a 0.05 level. The indirect impact of safety culture on construction personnel error behavior by the use of the mediating influence of personnel safety motivation to construction safety is significant at a 0.05 statistical level (β=0.093, p=0.001). Therefore, personnel safety motivation to construction safety does mediate the relationship between safety culture and personnel error behavior in construction sites. On the contrary, the indirect influence of safety culture on construction personnel attitude toward violation by the use of the mediating impact of personnel safety motivation to construction safety is not significant at a statistical 0.05 alpha level (β= -0.013, p=0.221). This concludes that personnel safety motivation to construction safety does not mediate the relationship between safety culture and personnel attitudes toward violations in construction environment.

The revised structural model for safety culture influence on safety performance theorized that construction personnel attitude toward violations mediates the relationship between safety culture and construction personnel error behaviors. The mediating effect of construction personnel attitudes toward violations between safety culture and personnel error behaviors is examined. As the direct influence of safety culture on construction personnel error behaviors is not significant at a 0.05 level, the indirect effect of safety culture through construction personnel attitude toward violation is figured out. The direct impact of construction personnel attitudes toward violation on personnel error behavior is found to be insignificant at a 0.05 statistical level (β= 0.093, p=0.107). Therefore, because construction personnel attitudes toward violation does not have a direct effect on personnel error behavior, the indirect impact of safety culture on construction personnel error behavior through personnel attitudes toward violation cannot exist. Therefore, the results of this research indicate that safety culture has an indirect effect on construction personnel error behaviors mediated by personnel safety motivation. On the other hand, safety culture does not have an indirect effect on construction personnel error behavior mediated by personnel attitudes toward violation. Also, a third test of mediation is implemented to test the mediating influence of personnel safety motivation to construction safety on personnel error behavior by the use of personnel attitudes toward violation. The indirect effect of personnel safety motivation to construction safety on personnel error behavior is calculated through the mediating effect of construction personnel attitude toward violations.

The indirect effect of personnel safety motivation to construction safety on personnel error behavior is found to be not significant at a 0.05 statistical level (β= -0.006, p=0.225). This outcome confirms that personnel safety motivation to construction safety does not have an indirect effect on personnel error behavior. However, personnel safety motivation to construction safety has a significant direct influence on personnel error behavior with β=0.510 and p<0.001. The demonstration of the total effects, direct effects and indirect effects of all exogenous and endogenous variables in the safety culture influence on safety performance structural model are shown in Table 36.

The effect of three demographic variables including participant's age, education level and nationality are calculated in this research. Age control variable has a direct significant influence on construction personnel safety motivation (β= 0.089, p=0.001) and a direct negative significant effect on personnel attitudes toward violations (β= -0.122, p=0.001) at a 0.05 level. The negative signal of the path coefficient indicates that whenever age is increased the violation attitude toward behavior tends to decrease. Age also has an indirect significant influence on personnel error behavior (β= 0.033, *p*=0.023) at 0.05 statistical level. Age control variable contains age categories that participants can choose from including under 26 years, 26-30 years, 31-35 years, 36-40 years and more than 40 years.

Table 37 Direct, Indirect and Total Effect of the Exogenous Variables on the Endogenous Variables

Independent Variable	Effect type	Dependent Variable	
		Personnel Error	Personnel violation attitudes
Safety Culture	Direct effect	-0.016	-0.304
	Indirect effect	0.065	-0.013
	Total Effect	.049	-0.317
Safety Motivation	Direct effect	0.510	-0.069
	Indirect effect	-0.006	0.00
	Total Effect	0.504	-0.069
Age	Direct effect	0.018	-0.122
	Indirect effect	0.033	-0.006
	Total Effect	0.051	-0.128
Education	Direct effect	0.00	.064
	Indirect effect	0.006	0.00
	Total Effect	0.006	0.064
Nationality	Direct effect	0.033	-0.032
	Indirect effect	-0.003	0.00
	Total Effect	0.030	-0.032

Education demographic variable effect on personnel violation is tested in this research. Education does not have a significant effect on attitudes toward violation although p value is 0.09, which is near the significance level of 0.05. This outcome encourages more investigation and analysis regarding the importance of education in improving safety performance.

Lastly, the effects of participants' nationality as a demographic variable are tested in this research. Unexpectedly, it is found that nationality control variable has a direct significant influence on construction personnel error behavior (β= .033, *p*=0.003) and a direct, negative significant effect on personnel attitude toward violations (β= -0.03, *p*=0.004) at 0.05 statistical level. Nationality of participants is recorded as an open-ended question. The majority of the respondents are Saudi (89%) and the rest of participants came from 11 different countries including Egypt, Kuwait, Iraq, Jordan, Britain, Syria, Slovakia, Palestine, Morocco, Tunis, Sudan and Yemen. This result suggests that nationalities of the construction personnel have a direct impact on construction safety performance including personnel error and violation attitudes. Thus, more investigation is needed in this regard as a future research opportunity.

4.5 Testing Research Hypotheses

Testing the study hypotheses is the last step of statistical analysis in this research. The obtained revised model of safety culture effect on safety performance in construction sites is used in examining the study hypotheses. This research includes five hypotheses, which are tested in accordance to the revised structural model obtained through SEM method using AMOS 23 software. Mediating effects of safety motivation to construction safety and personnel attitudes toward violation are tested using bootstrapping statistical method. The five hypotheses of the study are the following:

H1: Safety culture has a significant influence on personnel safety motivation in the construction sites.

H2: Safety culture has a significant impact on personnel error behaviors in the construction sites.

H3: Safety culture has a significant impact on personnel attitudes toward violations in the construction sites.

H4: Personnel safety motivation mediates the relationship between safety culture and employees error behaviors in the construction sites.

