Relationship between personality trait and multi-national construction workers safety performance in Saudi Arabia

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RELATIONSHIP BETWEEN PERSONALITY TRAIT AND MULTI-NATIONAL CONSTRUCTION WORKERS' SAFETY PERFORMANCE IN SAUDI ARABIA

By

Yousef Al-Shehri

BSc., MSc.

A Doctoral Thesis submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University

October, 2014
ABSTRACT

Given the large economic and social costs of work-related accidents and injuries, it is not surprising that organisations strive to reduce them; this creates a need to improve the safety performance of the whole construction industry. Health and Safety statistics in general appear to suggest a levelling off of safety performance across the construction industry as a whole and this implies that improving safety beyond the current level of attainment calls for a radical look at how safety is addressed by the industry. Such a radical approach needs to explore alternatives to current practices in safety improvement. Although it is acknowledged that human factors are involved in 80-90% of work-related accidents and incidents, the focus of safety research in recent years still addresses only organisational and environmental factors, rather than variables at the level of the individual. Occupational personality models suggest that the ability to understand, predict and control incidents could minimize their potential transition into accidents. The safety behaviour of the individual worker forms part of such occupational personality modelling. Understanding the safety behaviour of construction workers should provide opportunities for improvement beyond traditional practices in the quest to improve safety management. The study on which this thesis is based aimed to develop a conceptual framework for improving safety performance on sites. This was achieved by exploring, on the one hand, the relationship between the personality traits of individual workers and their safety behaviour (safety participation, safety compliance and safety motivation), and incident rates on the other. The data for the analysis was drawn from multi-cultural construction workers in Saudi Arabia. The emergence of the Big Five personality model has been widely accepted as a valid and reasonably generalisable taxonomy for personality structure and has been used by numerous researchers as a framework to explore the criterion-related validity of personality in relation to job performance. This study employed the Big Five categorisation of traits to explore the relationship between fundamental dimensions of personality and potential for involvement in accidents and incidents. The principal findings from the study showed a very good level of acceptance by practitioners in Saudi Arabia for the conceptual framework developed for managing safety behaviour. The study also established that some personality traits moderated the effects of safety behaviour for incident rates. In addition, the analysis revealed that individual workers characterised by conscientiousness and openness are least likely to experience incidents, and consequently, accidents and injuries at work. However, individuals characterised by high extraversion, neuroticism and low agreeableness are more likely to be
involved in incidents, and potentially, accidents and injuries. These important findings have significant ramifications for the way safety development and training for construction workers should be addressed in the future. Recommendations from the study culminated in the development of a conceptual framework for improving safety performance which aimed to minimize incidents attributable to the worker. The framework relies on the attitudes and behaviours of employees in proposing mitigation strategies for the construction industry.
Dedicated to My Beloved Parents,
My Wife and Children who are the source of my inspiration, encouragement, guidance and happiness.
ACKNOWLEDGEMENTS

Acknowledgment is due to Loughborough University for its support of this research. In the first instance, I would like to thank my supervisors, Dr Francis Edum-Fotwe and Professor Andrew Price who served as my major advisors and who provided me with excellent guidance and support. Their constructive criticism and direction served as an essential driver for the whole research study. In addition, their personal encouragement and empathy served as a motivation for the timely completion of this work.

I wish to express my special gratitude to my dear mother in whose debt I shall remain forever, and especially for making faithful Duaa to Allah during her prayer for my success and completion of the thesis. I also wish to express my sincere appreciation to my wife for her kindness, understanding, encouragement, unlimited patience and generous support during my studies.

To my children, I wish to say a big thank you for giving me pleasure and happiness by being by my side during the difficult times of this research.

I am particularly grateful to my friends for their encouragement, support and continual reassurance that enabled me to accomplish my goals.

Finally, my sincerest appreciation goes to all the construction contractors whose experience and information offered through their responses to the questionnaire survey provided me with the necessary research data and comprehensive perspective that have led to this thesis.
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<thead>
<tr>
<th>Abbreviation</th>
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</tr>
</thead>
<tbody>
<tr>
<td>KSA</td>
<td>Kingdom of Saudi Arabia</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>CIDB</td>
<td>Construction Industry Development Board</td>
</tr>
<tr>
<td>CIMP</td>
<td>Construction Industry Master Plan</td>
</tr>
<tr>
<td>ILO</td>
<td>International Labour Organisation</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standard Organisation</td>
</tr>
<tr>
<td>JKKP</td>
<td>Jonatan Keselamatan Kesihatan Pekerjaan</td>
</tr>
<tr>
<td>NEBOSH</td>
<td>National Examination Board in Occupational Safety and Health</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute of Occupational Safety and Health</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>NSC</td>
<td>National Safety Council</td>
</tr>
<tr>
<td>OSH</td>
<td>Occupational Safety and Health</td>
</tr>
<tr>
<td>OSH MS</td>
<td>Occupational Safety and Health Management System</td>
</tr>
<tr>
<td>SHO</td>
<td>Safety and Health Officer</td>
</tr>
<tr>
<td>UAE</td>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>GOSI</td>
<td>General Organisation for Social Insurance in Saudi Arabia</td>
</tr>
<tr>
<td>ZAP</td>
<td>Zero Accident Program</td>
</tr>
<tr>
<td>OHB</td>
<td>Occupational Hazards Branch in Saudi Arabia</td>
</tr>
<tr>
<td>RIDDOR</td>
<td>Reporting of Injuries, Diseases and Dangerous Occurrences Regulations</td>
</tr>
<tr>
<td>ICT</td>
<td>Information Communication Technology</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Name</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>SASREF</td>
<td>Saudi Aramco Shell Refinery Company</td>
</tr>
<tr>
<td>SABIC</td>
<td>Saudi Basic Industries Company</td>
</tr>
<tr>
<td>BLS</td>
<td>Bureau of Labour Statistics</td>
</tr>
<tr>
<td>CPWR</td>
<td>Centre to Protect Workers’ Rights</td>
</tr>
</tbody>
</table>
CHAPTER 1
GENERAL INTRODUCTION

1.1 Background to the Study

From a safety perspective, the global construction industry still suffers unacceptable levels of accidents and reportable incidents which contribute to its negative image of a dangerous work environment. Construction is often considered as having very unsafe operations compared with other industries as the conditions of work may change on a daily basis and often these present a number of challenges to the workforce. In addition, construction activity on site is considered as inherently dangerous as well as involving high levels of risk (Hinze and Olbina, 2008). In many national industries across the globe, construction often reflects high accident rates. Hinze (2005), for instance, argued that the only other industry in the world which has a worse accident record compared to construction is the mining industry. Within the industry, policy makers are aware of the unenviable and unfortunate reputation related to its high level of accidents and fatal cases, and there is no shortage of initiatives to improve the situation (Huang and Hinze, 2006). Notwithstanding the efforts to reduce construction accidents, injuries and fatalities, the level of these adverse events remains relatively high (Ferjencik, 2011; Smallwood and Haupt, 2005). In the UK, the Health and Safety Executive (HSE) has argued that construction has a level of safety performance that is far from desirable and that this needs to be improved to bring it in line with other progressive industries (HSE, 2006). Equally, the levelling out of safety performance improvement is a matter of concern and requires research attention to ensure safe working environments in construction. However, the evolutionary stages in the field of safety culture in the construction industry can be seen through the Pybus model (Pybus, 1996). In this model, the curve illustrates that this evolution developed in three distinctive stages, the traditional, transitional and innovative phases, which exist at times of high injury rates and ill-health. This forms a basic theory for the concept of studying safety cultures and their management by researchers in the field (see Finneran and Gibb, 2013; Lingard and Rowlinson, 2005; Pybus, 1996). Figure 1.1 shows the stages of change in safety cultures.
It is worth mentioning that the conventional method of addressing the notions of safety and health is reactive in its natural perspective through dealing with hazards as they appear and in developing protective plans for personnel, including adopting protective equipment and procedures – PPE (Finneran and Gibb, 2013). The problem of improving safety performance would therefore appear to lie outside the current efforts in safety management deployed by construction organisations in the traditional phase. It calls, in fact, for a more radical alternative to the current approaches for managing safety. Such a radical look would not only cover the planning, implementation and management of safety in construction, but also pay attention to aspects beyond the traditional practices of safety management for improving performance. In the transitional phase, according to the Pybus model, there exist as a start more prior procedures to deal with hazards; these are previously set plans to prevent accidents or injuries (Lingard and Rowlinson, 2005). It can be seen that the innovative stage, mentioned earlier, can be considered as an attempt to avoid hazards and decrease any risk within the workplace based on technological solutions that were designed for those cases (Finneran and Gibb, 2013). The Human Performance Technologies (1998), the National Safety Council (NSC) (a non-profit organisation promoting health and safety in the USA) and the Du Pont Company have argued that, depending on the observable reasons for accidents, and concentrating on the regulations concerning the physical situations alone to manage accidents may be deceptive, as depicted in Table 1.1. In this table, the data show that most unsafe outcomes are rooted in behaviours, with less than 10% accounted for by working conditions. Concentrating on the safety behaviours of individuals can therefore provide a
means for attaining the desired changes since it involve modifying attitudes to bring about the essential changes required to improve safety performance.

<table>
<thead>
<tr>
<th>Causes</th>
<th>National Safety Council (%)</th>
<th>Du Pont Company (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsafe conditions</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Unsafe behaviours</td>
<td>88</td>
<td>96</td>
</tr>
<tr>
<td>Unknown causes</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

(source: Human Performance Technologies, 1998)

Focusing on the dimension of behaviour may also provide an avenue for addressing the wider contextual social norms that often influence the adoption of safety practices by a workforce. In particular, an appreciation of these social norms is considered an essential option in establishing the most effective safety regime for any construction project. Thus, it could be argued that any safety improvement initiative that does not consider the human dimension is likely to be unsuccessful in terms of enabling and empowering the workforce to achieve progressive safety improvement.