H5: Personnel safety motivation mediates the relationship between safety culture and employee attitudes toward violations within construction sites.

The first hypothesis is supported by the statistical outcomes of this study because safety culture did have a significant positive effect on personnel safety motivation to construction safety (β=0.19, $p<0.001$). Based on early expectations, safety culture on construction sites has a substantial part in personnel safety motivation to construction safety. The second hypothesis is not supported by the results of this research. Safety culture does not have a statistically significant impact on construction personnel error behaviors at a 0.05 alpha level (β=-0.016, $p>0.05$). The direct influence of safety culture on personnel error behaviors is insignificant which suggests that the mediating effect can better elaborate the influence of safety culture on construction personnel error behaviors through safety motivation.

For the third hypothesis, it was supported by the statistical analysis of this research. Safety culture does have a significant negative direct influence on construction personnel attitudes toward violations (β= -0.31, $p<0.001$). The negative path coefficient between safety culture and personnel attitudes toward violation indicated that as construction personnel have a clear and positive awareness about safety culture, they are less likely to have an attitude toward safety violations. Also, hypothesis four was supported by the study outcomes. Personnel safety motivation to construction safety does mediate the relationship between safety culture and personnel error behaviors. The mediation can exist only when the mediator variable did have a significant influence on the dependent variable. The direct effect of personnel safety motivation to construction safety on personnel error was significant statistically at a 0.05 level (β= 0.510, $p<.0001$). Therefore, personnel safety motivation to construction safety mediates the relationship between safety culture and personnel error behaviors.

Lastly, the fifth hypothesis of the study is not supported by the results obtained from statistical analysis. Personnel safety motivation to construction safety does not mediate the relationship between safety culture and construction personnel attitudes toward violations behavior. Personnel safety motivation to construction safety does not have a direct significant impact at a 0.05 statistical level on construction personnel attitude toward violations behavior ($\beta = -0.069$, $p > 0.05$). Thus, personnel safety motivation to construction safety cannot be used as a mediator between safety culture and construction personnel attitude toward violations. It can be concluded that personnel safety motivation did successfully mediate the relationship between safety culture and personnel error behavior, but it failed to mediate the relationship between safety culture and personnel attitudes toward violation behavior. That conclusion was reached because safety motivation has a direct influence on error behavior, but it does not have a direct impact on attitude toward violation behavior.

It is not unexpected that personnel safety motivation did not mediate the relationships between safety culture and personnel attitudes toward violations because safety culture affects attitudes toward violation behavior directly. This implies that the focus should be on building effective safety culture in order to reduce attitude toward violation behaviors because either safety motivation direct effect or safety culture mediating effect alone or together will not enhance attitude toward violation behaviors unless strong safety culture exists. Conversely, safety motivation mediates the relationship between safety culture and personnel error behavior because there is a significant, direct effect from safety culture to safety motivation and from safety motivation to personnel error behaviors. Although safety culture does not have a direct effect on personnel error behavior, however, it has indirect effect on personnel error behavior through the mediating variable safety motivation. This implies that the existing safety culture should be accompanied with strong safety motivation in order to increase construction personnel’s adherence and competence to follow safety procedure without making mistakes.

CHAPTER 5: DISCUSSION, STUDY IMPLICATION, LIMITATION, CONCLUSION AND DIRECTION FOR FUTURE RESEARCH

The main objective of this study is to evaluate the effect of safety culture on safety performance among construction personnel in Saudi Arabia. The study has also examined the mediating role of personnel safety motivation to construction safety between safety culture and measures of safety performance, including error and attitudes toward violations. The next sections discuss the study outcomes and relate them to earlier research in the construction field. The discussion of the study outcomes, research implications, limitation, conclusions and direction for future research will be provided and elaborated on in subsequent sections.

5.1 Discussion

In the first hypothesis, safety culture role as a core interpreter of personnel safety motivation to construction safety is investigated. Safety culture as a second order latent factor is conceptualized by five, main, first order factors including management commitment toward safety, employee attitudes toward safety, coworkers' safety support, construction workplace pressure and construction sites safety management systems. Research outcomes showed that safety culture has a significant positive influence on personnel safety motivation to construction safety (β=0.19, p<0.001). This result emphasizes the role of safety culture as a central predictor of personnel safety motivation to construction safety. Furthermore, the finding highlights the significant contribution of safety management systems and management commitment to improve personnel safety motivation to construction safety by making them involved in safety processes, accommodating their safety concerns, assigning clear safety accountability to enable construction personnel to make crucial decisions about safety problems, and more essentially, to empower the construction personnel to be more committed to adhere , as well as to improve safety daily rules and procedures. Mohamed (2002) conducted a safety climate investigation study on construction workers in 10 different construction companies in Australia. He used the following aspects of safety climate including management commitment, communication, workers participation, attitude, capability and skills, management positive monitoring, safety rules and procedure and supportive environment (Mohamed, 2002). The results of the study stated that safety climate has a positive impact on a supportive environment and positive monitoring, which are directly related to safety motivation (Mohamed, 2002). Many studies evaluated safety climate dimensions and they concluded that employee safety empowerment and motivation are greatly affected by safety culture (Galler, 1994; Wiegmann et al., 2004; Zohar, 1980; Choudhry et al., 2009).

Furthermore, safety culture is positively impacted by management commitment, management support, workers motivation through awards to good safety culture (Vecchio-Sudus and Griffiths, 2004; Choudhry et al., 2009). Based on the questionnaire approach of their study, they stated that behavioral improvement and good safety behavior reassurance are the main blocks that a good safety program consists of (Vecchio-Sudus and Griffiths, 2004; Choudhry et al., 2009). Also, Ismail et al. (2012) stressed in their study that safety culture has an influence on management support and workers motivation because they are considered as safety climate elements. Therefore, the previous study in literature supported the findings of this research in regard to the influence of safety culture on personnel safety motivation to construction safety.

The second results in the research are related to the direct effect of safety culture on construction personnel error behaviors. Safety culture does not have a significant direct effect on construction personnel error behaviors ($\beta=-0.016$, $p>0.05$). Construction personnel awareness about safety culture in Saudi Arabia is not sufficient to influence error behaviors. There is a study implemented by Fogarty (2004) that investigated safety climate effect on maintenance personnel error behaviors. It was concluded in Fogarty (2004) study that error behaviors of maintenance personnel could not be interpreted only through safety climate directly. This supported the study result in which safety culture has no direct effect on construction personnel error behavior. Therefore, safety culture is not enough to be only used for predicting construction personnel error behavior, which was supported by Fogarty (2004) study. The research discussed that a mediating variable such as work pressure can be used to better clarify the impact of safety climate on personnel error behaviors (Fogarty, 2004).

For the third hypothesis, the research examined the influence of safety culture on construction personnel attitude toward violations. The study outcomes demonstrated that safety culture has a significant and direct influence on construction personnel attitude toward violations ($\beta = -0.31$, $p < 0.001$). As long as construction personnel in Saudi Arabia have excellent awareness about safety culture, construction personnel attitude toward violations tends to decrease. The construction personnel attitude toward violations construct was validated using CFA to get the revised final measurement model. The questions of the final revised measurement model for personnel attitude toward violations construct addressed the way construction personnel think about violations of safety procedures, such as their inner approach toward safety violation behaviors and their attitudes toward eliminating or avoiding some safety procedures. The impact of management attitudes toward safety on maintenance personnel attitudes toward violation was examined by Fogarty and Shaw (2010). The study indicated that management awareness and support toward safety has a substantial and direct influence into forming personnel attitude toward violations (Fogarty and Shaw, 2010). This result supports the findings of the present study where construction personnel awareness about safety culture in Saudi Arabia directly affects their own attitude toward violations.

The present study hypothesized personnel safety motivation to mediate the relationship between safety culture and construction personnel error behaviors and personnel attitude toward violations. In regard to the fourth and fifth hypotheses, the current study evaluated the mediating role of personnel safety motivation to construction safety between safety culture and personnel own attitude toward violations and personnel error behaviors. Personnel safety motivation to construction safety has a significant, direct impact on personnel error behaviors, ($\beta=0.51$, $p<0.001$) however, it does not have a significant direct effect on personnel attitude toward violations ($\beta=-0.069$, $p=0.119$) at a 0.05 level. Therefore, according to the study outcomes, personnel safety motivation mediates the relationships between safety culture and personnel error behavior, but safety motivation is not mediating the relationship between safety culture and personnel attitudes toward violation.

Vinodkumar and Bhasi (2010) examined the effect of safety management practices on safety motivation and safety knowledge among Indian factories personnel. Safety management practices are investigated by Vinodkumar and Bhasi (2010) in their study, which includes management commitment, safety training, workers participation, safety feedback and communication, safety guidelines, safety procedures and safety promotion programs. The study outcomes indicated safety motivation mediated the relationships between safety management practices and safety compliance. Safety culture has a significant indirect effect on construction personnel error behaviors through personnel safety motivation ($\beta= 0.065$, $p=0.040$). The finding of this research is consistent and supported by literature because it has a similar results where personnel error behavior is better elaborated through a mediating construct with safety culture rather than directly predicting errors from safety culture or safety climate (Fogarty, 2004). As mentioned earlier, Fogarty (2004) assessed employee safety climate including employee commitment and work satisfaction through examining the influence of safety climate on error behaviors of maintenance personnel. The study findings indicated that safety climate does not have a significant effect on error behaviors.

Safety motivation to construction safety does have a significant influence on construction personnel error behaviors. On the other hand, safety motivation to construction safety does not have a significant influence on construction personnel attitude toward violations. Although safety culture significantly affects attitude toward violation, safety culture does not have an indicant effect on attitudes toward violation through the mediating role of safety motivation. The current research demonstrated that safety culture has an indirect influence on personnel error behavior and a direct effect only on attitudes toward violation behavior. The insignificant influence of safety motivation on attitude toward violation is emphasizing the role of safety culture through eliminating violation attitudes. As a result, it is necessary to take care of the safety culture in order to reduce violation by establishing a robust culture of safety and not just focusing on motivating construction personnel.

Construction middle managers in Saudi Arabia are highly motivated to not perform a violation in implementing safety procedures. From my experience in the construction field in Saudi Arabia, personnel motivation to construction safety has no influence on personnel attitudes toward violation because, internally, they are motivated to safety. Instead, safety culture's practical applications in the field including safety management systems, management attitude, and work pressure are producing the main effects in shaping construction personnel attitudes toward violation positively or negatively. Construction personnel who are not highly motivated towards safety will not develop negative violation attitudes if the safety culture of the construction site is excellent and well maintained.

5.2 Study Implication

The present study has several implications for safety culture research in construction field and also for Saudi Arabian construction projects. First of all, the study indicated that safety culture has a significant effect on personnel safety motivation to construction safety. This outcome implies the substantial need to assess and enhance safety culture in construction sector. Saudi construction top management personnel should concentrate on appraising and improving the current safety culture in the construction sites, which, in accordance, will improve personnel safety motivation to construction safety. In order to improve personnel safety motivation to construction safety, Saudi government construction officials should have a high management commitment to safety, enhance employee attitudes through safety awareness and should get workers involved in decisions regarding safety. Also, Saudi construction government officials should have an excellent safety management system and balanced work pressure in the site in order to improve personnel safety motivation to construction safety. The current research proved the important role of safety culture as the main predicting factor to enhance personnel safety motivation to construction safety in construction sites.