The Irish Health and Safety Authority (HAS, 2013) adopted the view that implementing a behavioural safety programme has to involve the workforce to ensure that all operatives adopt the standards and procedures. In doing so, the workforce is provided with a relative level of authority and responsibility to define, identify and monitor their behaviours (safe and unsafe ones), as well as to provide their own agreed targets for safety improvement. Such an approach ensures that workgroups in construction can contribute proactively to what is adopted as their norms of safety in an atmosphere where they feel valued and have ownership of their personal well-being. Equally, achieving affective behaviour safety will also call for management input at both junior and senior levels of the project and construction organisation. For instance, the line management could simplify operational procedures by providing important support and resources to motivate workers’ ownership of safety, as well as concentrating on ensuring that no person will simply be sanctioned; instead, any monitoring procedure must be improvement-oriented. Such an orientation with regard to safety should help to create a proactive safety culture, which is vital for success in the longer term.
An appreciation of the behaviour dimension not only sheds light on an individual worker’s safety profile but also leads to a more proactive approach that shares the responsibility for accident prevention between the workforce and the top management of the construction organisation.

Over past few decades, construction organisations have managed to decrease the accident rates on their sites because of a growing awareness of their social responsibility, as well as the financial considerations and penalties that regulatory bodies increasingly apply to instances of safety transgressions. The essential point here is that health and safety initiatives must take advantage of the human dimension in order to expand the scope of improvements in safety performance. Such improvements would ensure that penalties instituted by regulatory bodies would be at least mitigated or even avoided. Al-shehri et al. (2012) argued that such human-based options have to address two important aspects: the first is achieving a shift from managing accidents to managing incidents while the second relates to the use of the safety orientation of individuals as a factor in managing safety performance. These two aspects have hitherto not featured in the management of safety in the construction industry.

1.2 Research Problem
Statistics compiled by the HSE (2014) indicated that fatalities, injuries, incidents and accidents still happen on construction sites in the UK and the same can be said of construction sites across the world. The safety performance of the construction industry is perhaps consistent with the very unsafe operations involved in the delivery of its products compared with other industries. Working conditions can change on a daily basis and often these present a number of challenges to the workforce. In addition, construction activities on site are considered as inherently dangerous, as well as involving high levels of risk (Hinze and Olbina, 2008; Centre to Protect Workers’ Rights, 1995; Berger, 2000). Clearly, it is important to obtain a more refined understanding of the factors that contribute to workplace injuries given the significant human losses and consequent cost to the individuals affected by accidents, as well as to national economies and to the construction organisations themselves.
It is therefore not surprising to note that research interest in workplace safety has been considerable over the past few decades, with notable contributions being made by Hofmann et al., 2003, Shannon et al., 1997 and Zacharatos et al., 2005.

The picture of safety performance in construction outlined in the previous sections reflects a European/American context; this indicates a national safety performance in the highest band
of attainment. The situation in many other countries cannot be considered in the same league, thus emphasizing their need to improve safety performance. In the Middle East generally, and Saudi Arabia in particular, the economy can be described as growing, and thus necessitates essential infrastructure developments to support the country. Saudi Arabia’s construction sector occupies the third largest sector in its economy after the huge and growing sectors of hydrocarbons and, more recently, Information Communication Technology (ICT). The growing volume of project activity in the construction sector has raised its profile to the point where its characteristics, in terms of structures, procedures and performance, for example, are coming under scrutiny. One such characteristic is its safety performance.

In referring to safety enforcement, it is well recognized that the Middle East countries, such as Saudi Arabia, are well known for their firm observance of rules. This offers a firm base for maintaining and implementing standards and codes of conduct in different organisations and severe penalties are often pronounced on those do not follow the laws and ethics. In spite of this, the construction industry in Saudi Arabia faces problems in attaining health and safety standards consistent with its aspiration to achieve a zero accident rate (Abdelhamid et al., 2000). While safety standards in Saudi Arabia are similar to those of other progressive countries, the requirements of those standards are all too often unclear to the workers themselves in the Saudi Arabian construction industry. For example, the standards are not well communicated to the workforce on site chiefly because of their low educational attainment and lack of fluency in the local language since many migrant workers are involved in undertaking the works. These two factors add to the severity and grave nature of accidents that are often reported in the country (Jha, 2011). A further matter of concern prevalent in Saudi construction companies is that recruitment practices for hiring workers from abroad only address technical aspects; they ignore workers’ ability to adapt to the local industry (Taylor et al., 2004).

In contrast to the Saudi context, in the UK, the situation is very different. In the UK, it is ensured that workers who are hired are fit; at the same time, they are not allowed to work on their own unless until they are fully competent and familiar with the tasks and the machineries that they may have to operate when carrying out construction task. Moreover, they are supported to adapt to their new work environment by the provision of adequate levels of supervision until new workers have attained the required level of competency and
familiarisation with machinery that they may use in their operational duties (Taylor et al., 2004).

According to Jannadi and Assaf (1998), senior executives in many Saudi construction organisations do not believe that there is a lack of safety in the industry, which has serious repercussions. Thus, good management must make each labourer, supervisor and engineer familiar with the main aspects of safety and its practices which will prevent any accidents or injuries to the workers on the construction sites. The levelling out of safety performance improvements is a matter of concern and requires research attention to ensure that improvement is continuous in providing a safe working environment in construction. The construction industry in Saudi Arabia has a high rate of fatal and non-fatal accidents, which creates the need for it to improve its safety performance there.

While it can be argued that Saudi Arabia’s national safety regime is influenced by the culture of the country, there is ample evidence to suggest that the problem of safety attainment is the same as in any other country. Essentially, how should safety performance be enhanced beyond what the planned and enforced regulatory approach has enabled construction in Saudi Arabia currently to achieve?

1.3 Key Research Questions

The background in the previous section demonstrates the need for a different approach to improve safety performance in the construction industry. This raises the important question of what alternative mechanisms for improving safety performance can potentially lead to the desired continuous enhancement of safety in the construction industry. To achieve this, this study explores the nature of the relationship between the personality attributes of construction workers and their safety behaviour in the Saudi Arabian construction industry. This overarching question can be associated with the following sub-questions:

i. To what extent does the factor of human error moderate and influence safety performance?

ii. Is there a need to develop the contribution to safety of individual workers as a means of improving safety performance in construction organisations?

iii. Is there any relationship between safety behaviour and safety performance in site-based construction activities?
iv. Is there evidence of an individual’s personality influencing (positively or negatively) their safety performance?

v. Is there a need to discover the extent to which each personality archetype appears to affect the level of safety performance by influencing the safety behaviour of a worker?

vi. Do construction workers tend to reflect personality archetypes that lean towards safety proneness or aversion?

Adequate responses to the above questions could potentially generate insights into pursuing new directions in safety performance and improvement initiatives. While a complete response to each of these questions and similar ones is desirable, the principal question requires the establishment of any causal links or possible correlations between the worker at a personal level and that individual’s safety performance; this forms the basis of this thesis. The research problem statement in the previous section clearly demonstrates the need for a different approach to improving safety performance in the construction industry. In seeking answers to the research problems and questions above, the study aims to understand the influence of the individual’s contribution to safety as a means of improving the safety performance of construction organisations in Saudi Arabia. While such a focus will yield essential information for managing safety in Saudi Arabia, the general principles that underpin the derivation of the results will have a wider application beyond that region.

1.4 Research Aims and Objectives

The aims of this study are to explore the nature of the relationship between the personality traits of individual workers and their safety behaviour on the one hand, and incident rates on the other, for construction workers in Saudi Arabia, and to employ the outcomes to develop a conceptual framework for managing improvements in safety performance on construction sites in Saudi Arabia. To achieve the aims of the research, the following objectives were pursued:

**Objective 1:** Establish the historical and current context and practices with regard to the performance of health and safety in the global construction field, as well as to examine the features of the construction industry. This will culminate in a critical discussion of the construction industry in Saudi Arabia which still suffers unacceptable levels of accidents and reportable incidents that contribute to its negative image as a dangerous work environment.
Objective 2: Conduct a state-of-the-art-review of safety performance in Saudi Arabia to provide essential details concerning the obstacles to progressive safety improvement, as well as important statistics on safety and work-related injuries in construction.

Objective 3: Provide a critical appraisal of the current theories that underpin attitudes to safety behaviour, incidents and incident rates, as well as accident forensics that reflect operational activities on construction sites.

Objective 4: Perform an empirical investigation into the role that the personality traits or attributes of individual workers have on safety behaviour, as well as incident rates and the extent to which such influences are reflected in the study sample.

Objective 5: Develop a conceptual framework that takes advantage of the outcomes from the study on personality versus incident rates to provide options for improving safety performance in Saudi Arabia.

Objective 6: Validate the developed conceptual framework as to its efficacy in enhancing safety performance in Saudi Arabia and propose recommendations for its application and exploitation.

1.5 Key Findings and Contribution to Knowledge

The research contributes to the understanding of the strategies and practices that Saudi Arabian sites use. The tools adopted in the data collection phase identified that individuals are the main cause of incidents while the situational models provide a link between individuals, the environment and conditions with regard to the occurrence of the incidents. Also, safety management efforts need to shift from managing and monitoring accidents to managing and monitoring incidents to ensure a safe working environment in construction which can be achieved by focusing attention on incidents as a means of preventing accidents.

This research presents a review of alternatives that could make the desired changes leading to changes in attitude and then to the behavioural changes required for safety improvement; it does this by concentrating on the safety behaviours of individuals. This research attempts to study the psychological factors affecting employees in construction industry. Theories concerning personal characteristics in humans which have been studied by psychologists have proved that humans react through these personal characteristics; these can be defined as well as improved in order to protect them from dangerous situations. The framework proposed in this study for investigating workers’ safety behaviour concentrates on the workers’ characteristics which are measured using “The Big Five Personality Model” of
Costa and McCrae (1992). This thesis provides a framework for investigating and establishing whether individuals require such an assessment from a safety perspective. The framework has three phases: the first phase addresses the management issues that precede a worker’s engagement on a project and helps in determining the worker’s personality. This is commonly conducted to select a personality model through face-to-face interviews and every single worker must be subjected to the personality evaluation test. The second phase, safety training and learning, is the most important parts in the risk-control process since this is a matter of serious concern and requires research attention to ensure the creation of a safe working environment in construction. By concentrating on the safety behaviours of individuals, this framework offers a review of alternatives that can make the desired changes which will lead to changes in attitude and subsequently to the behavioural changes required for safety improvement. Safety supervisors should pay attention for these two phases and should try to educate and train the workers to deal with heavy apparatus and dangerous materials, as well as educating and training engineers in areas related to design in order to control risk. Safety management systems are very significant in site safety, but unless safety becomes a culture on working sites, the desired goals will not be achieved. Third phase, the incident investigation and reporting system, is a major resource that can help the construction industry to determine safety problems in a clear and strategic manner. The adoption of an appropriate reporting system can minimise the level of unsafe conditions and it is further suggested that the monitoring arising from incident investigations that is required for such reporting often leads to corrective actions that contribute to improving safety. The framework presents interventions that can be measured to establish how safety performance can be improved based on personality traits.