Second, the present research confirmed the significant influence of safety culture role in forming personnel safety behaviors in construction sites. Safety culture did have a direct and significant effect on construction personnel attitudes toward violations and an indirect impact on construction personnel error behaviors through safety motivation. These outcomes emphasize the obligation of Saudi governmental construction management to decrease unsafe conducts and improve safety processes and daily application routine. These results highlight the urgent need to examine safety management systems, accidents and near miss cases to find out the organizational characteristics that took part directly or indirectly in influencing unsafe performance. Saudi government construction management should not directly make the decision to blame construction personnel for unsafe acts, but instead they should explore the elements that formed their behavior to make an error or violation behavior.

Personnel safety motivation towards construction safety had a significant effect on construction personnel error behaviors but it did not have a significant influence on construction personnel attitude toward violations. This shows that construction personnel attitudes toward violation is not effected directly by how they are motivated to safety values and procedures, but, rather, study results showed that attitude toward violation is greatly influenced by current safety culture in the construction site. Safety culture is confirmed to have a significant direct effect on personnel attitudes toward violation ($\beta = -0.31$, $p < 0.001$).

Construction personnel are motivated to apply safety rules and procedures and they place a high importance on safety values in workplace. However, the study found that although participants of this research have high motivation for safety, however, this will not affect their attitude toward violation, Saudi construction government officials should support safety-positive actions, like safety reward system, safety report system along with continuous behavioral modifications in order to decrease the attitudes toward violation. The study found that safety culture has a insignificant direct effect on construction personnel error behavior. The study findings proved that safety culture indirectly influences error behaviors through the mediating role of safety motivation. This research outcome was supported in the literature in which it is stated that personnel safety error cannot be directly predicted or explained through safety climate construct, which is a component of safety culture (Fogarty, 2004). Saudi construction management personnel should make sure construction personnel are skillful in knowing all safety procedures through motivating them to be more accurate in performing safe work practices. Most of the participants indicated that they have made a safety error when applying safety procedures unintentionally due to the lack of incentive to seek knowledge for the proper way to do the work safely. Therefore, the study findings can help Saudi government construction management to enhance safety performance by making construction personnel more attached and motivated to know all safety procedures proficiently to reduce error behavior and also to improve safety management practices including safety reward system and well established safety accountability to decrease attitudes toward violation.

The nature of the culture raises the need to do continuous assessment and monitoring of the safety culture in construction projects in order to correct and improve any human error or violation that may result without the necessary corrective actions. Moreover, there is a need to assess the culture types existed in the construction field in order to enhance the overall safety culture with the necessary corrective procedures. Choudhry et al. (2007) specified that safety culture is basically associated with organizational culture. Safety culture may have several differing forms within the construction sites, including engineer, executive, and worker safety culture (Schein, 1991; Cooper, 2000). The construction management in Saudi government should make sure that all the forms of safety culture in the construction sites are in harmony and have similar directions and goals for achieving excellent safety performance. Lastly, the construction management for Saudi government should concentrate mainly on the scopes of safety culture including management commitment toward safety, employees' attitude toward safety, coworkers' safety support, workplace pressure and the safety management system for each construction sites managed by them. These factors form the safety culture within Saudi government construction sites. Each scope of safety culture should be evaluated thoroughly to detect any potential improvement opportunities.

5.3 Conclusion

As the number of construction projects increase to meet the necessary demand of developing cities infrastructures and economic development, the risk probability of having an accident on the construction site will be increased. The construction sector is one of the major industries that contribute in economic growth and social wellbeing of all countries around the world. Safety culture has a significant role in decreasing accidents and injury occurrences and it has become the center of attention in all industries in the recent years, particularly in the constructions field. Lack of safety culture is a key reason of injury and accident occurrences since safety culture is fundamentally related to organizational culture. Organizational actions and activities are considered as the components of organizational culture that have major contributions in accidents causality in hazardous industries. Organizational culture elements influenced personnel behaviors when performing a required task in the work environment. A focus on understanding and applying safety culture concept in the construction field is essential to assure the safety of construction personnel in this high-risk work.

The present research evaluated safety culture among construction personnel working in government sites in Saudi Arabia. This study investigated the effect of safety culture on personnel safety motivation to construction safety and the influence of safety culture on safety performance. The two safety performance measures are construction personnel error behaviors and construction personnel attitude toward violations. Moreover, this research further explores the mediating role of personnel safety motivation to construction safety between safety culture and the safety performance's two measures, error and attitudes toward violations. A total of 434 construction personnel including project managers, engineers, supervisors and safety engineers agreed to participate in the study questionnaire representing a overall response rate of 50.11%. A confirmatory factor analysis is implemented in order to validate each latent variable in the research. Then, structural equation modeling is applied to test the research hypotheses by extracting the structural revised model. Study outcomes demonstrate the crucial influence of safety culture as a core predictor of personnel safety motivation to construction safety. Besides, safety culture has a vital consequence in forming construction personnel attitudes and behaviors within the construction project. Research findings revealed that safety culture, age, education and nationality in Saudi government construction sites accounted for 7% of the variance in personnel safety motivation to construction safety, 20% of the variance in construction personnel error behavior and 73% of the variance in construction personnel attitudes toward violations.

The findings of this study highlight the importance of safety culture as a significant part of organizational culture that influence employees' behaviors and attitudes. Furthermore, the current research verified and demonstrated the major effects of safety culture to improve construction personnel safety motivation, as well as their safety performance in the construction field. Saudi government construction management should provide more considerations for the scopes of safety culture in order to detect, and improve opportunities within the safety culture within these construction sites.

5.4 Research Limitations

The participation in this research was voluntary, where the respondents were free to join in or abstain from engaging in the survey, or any of the questions contained within. The study was supervised and facilitated by a government institution in Saudi Arabia, in which all the collected information is based on the participation of construction personnel working in government sites. The assessment of safety culture, personnel motivation to construction safety, personnel attitude toward violations and personnel error behaviors are performed based on construction personnel safety awareness to report their safety behaviors as a self-report study using the survey instrument. Safety culture is measured using five factors, management commitment to safety, employees' attitudes toward safety, coworkers' safety support, workplace pressure and construction sites safety management systems.

Since the study used a self-report manner of data collection through survey distribution, it is important to mention that the research participants might be influenced to report the general accepted safety procedure or conducts rather than stating their actual beliefs regarding each questions in the survey. Furthermore, construction personnel might have either negative or positive attitudes toward government construction management and this might lead them to be biased towards blaming or praising construction management in all the evaluated safety culture or safety performance factors.

Construction personnel error and attitudes toward violations behaviors were collected depending on what construction personnel believe about their own behaviors. Hence, self-reported behavior questions might make some of the construction middle managers hesitant to report their own errors or violations to avoid negative consequences. Although all the data collected in this research is anonymous, construction managers may still be uncomfortable to report negative behaviors. Therefore, it was an important target for this research to increase the sample size to more than 300 participants in order to overcome or lower the effect of such a limitation, as the information in this study and all self-report types of research are dependent on accurate and truthful opinions from the research participants.

5.5 Direction of Future Research

The present research examined the influence of construction safety culture on safety performance in terms of construction personnel error behaviors and attitude toward violations. Construction safety culture is conceptualized by five main factors, management commitment to safety, employee attitudes regarding safety, coworkers' safety support, construction work pressure, and safety management systems in the construction sites. Research outcomes demonstrated that construction safety culture has a direct effect on construction personnel attitudes toward violations and an indirect influence on construction personnel error behaviors. The direction for future research must be focused on the five scope of construction safety culture to inspect which aspect has the greatest impact on construction personnel safety performance. Safety culture is inherited through the individual's mind and psychology and it is going to be reflected in their daily actions and behaviors.

Hollnagel (2014) Safety II thoughts, which focus on the things that go right in the system not just the failures outcomes, are in agreement with the safety culture concept. Safety culture greatly supports and overlap with Safety II approach developed by Hollnagel (2014) because it can proactively predict the safety performance's good characteristics of the individuals that influence organization, procedures and values in continuous manner and is irrespective of the incidences of safety failures and outcomes. There is a future opportunity to do research using safety culture and safety II concepts in order to improve the safety level in organizations as well as to examine the relationships between the two perceptions. Nevertheless, future research should also make more effort in examining the impact of safety culture on certain kinds of violation and errors that are common in construction field for example and other industries to determine which unsafe behaviors are greatly affected by safety culture.

As a future research prospect, researchers may explore the differences among subcultures formed under the general safety culture within the same context of high risk organization field including variety of industries like construction, aviation, manufacturing and mining. This examination of the variances among each industrial division, along with differences between each countries' safety cultures, will highlight the positive and negative characteristics of organizational safety culture in such a way that elaborates and develops the current knowledge about the concept of safety culture.

APPENDIX A: IRB APPROVAL

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Omar Abdulrahman Alrehaili**

Date: **October 16, 2015**

Dear Researcher:

On 10/16/2015, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Assessing Safety Culture among Personnel in Governmental Construction Sites at Saudi Arabia: A Quantitative Study Approach
Investigator:	Omar Abdulrahman Alrehaili
IRB Number:	SBE-15-11600
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 10/16/2015 11:07:48 AM EDT

IRB Manager

APPENDIX B: RESEARCH SURVEY INSTRUMENT

Dear Participant,

My name is Omar Alrehaili. I am A PhD student at University of Central Florida. For my dissertation, I am carrying out a research survey on the concept of assessing safety culture in the construction industry of Saudi Arabia. The primary objective of this study is to explore the safety culture effect on personnel safety performance as well as their safety motivation.

The following questionnaire will approximately require ten minutes to complete. There is no risk associated with this study procedure nor is there any compensation. If you choose to participate in this survey you will be asked to record your response based on your opinions following dimensions: personal attitude toward safety, coworkers' safety support, construction work pressure, personnel safety motivation, management commitment toward safety, construction safety management system, error behavior and own attitude toward violation behavior.

Your participation in this study is voluntary. The information will be kept confidential and will be only used for this study. Moreover, you have the right to withdraw consent at any time without any consequences. Furthermore, you do not have to answer any question that is inconvenient for you. For more information about your participation rights, please contact Institutional Review Board (IRB) office, University of Central Florida, 12201 Research Pkwy#501, Orlando, FL 32826; (407) 823-3778.

If you have any further questions, concerns, inquiries, or require additional information, please contact me at Rehaili@Knights.ucf.edu, or contact my committee chair and supervisor Prof. Waldemar Karwowski at Wkar@ucf.edu.

It would be appreciated to express your thoughts and views by filling out the questionnaire below.

Thank you for your valuable time.

I have read the information described above. I voluntarily agree to participate in the survey.