The key findings from the study are:

- The review of the literature on safety performance exposed a less than satisfactory level of attainment for global construction, and endorsed the point of exploring other options for improving safety in construction.

- Saudi Arabia has the same needs in terms of safety performance as other countries, namely: to improve levels of attainment beyond what planned safety measures currently achieve. The Saudi Arabian context is important with regard to the kind of solutions suggested and this influences how safety solutions from other places can be adapted to the context of the country.
The review of developments in accident causation revealed that a more proactive perspective on safety will call for incidents to be addressed.

Contributions by several authors relating to the effect of personality traits on performance in non-construction activities have established a strong basis for supporting the assertion that certain personality attributes could make a difference to the level of safety performance currently attained within construction.

The empirical phase of the research established that safety behaviour attributes have a stronger effect on accident rates than their related incident rates.

Personality traits moderate the effects of components of safety behaviour on both accident and incident rates.

Individual workers characterised by conscientiousness and openness are least likely to experience incident and accident injuries at work.

Individuals characterised by high extroversion and high neuroticism, and low agreeableness, are more likely to suffer incident and accident injuries.

The developed conceptual framework was validated and tested to reveal a good potential for adoption by the construction industry in Saudi Arabia.

1.5.1 Contribution to knowledge

A conceptual framework was developed for improving safety performance on construction sites by exploring the relationship between the personality traits and safety behaviour of individual workers on the one hand, and incident rates on the other for construction workers in Saudi Arabia.

1.5.2 Theoretical contribution

- The Big Five Personality theory was tested in a new setting environment (Saudi Arabia) to help determine workers’ personalities in order to assign them safety training and learning paths that matched their trait types in phase B.

- Guidelines were adopted concerning safety training and learning during a project in order to control incidents, thus ensuring a safe working environment in construction by concentrating on the safety behaviours of individuals.
The study established that certain traits in construction workers (such as neuroticism) make them more prone to accidents. As a consequence, such workers should be supported with training that addresses both knowledge development and conditioning through skilling. Other traits that pre-dispose a worker to a lower accident potential (such as conscientiousness and openness) can be supported with simple knowledge development.

1.6 Method of Study and Overview of the Research Process

The aims and objectives adopted in the study demanded two types of evidence to be drawn together. The first was desk work that called for extensive and critical review while the second involved the collection of evidence that enabled the systematic representation of the links between the independent and dependent variables employed in the empirical phase of the study. Such links reflect either correlations or causations, and are best represented in studies that employ quantitative approaches. Consequently, a quantitative method was adopted to investigate the extent to which the individual personality characteristics of construction operatives affected and helped to determine their safety behaviour and performance. The research methodology, as detailed in Chapter Six, was followed to achieve the outlined research objectives which comprised four interrelated stages as shown in Figure 1.2.

This section provides a brief overview of the research process for this study. A flow diagram of the process is shown which defines the essential tasks adopted for delivering the whole study. This includes the main research steps: the literature review, an investigation of current practice in Saudi Arabia, the framework’s design and development, and the validation of the framework.

1.6.1 Literature review

An extensive literature review was conducted to provide a solid foundation, as well as a basis, for the formulation of the proposed improvement framework. The review covers historical and current contexts and practices with regard to the performance of health and safety in the global construction industry, as well as an examination of the features of the industry. This culminates in a critical discussion about the industry which still suffers unacceptable levels of accidents and reportable incidents, contributing to its negative image as a dangerous working environment. The review also covers the Saudi construction industry in terms of its current performance in terms of health and safety in construction works. A
“Problem Statement” is presented concerning the construction industry in Saudi Arabia. This is followed by a section which presents the rationale of the study and the research questions the study addresses; the aims and objectives of the study are also presented. This stage is dealt with in Chapters Two to Five. The relevant literature was located using the Loughborough University Library Catalogue and other Internet search engines (e.g. Google Scholar).

The literature review acted as: a basis for the foundation of the current framework for safety enhancement; making clear current matters and gathering information on gaps, knowledge, and practices; providing a strong basis for the study; and aiding the development of the data collection strategy, methods and methodology to be adopted in order to accomplish the stipulated objectives.

1.6.2 Investigation of the current practices in Saudi Arabia

In this study, a questionnaire survey was used to collect case-specific data to provide essential details about current safety performance in Saudi Arabia. In this study, 300 copies of the research tools were distributed. Of these, 223 copies were returned, and 219 copies were completed and valid for statistical analysis. The final sample consisted of 219 participants from five construction firms in Saudi Arabia. The variable was selected keeping in mind the vast nature of the topic and the need to return with ample information in order to support the facts and figures. The number of respondents who participated and shared their views with the researcher totaled 219. This was a reasonable response to the study as it allowed the researcher to work on the data and analyse them so that the output could offer some results that focused on improving standards in the construction industry from the perspective of health and safety standards, as well as from an economic point of view. After data had been collected from participants, the next step within the quantitative research was to analyse the information in order to answer the research questions. Conducting this research with multiple variables, the quantitative methodology showed how the personality traits mediated the relationship between incident rates and safety behavior. This was achieved by using a statistical instrument that could help to clarify and interpret the data correctly and thoroughly; the Statistical Package for the Social Sciences (SPSS) software was used in this study for quantitative analysis. Using such an instrument that could represent the data in a logical and efficient way helped to eliminate researcher bias.
Figure 1.2: Overview of the research steps and outcomes

- Literature review: Establish the historical and current context and practices on the performance of health and safety in the global Construction, Saudi construction Safety performance.
- Investigation in the context of safety performance in Saudi Arabia: Exploratory questionnaires involving 300 questionnaires with participants from five construction firms in Saudi Arabia.
- Development of improvement framework: Findings of questionnaires.
- Validation of proposed framework: A workshop involving 7 key stakeholders who were involved in Saudi construction industry.
- Key Outcomes:
  - research context clarified
  - contemporary issues highlighted
  - basis for conceptual framework
  - safety performance criteria
  - key issues affecting safety performance
  - suggested improvement framework
  - A framework for improving safety performance of Saudi construction sites.
  - Refined improvement framework for Safety construction sites in Saudi Arabia.
1.6.3 Conceptual framework

The findings from the results of the study helped in developing a framework to enhance the health and safety performance of construction sites in Saudi Arabia. Some outlines for the framework were devised using the literature review and earlier studies which provided a range of factors required for the developed framework. This improved framework contained three significant elements that affected its ability to enhance health and safety performance of in construction sites in Saudi Arabia, as well as enhancements in performance in general. Finally, the structure and contents, details of and accounts for improvements in the framework, including its purpose, are discussed in Chapter Ten. This chapter also presents a detailed account of the development of the improved framework including its purpose, structure and contents.

1.6.4 Framework validation

The aim of the validation was to test how much of the framework was workable and could be adopted for improving the safety performance of projects. Validation was achieved by way of the stakeholders’ workshop in Saudi Arabia where it was possible to obtain feedback on the framework. The conceptual framework was designed to improve safety performance by understanding the relationship between the personality attributes of construction workers and incident rates in Saudi Arabia. This was done by evaluating the relationship between the behaviours of individual workers on construction sites to identify how personality traits affected safety behaviour and incident rates before accidents happened. During the workshop process, there were discussions involving the primary stakeholders, as well as explanation of the methods the researcher used to facilitate the study. The template of the validation workshop is included in Appendix C. This workshop was aimed to seek stakeholders’ feedback on the clarity, structure, content and eligibility of the framework. Through the workshop, discussions, facilitated by the researcher, were conducted involving seven key stakeholders. The framework was further refined based on the feedback received from the validation, as shown in Figure 10.2. Chapter Ten presents the framework validation results in more detail.

1.7 Organisation of the Thesis

This thesis comprises eleven interrelated chapters. A brief overview of the content of each chapter is presented below while Figure 1.3 provides a graphic illustration of the structure of the work. The structure of the thesis is described as follows:
Chapter 1

The first section of the thesis (Chapter 1) is a general introductory chapter. It begins with a description of the global construction industry which still suffers from unacceptable levels of accidents and reportable incidents; these contribute to its negative image as a dangerous work environment. The chapter also concentrates on the safety behaviours of individuals which can lead to desired changes; these, in turn, can lead to changes in attitude which will bring about essential steps in improving safety performance. A problem statement is presented concerning the construction industry in Saudi Arabia. This is followed by a section which presents the rationale of the study and the research questions the study addresses. The aim and objectives the study intends to achieve are also presented.

The second section comprises a brief description of the chapters that present the context of the study and review literature on the performance of health and safety in the construction industry. This section is organised into four chapters: Chapters 2, 3, 4 and 5.

Chapter 2 presents a comprehensive critical review of essential and related literature to ascertain the frontiers of knowledge and current practice in safety performance in the international construction industry. Particular emphasis is given to construction workers’ safety.

Chapter 3 provides a special focus on safety performance in Saudi Arabia and selected leading countries in terms of safety regimes and improvement initiatives in order to establish the contextual differences between the regions. The chapter also establishes the principal safety challenges that confront a country such as Saudi Arabia.

Chapter 4 introduces the subject of safety behaviour and develops the foundation for using personality attitudes and traits as part of incident forensics in construction. The essence of the chapter is the argument that incidents in construction, which act as a safety trigger phase for accidents, is predominantly human driven. The chapter culminates in the identification of research gaps that characterise construction.

Chapter 5 explores and discusses various theories on accidents and incidents to elaborate the relation between the two concepts and to resolve the roots and causes of accidents in construction.