________________________ __________

Signature of participant Date

A. Basic Information: Please select the category that best describes you:

Nationality: ---

Language: ---

****Age***: [ ] under 26 [ ] 26-30 [ ] 31-35 [ ] 36-40 [ ] 41-45 [ ] more than 45

****Sex***: [ ] Male [ ] Female

****Education***: [ ] Not completed high school [ ] High School [ ] Diploma [ ] Bachelor [ ] Master [ ] PhD

****Position***: [ ] Project Manager [ ] Engineer [ ] Safety Engineer [ ] Supervisors [ ] Other _________

****Experience***: [ ] Less than 5 years [ ] 6-10 years [ ] 11-15 years [ ] 16-20 years [ ] More than 21 years

****Frequency of Safety Training***: [ ] Never [ ] 1-4 times [ ] More than 4 times

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B. The Questionnaire Survey: There is a total of 60 items in the survey to be scored in using five scales of judgment based on your opinion and belief. The degree of which you are agreeing or not to each statement is provided through a five levels scale: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree.

*The survey questions are based on the following dimensions including **SAFETY CULTURE, SAFETY PERFORMANCE and SAFETY MOTIVATION** in respect to construction environment.

*For each item identified below, **check** the column that best fits your judgment strongly disagree, disagree, neutral, agree, and strongly agree .

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Category 1					
Company's management provides efficient work safety training to workers					
If I report a mistake to my supervisor, management supports me					
Management incite workers to report every incident about work safety to supervisor					
Management strongly supports workers for work safety					
Managers support work safety even if it cause delay on work					
My managers sometimes ignore violation of work safety					
Our Managers frequently negotiate unofficially with workers about work safety					
My management leads workers to be able work by being sensitive to work safety rules					
My supervisor gives importance my opinion for improvement work safety					
Category 2					
Work safety rules provide safer work environment					
I make sure to use necessary safety equipment					
I alert my colleagues acting contrary to work safety rules					
If my colleagues do not take any notice, I notify my manager about unsafe works					
I try to follow work safety rules, even if they decrease my performance					
It is most likely to have accident in a working place where there are no work safety rules					
Work safety rules are important and necessary to prevent accidents in my work					
Category 3					
Most of worker notifies personals taking risk unnecessarily					
Most of the workers support work-place safety policies					
My colleagues usually suggest me to ignore work safety rules					
My colleagues recover each other's deficiencies in work safety					
My colleagues want to help each other about work safety					
My colleagues attach importance to assessment for incidents that can cause accidents					
Category 4					
Completing work is more important than doing work in safe ways					
I can do some part of my job briefly to finish my job on time					
Sometimes, it is expected from me to do work that is much more than doing it safely					
It is difficult to work by applying all work safety rules					
In my work place, cut corners and risky attitudes are common because of heavy workload					
I am sometime not sure about how a work can be done by following safety rules					
I easily can get necessary safety equipment from my workplace					

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Category 5					
Safety feedback and comments always presented form and to management					
There is an understanding that workers will be thanked for their safety performance					
My company often offers safety incentives to site manager, site personnel and project engineers					
Safety rewards presented from my company is valuable					
Subcontractors are placing important level on safety					
Subcontractors often attend safety meeting and training and share the responsibility of safety on the site					
Safety responsibility and accountability is clearly allotted					
Site managers and field personnel are placing important level on safety					
There are dedicated safety agents and they usually observe and correct field personnel unsafe act					
Field personnel aware of the understanding that unsafe performance will be punished and not tolerated					
Unsafe performance is consistently punished with reasonable level that fit the violation					
Safety is always reinforced even though if just a violation occurred with no accidents resulted					
Management places important level on safety and safety is strategic concern for top management					
Everyone is responsible for safety not only safety staff					
My company policies and actions portray a sincere commitment to safety					
Hazards analysis, prevention and control are very important and often performed in the construction site					
Unsafe behavior identification with implementing necessary correction is often performed					
Category 6					
I feel it is essentially important to maintain safety all times					
I believe safety at workplace is a crucial key issue					
I feel that it is compulsory to spend efforts to decrease accidents and incidents at my workplace					
My feeling it is important to encourage others to use safety practices					
I feel it is important to promote safety programs					
Category 7					
I am capable to follow all safety regulation and procedure					
It is clear for me how to follow work safety rules and procedures					
I made safety error due to not knowing how to work safely					
I have made error caused risks in doing a work rarely					
Category 8					
I carefully follow work safety rules and procedure when assigned on a construction task					
I can do a task that I am familiar without looking at written procedures and manuscripts					
I intentionally bend formal procedures to finish work on time					
I ignored some part of procedures and don't record this to make work easier in abnormal circumstances					
I am conscious of my responsibility about work safety					

If you have further notes or opinions, Please write them in the box below:

Thank you for your participation in the study.

APPENDIX C: CORRELATION MATRIX FOR MULTICOLLINEARITY TEST

Correlations: Management Commitment toward Safety

			MC1	MC2	MC3	MC4	MC5	MC6	MC7	MC8	MC9
Spearman's rho	MC1	Correlation Coefficient	1.000	.592**	.599**	.600**	.593**	-.370**	.459**	.687**	.590**
		Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434
	MC2	Correlation Coefficient	.592**	1.000	.660**	.583**	.561**	-.410**	.440**	.615**	.582**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434
	MC3	Correlation Coefficient	.599**	.660**	1.000	.664**	.610**	-.355**	.483**	.611**	.586**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434
	MC4	Correlation Coefficient	.600**	.583**	.664**	1.000	.649**	-.375**	.465**	.635**	.612**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434
	MC5	Correlation Coefficient	.593**	.561**	.610**	.649**	1.000	-.429**	.451**	.656**	.599**
		Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434
	MC6	Correlation Coefficient	-.370**	-.410**	-.355**	-.375**	-.429**	1.000	-.229**	-.345**	-.343**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434
	MC7	Correlation Coefficient	.459**	.440**	.483**	.465**	.451**	-.229**	1.000	.604**	.500**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000	.000
		N	434	434	434	434	434	434	434	434	434
	MC8	Correlation Coefficient	.687**	.615**	.611**	.635**	.656**	-.345**	.604**	1.000	.668**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.	.000