Chapter 6 provides a detailed discussion of the overall research methodology, including the background to research and the philosophical stance adopted in the study; the research approach; the actual research process, including the literature review, the population and sampling; and the framework’s development and validation.
Chapter 7 presents the first stage of the analysis. It covers demographic variables and the psychometric properties of the instruments in the study, as well as offering descriptive statistics including Pearson Correlation coefficients between the research variables.

Chapter 8 provides a regression analysis for the study involving a number of moderating effects of the personality dimensions on the independent variables of accident and incident.

Chapter 9 places the results of the empirical investigation in context to provide a discussion of options for improving safety performance. This is achieved by considering the moderating effects of personality traits on both accident and incident rates, and safety performance.

Chapter 10 provides a discussion of the results from the whole research to extract the essential factors for developing the conceptual framework for improving safety performance in Saudi Arabia. It details the steps in the development of the framework and its validation.

Chapter 11 presents the conclusions from the study and the contributions to knowledge made by this thesis. It also provides key recommendations and directions for future research to drive forward the agenda of continuous improvement in safety performance.
Figure 1.3: Organisation of the thesis
2.1 Overview
This chapter presents key information on the nature of construction as an industry and its significance to the general economy. The state of the construction industry in a country is symptomatic of the state of its national economy. Put another way, the fate of any national economy cannot be separated from that of the construction industry. This is a consequence of the forward and backward linkages the construction sector forges with the rest of the economy (Drewer, 1980; Ahmad and Yan, 1996). The backward linkages refer, for instance, to the construction materials and service sectors of the economy. The forward linkages refer to the economic activities that result from the use of constructed buildings and facilities.

This chapter shows that, as an industrial sector, the construction industry is too important to ignore. For this reason, the nature and characteristics of the construction industry are examined. Against this background, the safety performance of the construction industry is critically discussed.

2.2 Economic Importance of Construction
The national economic situation in any country often reflects the condition of the construction industry. The role of the construction industry in economic development has been validated by several studies (Strassman, 1975; Turin, 1969; Wells, 1986; Ofori, 1988). Within these investigations, using a robust numerical relationship that recognised the state of economic development and the situation of the construction industry, Turin (1969) tested data drawn from eighty-seven (87) developing and developed countries over the decade 1955 – 1965. The results from Turin’s study showed that a positive correlation existed between the value added by construction and the Gross Domestic Product (GDP) of the country. Strassman (1975), who argued that the construction industry mirrored a pattern of structural change that reflected a country’s level of economic development, echoes this conclusion. It has further been established that where economic growth has been significant, the growth of construction output has been even more dramatic (Wells, 1986). For example, in the UK, the construction industry was projected to have an economic output of some £58 billion ($87
billion) in 1998, which constituted approximately 10% of the GDP (Construction Task Force, 1998). In China, while the GDP was growing rapidly since 1979, the share of the construction industry as a percentage of GDP increased as well (Ahmad and Yan, 1996). Generally speaking, the assessment of the total value of construction output in any economy is difficult to determine and usually understated. Nowhere in the national accounts of any country is there a comprehensive picture of the total output of construction (Wells, 1986). Wells, who has worked in the area of development economics as it relates to the construction industry, cites as one of the reasons for this scenario the fact that the value added by construction to GDP is the difference between the value of sales at market prices, and the market value of all current purchases. It therefore excludes the value of purchased building materials and components, fuel, transport, professional services, insurance and legal fees. Additionally, the value of capital formation in construction, which is a measure of the gross output of the construction sector, excludes the value of repairs and maintenance work. Furthermore, a large percentage of construction activity, especially in developing countries, is carried out in the informal sector. This contribution is not included in national statistics. While caution must be exercised in the use of employment statistics, particularly in developing countries, Turin (1969) found that regular construction employment contributed between 40 and 80 workers per 1000 where the industry plays a lesser role, and between 300 and 400 workers per 1000 where construction plays a more significant role as an economic sector in the national employment statistics. Similarly, in most developing countries, the construction sector contributed between 2% and 6% of total employment (Low and Christopher, 1992). Within Saudi Arabia, the construction industry developed at an annual rate of 10% p.a. between 2003 and 2008. This decelerated down to 4.7% in 2009 and a rate of 7% development was predicted through 2010 with 10.4% added from GDP that would add almost $17.1 billion to the country's economy. Analysts forecast a 4.1% average growth between 2010 and 2014, figures which were considered to be good but not prosperous, and construction presently offers jobs for 2.5 million employees within Saudi Arabia. 40.4% of this workforce is involved in accounting which has risen up to 1.5% from 2009, as stated by EC Harris Research International Focus on Saudi Arabia (2011). In economies with a labour surplus, where employment is scarce and seasonal, labour-intensive industries like construction remain invaluable sources of employment and income. There is statistical evidence provided by ILO (1998) from South Africa which confirms that the contribution made by construction employment to the countries shown is vital to the economies of these
nations. Such contributions are likely to rise as the economy grows, industry develops and per-capita income increases (Edmonds and Miles, 1984). Per capita income refers to the average annual income per individual citizen. Therefore, as economic growth accelerates, construction output will not only expand but will also be a clear linkage to the rest of the economy (Wells, 1986; Ahmad and Yan, 1996).

2.3 Nature of the Construction Industry
Berger (2000) and Porteous (1999) agree that construction is a naturally-based industry since most of its input resources rely on natural materials to generate its outputs and products. Often, the degree of processing of its input materials is at a rudimentary level that involves minimal processing but a heavy demand in terms of energy. The reliance on naturally occurring materials makes each product unique, but it also imposes a significant impact on the sustainability of the environment through operational activities in construction. Wells (1986) pointed out that construction products change broadly as a result of site conditions, production techniques and supplies, as well as the standards of the finished product with reference to space, durability, quality and visual concerns. It is less well recognised that they vary from each other, even when built to identical plans and specifications (Porteous, 1999). For example, ground conditions may require different foundation depths or systems for two otherwise apparently identical buildings. A further consideration is that the completed products are generally not mobile in that they are permanently fixed in specific locations. This consideration implies that even if components are prefabricated and/or pre-assembled elsewhere, the final assembly process remains site-specific. Where they are not unique, work operations that are similar and repetitive are executed in work environments that change from hour to hour due to changes in the environment such as weather conditions, location, physical conditions, and height (Porteous, 1999). The physical working environment in construction varies with seasons and job site conditions. Site conditions conceivably vary between work done below a natural ground level, at ground level, at elevated heights, and sometimes even over and under water. This changing working environment results in potentially hazardous situations. Construction workers are required, therefore, to familiarise themselves constantly with these new situations. Unlike manufacturing, continuity of production is not always possible, since each product of construction is usually unique. Construction sites are subject to local conditions (Berger, 2000). The availability of materials and plant equipment may vary, requiring the substitution of materials and plant with which the labour force might be unfamiliar. Moreover, each building site represents in effect the creation of a production site
where new workplaces are set up. The term ‘mobile factories’ could be used to describe this phenomenon. At the end of each construction project the ‘factory’ is disassembled and relocated to the site of a new or different project. However, the conditions at the new site might be completely different from those of the previous project site.

Construction is frequently described as an industry that is characterised by fragmentation (Centre to Protect Workers’ Rights, 1993; Helledi, 1999). Haupt (1996) has argued that the fragmentation occurs because of the extensive number of participants and stakeholders involved in the development of most major construction projects, ranging from the early phases making up the planning, right through to the project’s finishing point. Haupt (1996) suggests that the different participants and stakeholders often act away from each other through the exercise of different aims and aspirations, roles, skills and expertise. Some of the symptoms suggested by Haupt (1996) which reflect such fragmentation include the following adverse elements of inefficiency:

- Relative increase in the costs of construction
- Overall reduction in productivity levels
- Ineffective communication between project participants
- Increasing contradiction and unnecessary confusion in project documentation
- Inefficient and ineffective management of project
- Redundant and needless stoppages
- Unacceptable performance of quality
- Poor safety performance
- Lengthy and costly disputes.

Additionally, the composition of construction project teams responsible for the design, project management and project execution, changes from project to project, resulting in a lack of continuity and consistency. Traditionally, design is separated from the actual construction process with resultant problems in communication, coordination and interpretation. Significant professional, legal and institutional barriers may accompany this separation, which can create continuity problems between the various members of the project team, constructors and subcontractors.

The divorce of design from production in the construction process is reinforced by the rigid compartmentalisation of training in the various design and construction professions (Wells, 1986). A consequence of this compartmentalised approach has been the isolation of
professionals from technical developments in the industry due to a corporate approach to construction activities that disallows innovation and technological development in the industry. The effect of this isolation results in little consideration being given to alternative construction materials and techniques. Even more fundamental is the consequent and apparent lack of concern for worker safety. It is rarely central to the thinking of owners, designers, contractors and unions (Center to Protect Workers’ Rights, 1993). Under the traditional building procurement system, there is little incentive to investigate alternative materials, methods and safety options as a result of professional fees being linked to the final cost of the project (Wells, 1986). The cost of the time spent in investigating alternatives cannot be recovered from the client under such procurement and contractual arrangements. Aside from the separation of planning from production, the very nature of contracting in the construction industry is rooted in a culture of rivalry. The various contracting parties often have aims that are quite dissimilar (Binnington, 1999). The aims of the main contracting parties (contractor and client) are different on traditional project parameters of quality, cost and time. For instance, contractors are continually under pressure from clients to accept very aggressive offers by reducing the construction cost, often in a process that involves value engineering. Such aggressive behaviour typically ends in the client choosing the contractor who is ready to accept the largest risk or who has made the biggest error in their cost and solution for delivering the client’s requirements (Binnington, 1999). This tension contributes to the climate of disputes. Consequently, safety is one of the first areas to be sacrificed in the effort to reconcile the divergent objectives.

Research conducted in New Zealand in 1997 (Site Safe, 2000) proposed that projects driven by cost and the competitive nature of tendering resulted in an absence of margins of safety and lower costs. The building and construction industry is subject to economic cycles; it relies on changing priorities and government policies which produces a "stop-go" approach in the sector (Ahmad and Yan, 1996). In most economies of the world the density of building activity fluctuates according to changes in the confidence of investors, the availability and cost of financing, and the demand for consumer goods, or even a combination of these (Porteous, 1999). These differences mean that investor and consumer reactions typically react to changing priorities and government policies. As a result, the construction industry does not have continued demand for its products and services. This scenario means that the demand for skilled building fluctuates and so qualified workers and trainers, who need work of some kind, leave the industry when the demand for their services disappears. The impact of this
repetition is that there is a lack of investment in, and lack of commitment to training for workers who are an important element in any plan to improve safety performance.