		N	434	434	434	434	434	434	434	434	434
	MC9	Correlation Coefficient	.590**	.582**	.586**	.612**	.599**	-.343**	.500**	.668**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.
		N	434	434	434	434	434	434	434	434	434

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

Correlations: Employees' Attitudes Toward Safety

			EA1	EA2	EA3	EA4	EA5	EA6	EA7
Spearman's rho	EA1	Correlation Coefficient	1.000	.535**	.437**	.303**	.267**	.278**	.322**
		Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434
	EA2	Correlation Coefficient	.535**	1.000	.593**	.450**	.460**	.242**	.238**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434
	EA3	Correlation Coefficient	.437**	.593**	1.000	.601**	.512**	.228**	.244**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000
		N	434	434	434	434	434	434	434
	EA4	Correlation Coefficient	.303**	.450**	.601**	1.000	.518**	.111*	.152**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.021	.002
		N	434	434	434	434	434	434	434
	EA5	Correlation Coefficient	.267**	.460**	.512**	.518**	1.000	.211**	.197**
		Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000
		N	434	434	434	434	434	434	434
	EA6	Correlation Coefficient	.278**	.242**	.228**	.111*	.211**	1.000	.457**
		Sig. (2-tailed)	.000	.000	.000	.021	.000	.	.000
		N	434	434	434	434	434	434	434
	EA7	Correlation Coefficient	.322**	.238**	.244**	.152**	.197**	.457**	1.000
		Sig. (2-tailed)	.000	.000	.000	.002	.000	.000	.
		N	434	434	434	434	434	434	434

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

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

Correlations: Coworkers'' Safety Support

			CS1	CS2	CS3	CS4	CS5	CS6
Spearman's rho	CS1	Correlation Coefficient	1.000	.709**	-.195**	.038	.495**	.577**
		Sig. (2-tailed)	.	.000	.000	.435	.000	.000
		N	434	434	434	434	434	434
	CS2	Correlation Coefficient	.709**	1.000	-.190**	.081	.487**	.522**
		Sig. (2-tailed)	.000	.	.000	.094	.000	.000
		N	434	434	434	434	434	434
	CS3	Correlation Coefficient	-.195**	-.190**	1.000	.448**	-.159**	-.190**
		Sig. (2-tailed)	.000	.000	.	.000	.001	.000
		N	434	434	434	434	434	434
	CS4	Correlation Coefficient	.038	.081	.448**	1.000	.148**	.026
		Sig. (2-tailed)	.435	.094	.000	.	.002	.593
		N	434	434	434	434	434	434
	CS5	Correlation Coefficient	.495**	.487**	-.159**	.148**	1.000	.578**
		Sig. (2-tailed)	.000	.000	.001	.002	.	.000
		N	434	434	434	434	434	434
	CS6	Correlation Coefficient	.577**	.522**	-.190**	.026	.578**	1.000
		Sig. (2-tailed)	.000	.000	.000	.593	.000	.
		N	434	434	434	434	434	434

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

Correlations: Construction Workplace pressure

			WP1	WP2	WP3	WP4	WP5	WP6	WP7
Spearman's rho	WP1	Correlation Coefficient	1.000	.361**	.398**	.244**	.345**	.267**	-.084
		Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.079
		N	434	434	434	434	434	434	434
	WP2	Correlation Coefficient	.361**	1.000	.303**	.151**	.182**	.234**	-.089
		Sig. (2-tailed)	.000	.	.000	.002	.000	.000	.063
		N	434	434	434	434	434	434	434
	WP3	Correlation Coefficient	.398**	.303**	1.000	.307**	.380**	.269**	-.108*
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.024
		N	434	434	434	434	434	434	434
	WP4	Correlation Coefficient	.244**	.151**	.307**	1.000	.455**	.301**	-.019
		Sig. (2-tailed)	.000	.002	.000	.	.000	.000	.690
		N	434	434	434	434	434	434	434
	WP5	Correlation Coefficient	.345**	.182**	.380**	.455**	1.000	.336**	-.093
		Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.054
		N	434	434	434	434	434	434	434
	WP6	Correlation Coefficient	.267**	.234**	.269**	.301**	.336**	1.000	-.267**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000
		N	434	434	434	434	434	434	434
	WP7	Correlation Coefficient	-.084	-.089	-.108*	-.019	-.093	-.267**	1.000
		Sig. (2-tailed)	.079	.063	.024	.690	.054	.000	.
		N	434	434	434	434	434	434	434

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

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

Correlations: Construction Sites Safety Management Systems

			SMS1	SMS2	SMS3	SMS4	SMS5	SMS6	SMS7	SMS8	SMS9	SMS10	SMS11	SMS12	SMS13	SMS14	SMS15	SMS16	SMS17
Spearman's rho	SMS1	Correlation Coefficient	1.00	.461**	.418**	.251**	.128**	.192**	.418**	.400**	.389**	.420**	.452**	.441**	.484**	.264**	.416**	.461**	.500**
		Sig. (2-tailed)	.	.000	.000	.000	.008	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
	SMS2	Correlation Coefficient	.461**	1.000	.601**	.444**	.273**	.327**	.451**	.454**	.420**	.458**	.475**	.451**	.390**	.187**	.349**	.385**	.476**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
	SMS3	Correlation Coefficient	.418**	.601**	1.000	.621**	.371**	.408**	.448**	.465**	.438**	.444**	.493**	.437**	.416**	.091	.319**	.398**	.406**
		Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.058	.000	.000	.000
		N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434