A one-off increase in construction activity and a lack of skilled and trained workers is a serious problem. Compensating for the resulting shortage increases the possibility of using with workers who lack proper training and the experience necessary to perform properly and safely the basic operations required in the assembly of a building. Often, it is expected that new skills that are relevant to a new project will be gained by these workers automatically and not necessarily obtained through structured programmes of education or training (Porteous, 1999). Often, workers' tariff programmes tend not to pay much attention to health and safety, ignoring the fact that workers who make up this group are most likely to suffer accidents (Haynes, 1997). According to Porteous (1999), another consequence of this is the variation in the number of workers who have been trained and can be distinguished from learners. A further factor is that coaches know how to carry out construction activities in a certain way while educated workers know why such an activity should be executed in a particular fashion. In addition, it takes longer to educate a worker than to train one. Gaining knowledge of various science-related building activities is a gradual process and takes longer than just learning how to perform a series of activities. This industry therefore responds to an acute shortage of skilled workers by investing in training skills for employees instead of providing them with a good education which covers all aspects of the construction process; it also often relies on the procurement systems used in the industry to react to competitive bidding.

These tendering practices in the implementation of construction projects result in contractors being hired on a "one-time" basis. Implicitly, therefore, each project is treated as being unique, without the possibility of either the physical structure being reproduced or the project team working together again on the next draft. Since this practice is the predominant means of obtaining employment in many countries, it is difficult for contractors to determine the workload in the future, or plan to invest for the future. Risks associated with this uncertainty lead to limited investment in fixed capital, working with a minimum of permanent staff, and an increased use of subcontractors and casual workers (Centre to Protect Workers’ Rights, 1993). There are few opportunities to learn from mistakes in one building when the next one to be constructed is completely different. Legal considerations tend to make mistake-makers reluctant to disseminate any newly discovered knowledge (Porteous, 1999). In addition, the highly competitive nature of the industry does not encourage the sharing of knowledge with
potential competitors (Porteous, 1999). Workers in the industry will defend their responsibilities relating to health and safety, using the reasons as an excuse not to monitor health and safety policies. Because of the financial rewards and incentives to build much cheaper in the short term, one of the first areas, unfortunately, to experience cost-cutting to improve the competitiveness of a bid is that of health and safety (Porteous, 1999; Site Safe, 2000). As long as building products and goods are built for immediate sale or financial returns, there are powerful incentives for investors to pay the minimum obligatory attention to health and safety. Market forces in the short term are repellent to the expenses incurred in complying with building codes, while building control systems neither encourage nor discourage the construction of buildings that exceed the minimum requirements for health and safety. It is likely that the mandatory minimum requirements of the law will be the base as long as financial outlooks prevail in the short term.

Another feature of the industry is the high negative proportion of supervisors at work which, according to Haines (1997), should be of the order of 1 supervisor to 2.7 workers. Supervisors who have a more positive relationship with personnel and workers have better safety performance records (Heinz (1997) in Levitt and Samelson 1993). This relationship is not difficult to develop if the ratio is high. For a long time, the building and construction industry has been described as one with a weak culture of health and safety but efforts to improve health and safety performance will not be effective until the industry’s safety and health culture improves (Dester and Blockley, 1995). Thus, there is a need for a quantum leap with regard to attitudes towards health and safety on construction sites.

2.4 Safety Performance in Construction

The construction sector is a dangerous and highly hazardous one (The Business Roundtable, 1983; Churcher and Alwani-Starr, 1996; Birchall and Finalyson, 1996; Khalid, 1996; Smallwood and Haupt, 2005). Moreover, it has a high rate of accidents across the world which has therefore classified as only second in rank after the mining industry (Hinze, 2000). It has earned itself this unfortunate and unenviable reputation due to the disproportionately high incidence of accidents and fatalities which continue to occur on construction sites around the globe. For example, construction employees in New Zealand are three times more likely to be killed and twice as likely to have serious accidents compared to the overall workforce, as Site Safe (1999) noted. Globally, construction employees are three times more likely to face death during working hours compared to employees in other fields because the risk of dangerous accidents is more than three times higher (Site Safe, 1999).
The construction industry in the United Kingdom, for example, has for many years consistently had the highest incident rate for fatal accidents and serious injuries when compared with all other industrial sectors. According to both HSE (1998) and HSE (2002), it seems that it is “the second worst of any industry” with incidents contributing to almost four to six of current spending projects: when the incident rate is continuing to fall in all other industries. HSE (2008) argued that almost 3,000 individuals have died because of accidents that have occurred on construction sites within the last 25 years; a high percentage of illnesses or injuries have also stemmed from construction sites. This reached a rate of 5% of employees who died and 9% of important accidents; also in Britain the rate reached 27% of employees who suffered dangerous injuries, as HSE (2011) explained. Figure 2.1 shows that between 2010-2011 construction employees had 50 accidents as an overall rate, while other self-employed workers suffered 18 dangerous injuries, compared with almost 61 accidents in the last five years and 19 accidents for self-employed workers (RIDDOR). In addition, the overall rate of fatal accidents increased to almost two-thirds compared with the rate of the last twenty years which reached almost a third; furthermore, this rate decreased from a quarter between 2007 and 2008, as RIDDOR illustrated. Moreover, more than 5,000 cases of occupational cancer have been diagnosed every year because of exposure on construction sites, as the Cancer Burden Study (2010) confirmed. Furthermore, over 36,000 cases of musculo-skeletal disorder increased the number of cases of illness through work, as illustrated by the Labour Force Survey (LFS) (2010) and almost 2.3 million working days (which accounts for 1.1 days for every employee) were lost because of work-related health issues. As LFS (2010) confirmed, health problems reached 75% and injuries cases reached 25%. For example, in the United States of America, construction sites employed almost 7% of the industrial workforce, as Dong and others (2005) stated in a CPWR report while, at the same time, the construction industry was responsible for 21% of industrial fatalities (Hinze, 2006).
Figure 2.1: Twenty year trend in worker fatalities

Studies have demonstrated that the construction industry has the highest rate of days that are lost. Grubb and Swanson (1999) argued that the industry also has the highest rate of fatalities in the world, as Pollack and Chowdhury (2001), Suraji et al. (2001), Ngai and Tang (1999), and Coble and Haupt (1999) stated. However, fatal accidents decreased by 40% EVERY year since 2006. Do you mean and have decreased therefore by a total of 40% since 2006. This reduction may be related to economic status since working hours have decreased by about 6 per cent since 2010, which has occurred since the reduction in accidents during 2008 and 2009. Although the rate of fatal accidents has decreased, the construction industry still had the highest accident rates during 2010 compared to other industries, as Figure 2.2 shows. In addition, the number of deaths, injuries and accidents in the construction industry reached very high levels despite a reduction in the rate of fatalities, injuries and accidents by about 50% in the last 30 years. Levitt and Samelson (1993) showed that accidents in the construction industry in the United States cost more than $17 billion every year and, according to the Centre to Protect Workers’ Rights (1993), employees in the construction trades in the United States died on an average 8 to 12 years earlier compared to white collar employees. Around three to four construction employees in the United States die from accidents at work every workday which indicates 18.6 to 34 fatalities for every 100,000 full-time employees. Moreover, the highest death rates relate to work accidents in the construction industry compared to other sectors of industry. In the United States, more than 229,000 construction employees lost time at work because of accidents, needing time off or restricted workloads in order to recover from these accidents.
According to the International Training Centre of the International Labour Organization (2009), the ILO (International Labour Organization) demonstrated that the number of fatal occupational injuries within the construction industry reached almost 60,000 annually; it reached almost 64% in Asia and the Pacific region; 17% in America; almost 10% in Africa; and, in Europe, almost 9%, as Figure 2.3 demonstrates.

Figure 2.3: Distribution of fatal accidents in the construction industry
Many nations have double the number of occupational injuries which cause more than 3 days of absence annually in the construction industry taking an average of the total number of industrial employees. This shows that individuals might expect their chance of being fatally injured is three times as likely as the average, as Figure 2.4 shows.

![Bar chart showing the comparison of construction accidents to all industries. The chart indicates higher rates of accidents in construction compared to other industries.](chart.png)

Figure 2.4: Accidents in the construction industry versus all industries

Figure 2.5 shows that the death rates in 2005 for construction work reached almost 4.4 deaths for every 100,000 employees in Sweden and 14.0 deaths to every 100,000 employees in Italy and Spain. (These rates were chosen from industrial nations.) In addition, the rate of death in construction in the United States was also high since it reached 11.1 deaths to every 100,000 employees, making it comparable with Italy and Spain, and putting it 2.5 times higher than Sweden which has a lower rate than other industrialised countries. The current death rates on construction sites since 1992 have decreased in the United States, Australia, Canada and Sweden. According to ILO (2005), the death rate on construction sites in the United States since 1992 reached 18.6 for every 100,000 employees or 3.1 times higher than the rate for Sweden, which reached 6.0 for every 100,000 employees, over the same period.
Regardless of the real cost that both fatalities and injuries incur, the national economy of any nation suffer huge costs and poor productivity because of the number of lost workdays related to the occupational deaths or injuries. Advancements in technology, the development of sophisticated plants, new construction techniques, the increased size and complexity of construction works, and improvements in the recognition of risks and hazards, suggest that there is still an opportunity for improvement in the safety record of the construction industry (Joyce, 1995). The success of any construction project is usually measured in terms of the universally acceptable project parameters of time, cost and quality. Safety performance on projects should be just as much a measure of the success of that project as is project completion within the desired time frame, within the budget and to satisfactory quality performance standards (Hinze, 1997). It is inconceivable that a project should be regarded as ‘successful’ when limbs and lives have been lost through accidents that could have been prevented if adequate safety measures on a project had been regarded as important as productivity and/or quality. However, to work toward the goals of zero accidents and zero incidents, a concerted and coordinated effort is required on the part of all the participants in the construction process. At present, the construction industry’s safety activities are untargeted, inconsistent and uncoordinated with the industry focusing on compliance with minimum standards rather than best practice (Site Safe, 2000). Risks of exposure to hazards need to be eliminated at source and where this is not possible, the risks must be controlled and means for protecting workers against these risks must be seriously considered (Lan and Arteau, 1997).
2.5 Review of Safety Improvements

Within construction, safety is regulated by a national body in most countries, either as a department of the government machinery or as an independent executive arm (Morrison, 2004). Often, such safety bodies, along with academic interest groups associated with safety performance, often share an aspiration to achieve zero accidents in the industry. In exceptional cases, a “no incidents” goal in delivering construction projects is pursued. To illustrate the point, the sub-sections that follow explore some of the goals, developments and initiatives that have driven safety performance in a selection of countries. They are addressed under the categories of the UK and Europe, the USA and KSA.

2.5.1 Developments in the UK and Europe

The principal agency responsible for safety within the construction industry in the UK is the Health and Safety Executive (HSE); similar public agencies with the same level of independence exist across the EU countries. The HSE coordinates both practice and research and development in safety performance. Institutions that support and promote the safety agenda of the HSE include the European Construction Institute (ECI) and the Engineering Construction Industry Training Board (ECITB). Improvement initiatives championed by these institutions include promoting a safety passport agenda, and using a cross-company taskforce to improve safety performance. Such improvement efforts explore safety across the full delivery of the project. Gibb et al. (2009) reported that, in order to achieve a significant minimization of the amount of accidents, serious consideration should be given to the whole system from the designer to the supervisors and the workers, as well as every other member related to the project. Such a focus is driving an agenda of designing for safety in the same mode as the assurance scheme for quality. Simultaneously, initiatives such as ‘zero-harm’, the Considerate Contractor Scheme, Carbon Footprint measures with neutral being the accepted norm, are fostering a new culture regarding safety on construction sites. These developments should enable safety improvement to become more tactical in the delivery of projects.

2.5.2 Developments in the USA

In the USA, the notion of zero-accident and a minimal incident rate has been at the forefront of construction projects for the past two decades (Hinze and Teizer, 2011). According to Rosenbaum (2001), the Zero Accident Program (ZAP) is defined as a program that aims to develop the safety and quality of any organisation through research and offering support for
members, thus decreasing the risks that any workers may face. An efficient ZAP depends on many methods, such as previous preparation for safety, training and direction in safety, recorded safety motivation, alcohol and drugs testing, and accident examination. Previous preparation includes studying work dangers, carrying out construction reviews, and preparing for the job. Training involves guiding new workers, being up-to-date with training and joining training meetings. Recorded Safety motivation consists of injury documents and participation in management to prevent risks. While this aspiration is achieved for many projects, there are still instances of accidents and incidents. The recent Gulf of Mexico accident involving Halliburton and BP is a typical case. The persistence with which adverse safety episodes occur in the world’s most advanced construction industry underscores the importance of extending the frontiers of safety agendas if any further improvement can be achieved. It would appear that such an extension should look beyond production sites. Gambatese et al. (2008) evaluated safety risks that originate from the design process and argued that applying safety management systems should make it easier to mitigate most of them.

The researchers studied 224 cases of site accidents and concluded that 71% of the 224 accidents were related to the planning of safety management. Where such planning is conducted at the design phase, it provides a more strategic orientation for safety. The argument here is that planning for safety management should be an important issue which needs to be tackled strategically by the construction industry. In some cases, however, even the most careful safety planning may not exclude the occurrence of accidents due to the multifarious influences that play out on sites. In general, nonetheless, there is a widely accepted view among professional engineers in the construction industry that planning for safety management reduces the possibility of accidents. Gambetese et al. (2009) suggested a strong correlation between construction site safety performance and planning for safety management. According to data from OSHA, the USA had 3500 incident cases per 100,000 in 2010 (or a rate of 3.5%), a figure which was down from 3.6% in 2009. This improvement correlates with safety performance in US construction and confirms the potential for improving safety by focusing on the elimination of incidents. Equally, the percentage reduction from 2009 to 2010 means that site incidents provide a clear and structured approach to identifying safety risks.
2.5.3 Developments in the KSA

As mentioned in the previous literature about health and safety, these factors have several impacts on the behaviours of employees with regard to the performance of safety measures within the construction industry in Saudi Arabia. According to HMSO (1974), the Work Act of 1974 supposes the importance of introducing health and safety within the construction industry. Also, HMSO (1994) confirmed that regulations regarding construction, design and management (CDM) in 1994 had promoted the significance of pursuing safety within the construction industry in a self-regulatory context. This context works by improving the culture of safety and subsequently changing behaviour. Also, this context is informed by the regulatory outline that controls safety in the construction industry. However, a huge impact will come from factors that focus on construction employees and the behaviour of individuals. Therefore, the main aim of this study is to define the most important issues that have an impact on the behaviours of employees with regard to matters of safety. Both regulations and laws are considered to be the main foundation of safety management while actions and beliefs are considered only as factors that impact the performance of safety within construction sites. The safety problems in construction are considered to be the concern of the construction industry but enhancements in safety performance also come from health and safety executives, employers’ associations, and trade unions. So, a study needs to be conducted to gain a better understanding of the problems surrounding safety from the point of view of all these areas. Some control is exercised through the regulations of CDM which are used by the planning supervisor who affects the whole performance, especially by observing the safety management of the construction industry. Based on the aim of this research, behaviours during construction processes stem from values and beliefs that often differ from the safety plans. Employing regulatory guidelines leads to a definition of techniques to instigate behavioural studies, instruments and methods for safety measurement, and uniformly classifying accidents to teach employees about risks to safety (Duff et al., 1994). The influence of these efforts and initiatives can be assessed and then compared with other processes of a dangerous nature. Accident rates differ among contractors and places of work are also varied; these differences can be used as variables which are present in the work environment, as are the responses of employees to these dangers. Therefore, this study attempts to connect organizational factors with the individual factors related to accidents. The research model, which connects the behaviours of employees with safety issues, are relevant to the construction industry. The physical factors within the environment include:
• Pay structure,  
• Role and position of the safety officer and safety representatives,  
• Effectiveness of long-term planning,  
• Control and supervision of work,  
• Inter- and intra-group co-operation,  
• Availability of technical resources,  
• Site tidiness,  
• Site conditions and access to work.

The psychological factors include:
• Accuracy of subjective risk evaluations,  
• Safety training,  
• Feeling of competent autonomy or fatalism,  
• Skill and experience brought to the job,  
• Perceived responsibilities,  
• Care and attention by the individual,  
• Origins of safety norms.

Within these two themes, the environmental factors have been confined to the fields covered by regulations and the collection of statistics: protection at depths and heights, personal protective clothing, safety risks, and guards. According to Booth (1993), psychological matters can be added to the agenda of safety studies. The causes of accidents have two models: a behavioural model and a situational model, as Raouf and Dhillon (1994) stated.

2.6 Comparative Safety in a Developing Country

Saudi Arabia is considered to be a developing country where the management of health and safety is a big challenge for both the governments and for owners of businesses. Any attempt to implement management interventions without bearing in mind the hard and unpredictable business environment will certainly result in failure. Institutions and regulatory systems in most developing countries have followed and inherited the attempts made by developed countries. However, regulations in the developed countries have not been modernised to reflect their current cultural milieu and level of development. Health and safety therefore, is limited and not comprehensive in scope (Suazo and Jaselskis, 1993). LaDou (2003) argued that the laws concerning professional health and safety cover only 10% of the total working population in developing countries, taking into account that many sectors of high risk, such as fishing, agriculture, construction and forestry, are not well addressed. Koehn et al. (1995)
noticed that time pressures, bureaucracy, unproductive institutional structures for occupational health implementation, and the lack of awareness of workers about their right to a civilised workplace, as factors preventing the effective practice of safety management and health implementation in developing countries. Similar research by Mwombeki (2005) showed that most Tanzanian contractors understood the significance of the role of health and programmes of health and safety, but had not implemented these programmes to improve health and safety performance in the construction industry. Gibb and Bust (2006) explored health and safety in developing countries and discovered certain factors that had a negative impact on the management of health and safety. These included: poor infrastructure; communication problems due to low, or the absence of, educational levels; informal practices with regard to the structure of construction sites; commitment to working using traditional methods; shortage of equipment; harsh climatic conditions; incorrect use of available equipment; and depravity. The construction industry society in developing countries does not encourage health and safety. Some of its practices even discourage the effective management of health and safety. Ngowi and Mselle (1999) noted that contractors in developing countries derive little competitive benefit from good management of health and safety while competitive bidding practices and the awarding of the majority of public contracts to the lowest bidder in several developing countries force contractors to reduce their prices when reducing costs impacts on health and safety. Many developing countries suffer from the problem of illiterate workers which causes difficulties in training such uneducated individuals, leading to major health and safety dilemmas (Koehn et al., 2000). High levels of unemployment force workers to agree to work on initiatives that are high risk without complaining or calling for their managers to build workplaces that consider health and safety measures.

2.7 Summary
It is more important to reduce the occurrence of incidents than to reduce accidents which lead to injuries. If accidents and hazardous exposure can be eliminated, injuries and illnesses can consequently also be eliminated. In this chapter, the construction industry has been shown to be an important sector of any national economy, especially regarding its employment potential. The nature and characteristics of construction have been examined and the unsatisfactory safety and health record of the industry has also been highlighted. Additionally, comparative safety levels in developing countries were discussed. The construction industry tends to have a low awareness of the long-term benefits of safe
practices, while the tendering process often pays little attention to safety, resulting in cost and corner cutting.