SMS 4	Correlation Coefficient	.251**	.444**	.621**	1.000	.583**	.558**	.373**	.398**	.332**	.333**	.397**	.360**	.362**	.050	.276**	.278**	.304**
	Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.299	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 5	Correlation Coefficient	.128**	.273**	.371**	.583**	1.000	.627**	.416**	.496**	.288**	.306**	.321**	.306**	.248**	.044	.181**	.240**	.237**
	Sig. (2-tailed)	.008	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.360	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 6	Correlation Coefficient	.192**	.327**	.408**	.558**	.627**	1.000	.515**	.500**	.391**	.365**	.395**	.385**	.359**	.103*	.239**	.312**	.327**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.031	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 7	Correlation Coefficient	.418**	.451**	.448**	.373**	.416**	.515**	1.000	.625**	.558**	.535**	.527**	.546**	.495**	.206**	.413**	.456**	.496**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 8	Correlation Coefficient	.400**	.454**	.465**	.398**	.496**	.500**	.625**	1.000	.519**	.584**	.554**	.551**	.512**	.216**	.419**	.462**	.511**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 9	Correlation Coefficient	.389**	.420**	.438**	.332**	.288**	.391**	.558**	.519**	1.000	.617**	.620**	.542**	.465**	.245**	.427**	.482**	.566**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 10	Correlation Coefficient	.420**	.458**	.444**	.333**	.306**	.365**	.535**	.584**	.617**	1.000	.700**	.645**	.561**	.224**	.505**	.498**	.581**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 11	Correlation Coefficient	.452**	.475**	.493**	.397**	.321**	.395**	.527**	.554**	.620**	.700**	1.000	.667**	.543**	.244**	.484**	.512**	.571**

	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 12	Correlation Coefficient	.441**	.451**	.437**	.360**	.306**	.385**	.546**	.551**	.542**	.645**	.667**	1.000	.598**	.335**	.518**	.534**	.599**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 13	Correlation Coefficient	.484**	.390**	.416**	.362**	.248**	.359**	.495**	.512**	.465**	.561**	.543**	.598**	1.000	.325**	.637**	.509**	.611**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 14	Correlation Coefficient	.264**	.187**	.091	.050	.044	.103*	.206**	.216**	.245**	.224**	.244**	.335**	.325**	1.000	.467**	.372**	.359**
	Sig. (2-tailed)	.000	.000	.058	.299	.360	.031	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434

SMS 15	Correlation Coefficient	.416**	.349**	.319**	.276**	.181**	.239**	.413**	.419**	.427**	.505**	.484**	.518**	.637**	.467**	1.000	.552**	.599**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 16	Correlation Coefficient	.461**	.385**	.398**	.278**	.240**	.312**	.456**	.462**	.482**	.498**	.512**	.534**	.509**	.372**	.552**	1.000	.653**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434
SMS 17	Correlation Coefficient	.500**	.476**	.406**	.304**	.237**	.327**	.496**	.511**	.566**	.581**	.571**	.599**	.611**	.359**	.599**	.653**	1.000
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.
	N	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434	434

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

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

Correlations: Personnel Safety Motivation

			SM1	SM2	SM3	SM4	SM5
Spearman's rho	SM1	Correlation Coefficient	1.000	.655**	.533**	.525**	.554**
		Sig. (2-tailed)	.	.000	.000	.000	.000
		N	434	434	434	434	434
	SM2	Correlation Coefficient	.655**	1.000	.625**	.590**	.624**
		Sig. (2-tailed)	.000	.	.000	.000	.000
		N	434	434	434	434	434
	SM3	Correlation Coefficient	.533**	.625**	1.000	.719**	.674**
		Sig. (2-tailed)	.000	.000	.	.000	.000
		N	434	434	434	434	434
	SM4	Correlation Coefficient	.525**	.590**	.719**	1.000	.743**
		Sig. (2-tailed)	.000	.000	.000	.	.000
		N	434	434	434	434	434
	SM5	Correlation Coefficient	.554**	.624**	.674**	.743**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.
		N	434	434	434	434	434

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

Correlations: Personnel Error Behavior

			Er1	Er2	Er3	Er4
Spearman's rho	Er1	Correlation Coefficient	1.000	.686**	.307**	.380**
		Sig. (2-tailed)	.	.000	.000	.000
		N	434	434	434	434
	Er2	Correlation Coefficient	.686**	1.000	.382**	.465**
		Sig. (2-tailed)	.000	.	.000	.000
		N	434	434	434	434
	Er3	Correlation Coefficient	.307**	.382**	1.000	.648**
		Sig. (2-tailed)	.000	.000	.	.000
		N	434	434	434	434
	Er4	Correlation Coefficient	.380**	.465**	.648**	1.000
		Sig. (2-tailed)	.000	.000	.000	.
		N	434	434	434	434

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

Correlations: Personnel Own Attitudes toward Violation Behavior

			VI1	VI2	VI3	VI4	VI5
Spearman's rho	VI1	Correlation Coefficient	1.000	.068	-.227**	-.045	.595**
		Sig. (2-tailed)	.	.158	.000	.346	.000
		N	434	434	434	434	434
	VI2	Correlation Coefficient	.068	1.000	.338**	.393**	.019
		Sig. (2-tailed)	.158	.	.000	.000	.690
		N	434	434	434	434	434
	VI3	Correlation Coefficient	-.227**	.338**	1.000	.494**	-.176**
		Sig. (2-tailed)	.000	.000	.	.000	.000
		N	434	434	434	434	434
	VI4	Correlation Coefficient	-.045	.393**	.494**	1.000	.009
		Sig. (2-tailed)	.346	.000	.000	.	.848
		N	434	434	434	434	434
	VI5	Correlation Coefficient	.595**	.019	-.176**	.009	1.000
		Sig. (2-tailed)	.000	.690	.000	.848	.
		N	434	434	434	434	434

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

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