In Saudi Arabia, the construction industry has a relatively high level of fatal and non-fatal accidents which stresses the need to improve safety performance. In the next chapter, the extent of health and safety in the construction industry of Saudi Arabia is evaluated, along with practices that respond to the unsatisfactory level of safety in this chapter.
3.1 Overview
This chapter presents the national context of safety for The Kingdom of Saudi Arabia (KSA). It begins with a background of the country and its history. The chapter also provides coverage of the economy of KSA to establish a context for the nature and environment in which Saudi construction projects are undertaken. This is followed by different key issues that relate to the occupational health and safety within the construction industry of Saudi Arabia. The chapter then addresses the level of performance of construction safety and the different practices and systems in place for attaining health and safety in the Saudi Arabian construction industry. The review of Saudi safety is supported with relevant statistics on work-related accidents as well as the challenges faced in the construction industry in Saudi Arabia to identify gaps in current safety practices.

3.2 The National Context of the Study
The Kingdom of Saudi Arabia, as it is officially known, is considered in its national context in this study. KSA was founded by Abdulaziz Al Saud on September 23rd, 1932 by royal decree as the kingdoms of Hejaz and Nejd were unified. It is run by a unitary Islamic absolute monarchy with its capital based in the city of Riyadh. Being the birthplace of the Islamic religion and because of its superior position in terms of its vast oil reserves, Saudi Arabia is one of the most influential countries in the world. A comprehensive outlook is thereby presented for the case of KSA.

3.2.1 Geography of Saudi Arabia
Saudi Arabia is the second largest country in the Arab world, next to Algeria, and the largest in Western Asia, with a land area of approximately 2,150,000 km2. The country therefore, occupies most of the northern and central Arabian Peninsula, and accounts for almost 80 per cent of the total area making up the Peninsula. Hejaz, the Islamic crib, is situated in KSA’s western highlands alongside the Red Sea where the holiest cities of the religion lie: namely, Mecca and Medina. Najd, which etymologically means Highland, is a vast region of barren land in the heart of the country, and until recently, it had been the hub of the many feuds and wars between Bedouin tribes and clans. The Persian Gulf envelops the east of the landmass
and harbours rich reserves of oil and natural gas which have made KSA a pioneer in the
global petroleum industry since the 1960s. KSA shares its northern borders with Jordan,
Kuwait and Iraq; its eastern border is shared with the Persian Gulf, the United Arab Emirates
(UAE), Qatar and Oman, the latter extending somewhat to the south-east. Yemen lies to the
south and south-west and to the west lies the Red Sea and the Gulf of Aqaba. Figure 3.1
presents the political map of KSA that show the adjoining countries and features.

Figure 3.1: Map of Saudi Arabia and neighbouring countries

The country is characterised by various geographic regions that influence the climate of KSA
and can be classified into the following three zones:

Desert encompassing most regions;
Steppe (grasslands) along the western highlands, along with strips of widths below 100 miles
(160 km) in the north, except at the latitude of Mecca where they are 300 miles (480 km)
wide;
The highlands to the north of Yemen, which is a small area of moderate and humid climate
featuring long summers. The northern Arabian Peninsula generally experiences cyclonic
weather conditions during winter which tend to shift from the Mediterranean Sea in the east.
Sometimes these weather systems also reach the eastern and central parts of Saudi Arabia as well as the Persian Gulf. Some of them move along the Red Sea trough towards the south, causing mild winter rainfall that reaches Mecca and sometimes advances even more southwards in Yemen. The months of March and April usually witness torrential rain. Steppe-like land forms are sustained by the adequate falls of rain brought about by the monsoon-type winds across the highlands of Asīr to the southeast of Mecca during summer. The months of December through to February feature cool winters with occasional frost and snow about the southern highlands. Some of the recorded average temperatures during these months are: Jeddah at 74°F (23 °C), Riyadh at 58°F (14 °C) and Al-Dammām at 63°F (17°C). Hot summers are experienced from June to August when temperatures during the day soar to over 100°F (38°C) for almost all regions, with a maximum temperature of 130°F (55°C) in the desert regions.

### 3.2.2 Demographics of Saudi Arabia

Despite being a relatively young country, Saudi Arabia has a rich history which has been largely fuelled by its religion, tribalism and huge potential wealth. As per a recent estimation by the CIA in The World Factbook, the population of the Kingdom is set at 26,939,583 which comprises 5,576,076 expatriates. The expatriate demographic (from the same source) has been found to comprise 21 percent of the total population with 4.8% Indians, 3.3% Pakistanis, 3.3% Egyptians, 2.9% Yemenis, 1.8% Bangladeshis, 1.8% Filipinos, 0.96% Palestinians/Jordanians, 0.92% Indonesians, 1.35% Sri Lankans, 0.92% Sudanese, 0.38% Syrian, 0.38% Turkish and 0.38% Westerners (mostly Europeans and Americans). The ethnic demographic is composed of 50% Arabs, 5% Bedouin Arabs, 10% Afro-Asians and 35% al-Arab al-Ifriqiyyah (Arabic speaking Africans). The Bedouin Arabs in KSA can be understood to be analogous to the Western cowboy folk heroes in America. These Bedouins have been visualised as the powerful prototype of a desert warrior and seem to influence the average Saudi Arabian value system and behaviour patterns, thus serving as the cultural bedrock of the country. Since the 1960s, a largely proportioned nomadic demographic has been found currently to be as far as 95% settled. The nomadic population, along with the sedentaries, exhibit a degree of ethnic heterogeneity marking them as the descendants of the original ethnic stock of the Arabian Peninsula. The variation in the ethnic demography has been a result of the influence of sub-Saharan Africa along the Red Sea and the immigrants throughout history from Iran, India and Pakistan along the Arabian Gulf.
3.2.2.1 Languages
The Semitic language that had originated on the peninsula is Arabic which is aptly the official language of KSA. It is spoken by the Saudis in three regional variants: Hejazi Arabic, Nejdi Arabic and Gulf Arabic. As Arabic exists in many vernacular dialects, in KSA it has been identified as three main groups according to region: eastern, central and western. Other languages used among the expatriate population include Tagalog, Persian, Pashto, Rohingya, Urdu, Korean and Egyptian Arabic. Classical Arabic, which is the language of the Qur’an, has been found to give rise to modern standard Arabic as the official script or written language within the country, as well as in the extended Arab world. English is also widely understood among both the citizens and expats, and is used officially.

3.2.2.2 Religion
Saudi Arabia bears a significant position among the followers of Islam throughout the world for being the birthplace of the religion. Most Saudi natives adhere to the Sunni branch of Islamic practice, the modern interpretation of which has been particularly influential through Muslim scholars; the sect’s views have been a major governing factor socially as well as economically. Political legitimacy has been established by the highly religious-oriented Saudi government, which is the Saud family, as the country’s custodian of the two holy cities of Mecca and Medina. The primary branch of Islam followed in KSA is Wahhabism, also referred to by native members as muwaḥḥidūn, meaning Unitarians; this is the Ḥanbali school of Islamic law’s strictly interpreted practice. The framework of this sect derived from the alliance of the religious scholar, Muḥammad ibn ʿAbd al-Wahhab (1703–92), with Ibn Saud, and is therefore directly connected with the establishment the first Saudi state. Another important branch of Islam practiced in KSA is that of the Shiites who constitute a minority demographic existing among the oases of Al-Hasa and Al-Qaṭīf, located in the country’s eastern part.

3.2.2.3 Culture of Saudi Arabia
The cultural scenario of KSA is quintessentially Arab and Islamic. Laws and regulatory enforcement are primarily imposed on dress and behaviour so as to preserve the purist religious stance of the state. This is evident in the ban on alcoholic beverages, and restrictions with regard to the public exhibition of films and theatre. Privileges are limited concerning the public expression of opinions on matters concerning everything internal to KSA, in spite of the abundance of well-educated Saudi citizens who are well informed on internal and international matters, and those within the Arab world. The government has
always been an absolute Islamic monarchy since its foundation, which prohibits the introduction of any other political system or the formation of political parties or labour unions for accessing public forums. Islamic teachings monitor the daily pattern of activities of an average Saudi Arabian native. This includes the mosque minarets summoning Muslims to prayer five times every day. Unlike the rest of the world, Saudi Arabia used to observe Thursday and Friday as weekend, which it shares with other Arab countries, as Friday is regarded as holy for all Muslims. However, since June 28, 2013, the weekend has been shifted to Friday and Saturday in order to allow better economic coordination with international activities. The national sport of KSA is football; other popular sports include basketball and adventure sports like scuba diving, windsurfing and sailing. More traditional sports, such as camel racing and falconry, are also very much a part of the Kingdom’s culture.

3.3 The Saudi Arabian Rule of Law

The politics and economy of KSA are centred around the Islamic code of conduct, and are very much influenced by the Wahhabi religious tradition. The dominance of the Wahhabi is significant to all industries as it helps to determine the conduct of business and corporate activities.

3.3.1 Framework of construction

The Al Saud family is the monarchy which founded the constitution, based on the Islamic law – the Shari‘ah; that is used to legislate on all formal social and commercial life. The actual implementation of legislative policies, however, often follows mitigation by factors such as the inner rulings of family politics, political expediency, and the influence of inter-tribal politics. The constitution of KSA had never been drafted in written form until 1992 when the Basic Law of Government, termed Al-Nizam al-Asasi li al-Ḥukm, was issued by the King. Al-Nizam al-Asasi li al-Ḥukm is basically a set of guidelines for running a government and combines legislative, executive and judicial functions, whilst laying down the rights and responsibilities of the citizens. The king also performs the role of prime minister as he presides over the Council of Ministers, or Majlis al-Wuzara’, and enjoys the power of dismissing/appointing its members. The latter takes over the execution and administration, through separate agencies, of various matters concerning domestic and foreign policy, defence, finance, health and education. A new quasi-legislative body was formed in 1993 following the Majlis al-Wuzara’; this is known as the Consultative Council,
or Majlis al-Shura, and is composed of technical experts. The technical experts help to provide support on how sectors such as construction should be run. Also appointed by the king, the Majlis al-Shura normally drafts legislation and offers it for the king’s approval through the Majlis al-Wuzara’. The eventual decision-making process, however, excludes these formal systems and is carried out within the royal family by the many descendants of Ibn Sa’ud (the Kingdom’s founder) who mostly hold key government positions. Decision making also involves prior supplementary reviews carried out by important religious leaders (ulama), tribal sheikhs, and patriarchs of leading commercial families.

3.3.2 Local government
Governance is carried out at a local level by administrative regions known as manāṭiq, which are composed of a number of districts. The royal family appoints regional governors, generally from amongst their own, who are responsible for regulating one or more municipal councils. Some members of a municipal council are appointed while the rest are elected. The governors take responsibility for the council’s functioning over the financial, health, education, agricultural and municipality sectors. A similar principle of consultation is also applied at rural and tribal levels of government.

3.3.3 Judiciary
The KSA judiciary system is based on the Shari’ah law. The Islamic tradition of Ḥanbalī is strictly adhered to whenever a formal judgment at an official level is passed. The nature of the law is usually conservative and severe punitive actions are taken where there are proven transgressions. Rulings in favour of amputation for crimes such as theft, and execution for more severe crimes such as drug trafficking or witchcraft are instances of the harsh punishments that are ordered to serve as a deterrent. A Supreme Judicial Council, formed from the leading ulama members, assisted in forming the Ministry of Justice in 1970. With more than 300 Shari’ah a courts across the country, jurisdiction is mostly traditional. More modern issues, such as traffic violations or industrial accidents, were introduced into the judiciary’s functionality, being brought about by advancements since the mid 20th century; handling these cases had to be transferred by royal decrees which later evolved into an administrative legislative body. Although this aspect of the judiciary was not directly derived from the precepts of Islam, the monarchy made itself the final court of appeal and the body which dispensed pardons, while avenues were made available for making appeals.
3.3.4 Health and welfare
The adequate financial capabilities of the country have been a positive factor in its implementation of regulations for establishing proper health care facilities. The country can boast of sufficient number of hospital beds, clinicians (including physicians and nurses), and other health facilities to promote excellent health for the citizens. The health is delivered through a distribution of several and growing health institutes and centres, hospitals and pharmacies throughout the country. For example, as a norm, a network of pharmacies have been set up to serve communities of over 10,000 people. In addition, a provision of numerous mobile health services that enable access by small communities facilitate a reach to the nomadic population.

3.3.5 Education
The government gives high priority to education and thus has made it free at every level. The KSA school education system is divided into three levels:

- Elementary – grades 1 to 6
- Intermediate – grades 7 to 9, and
- Secondary – grades 10 to 12

Religious studies occupy a significant proportion of the curriculum at all levels of education. At the secondary level, it becomes an alternative to technical subjects. Schooling is allowed for girls but all courses are segregated on the basis of gender. The literacy rate among the two genders is disproportionate as it is over 85 percent for males but only 70 percent for females. This illustrates that fewer girls attend school in comparison to boys. Beyond primary and secondary school education, the government has in recent times placed much emphasis on the expansion of higher education. Major higher education institutions in Saudi Arabia include the King Sa’ud University, formerly the University of Riyadh, which was founded in 1957; the Islamic University at Medina, founded in 1961; and the King Abd al-Aziz University founded in Jeddah in 1967. Institutes for Islamic studies have been established across several towns and schools for religious pedagogy are quite numerous. As well as religious studies, the curricula of the other colleges and universities also include sciences and technology, medicine and military studies. The technical and medical schools in particular employ many faculty from abroad where a large number of students also travel for their higher studies. Segregation applies in colleges as institutions are typically provided
separately for women. Universities, however, which were developed mainly by drawing students from abroad, harbour a more liberal environment outside the conventional society of Saudi Arabia. Here, women have permission to wear the *hijab* and *niqaab* at their own discretion and may also drive within the campus. One major example of such an environment is King Abd Allah University of Science and Technology, which was established in September 2009 near Jeddah. This institution provides a campus with state-of-the-art laboratories and virtual reality facilities; one of the world’s most powerful supercomputers has been installed in the University. This is a part of the Saudi government’s drive to become a scientific competitor on the international platform while gaining the status of being a regional scientific hub.

### 3.3.6 The economy

By 2010, the economy of Saudi Arabia (KSA) had healthily increased to 3.7%. The economy takes advantage of a large counter-cyclical stimulus package that ran the deficit budget of KSA to 3.3% of GDP in the last year in 2002; KSA was also expected to have a small deficit in 2010. Although KSA has high inflation which, at a level of 6.1%, is the highest rate in the Gulf, economists do not predict any inflationary spiral because high prices do not provide high wages. However, this situation can be described as an uncomfortable one because it cannot be maintained in the long term. The 6.1% inflation rate is determined from higher commodities’ markets and Saudi’s speculative boom based on ArabianBusiness.com; it was expected that inflation would decrease to 5.4% in 2010 (which is still high), 5.1% in 2011, and 4.7% in 2012. These expectations depended on the assumption that the housing market would increase because of sharply rising commodity price pressures. Most of business lenders (57% of those surveyed) expected to face increases in the inflation rate within the 6 months while 14.5% of others expect to still the same. Recent studies have shown that almost 55% of those surveyed planned to keep the prices of their services and goods the same in the last quarter of 2010 and the first quarter in 2011; only 20% were hoping to try to raise their prices. Governments in Saudi Arabia have had a complex response to inflation because of the Riyal which is pegged to the United States dollar; thus, domestic interest percentages cannot increase as a response to high inflation levels although withdrawing the government stimulus can damage the whole economy and jobs. Increasing credit dramatically held onto credit growth in Saudi Arabia which then caused a policy dilemma and other speculation, as Soussa (2011) stated. In the future, levels of investment in the construction industry within the governmental and private sectors can be
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expected to increase. The country has a high demand for residential properties which are required mainly by the indigenous population rather than the expatriate community whose needs are fairly static in the future. Also, more opportunities will be required in education, energy and transportation and the government will support these plans. Inflation was expected to reach 5.7% in 2011 and to decrease to 5% in 2012. These expectations would increase commodity prices and push up the costs of contractors since the price of cement, copper and steel would also be expected to increase in the near future or in the next couple years. Despite development plans being well advanced, the ability to deliver might be a serious problem. Saudi Arabia does not attract the attention of overseas companies and many foreign professionals consider being posted to the country as a hardship. Foreign companies still face many difficulties in entering the Saudi market so this may be a significant issue in its ability to deliver its development plans; this also acts as a damper on growth and stifles any predicted surge in construction. EC Harris has identified a pattern which suggests that prices of construction tenders could increase in line with the trend of almost 5.5% in 2011, 5.7% in 2012, and 5% in 2013 and 2014, with the earlier statistics depicted in Table 3.1.

Table 3.1: Economy and construction in Saudi Arabia (EC Harris Research, 2011)

<table>
<thead>
<tr>
<th>GDP growth (%)</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer price inflation (%)</td>
<td>4.0%</td>
<td>5.5%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Unemployment rates (%)</td>
<td>10.5%</td>
<td>10.5%</td>
<td>10.8%</td>
</tr>
<tr>
<td>GDP per Capita</td>
<td>US$10,250</td>
<td>US$16,641</td>
<td></td>
</tr>
<tr>
<td>Exports</td>
<td>US$295 bil</td>
<td>US$192 bil</td>
<td></td>
</tr>
<tr>
<td>Imports</td>
<td>US$120 bil</td>
<td>US$95 bil</td>
<td></td>
</tr>
<tr>
<td>Industrial Production Growth</td>
<td>5.4%</td>
<td>2.2%</td>
<td></td>
</tr>
<tr>
<td>Current Account Balance (% of GDP)</td>
<td>5.4%</td>
<td>9.1%</td>
<td></td>
</tr>
<tr>
<td>Interest rates (3 months) (%)</td>
<td>2.02%</td>
<td>2.0%</td>
<td></td>
</tr>
<tr>
<td>Construction Industry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>821,000</td>
<td>870,000</td>
<td>905,000</td>
</tr>
<tr>
<td>Cement consumption</td>
<td>36.5 million</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Construction Output</td>
<td>4.7%</td>
<td>6.1%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Labour Rates % increases - Skilled workers</td>
<td>$3.2</td>
<td>$4.8</td>
<td></td>
</tr>
</tbody>
</table>
This might be sound economic sense if Saudi Arabia uses the advantages of the availability of professionals while other regions are still suffering from the restrictions imposed by the continued financial difficulties. According to EC Harris’ Research (2011), steps should be taken to end the professional brain drain that occurred in 2013/2014 when many professionals left to find easier places to work within the region.

3.4 Performance of Saudi construction

Legislation concerning occupational health and safety is defined as controlling the work environment in a safe, healthy and welfare-driven way so that individuals and employees are not adversely affected by this environment. The construction industry can increase the economy of countries because of its ability to provide an infrastructure that the economy can use in other areas. Construction, therefore, shows the economic development of countries (Coble, 1999). In the Middle East, the construction industry has found many opportunities of which contractors can take advantage. The flourishing of the construction industry in the early 70’s made Saudi Arabia a perfect place for this industry. Ahcom (2004) argued that the huge demand for construction work caught the attention of a number of investors across the world, leading them to become “Construction Contractors”. Recently, local construction players have completed several projects.

Moreover, the construction industry appears to have the highest rate of accidents compared with other industries and the highest rate of disabling injuries and fatalities (Sawacha et al., 1999).

According to Bomel (2001), more than 40% of accidents in Japan happened within the construction industry; this figure was 50% in Ireland and 25% in the United Kingdom. In the developing countries, safety issues take a lower priority because of the lack of strict safety regulations. Moreover, safety rules in the developed countries do not work effectively and appropriately because of the absence of an efficient implementation of safety programs and rules from the authorities (Hinze, 1997). Although Saudi Arabia is a fast growing country in the Middle East, it has a low level of safety in construction. Different construction companies have tried to manage the high costs of accidents and decrease delays in projects because of these accidents but they do not perhaps understand why such accidents occur and do not know where to start on a safety perspective. Aksorn and Hadikusumo (2008) demonstrated that activities in the construction industry have increased quickly over the past two decades and this has motivated construction companies across the world to share
different development plans despite the high rate of employment in the construction sector, which reached 15% of the total workforce in Saudi Arabia (Alhaadir, 2011). Despite this, Saudi Arabia did not join any government agency with regard to safety in the construction industry. A recent safety study of several of Saudi Arabia’s construction projects showed that 25% of contractors provided no safety orientation for their workers, 25% did not provide personal protective equipment, 25% did not put first-aid advice on the web, and 38% did no training in personal safety. This shows clearly, therefore, that construction contractors in Saudi Arabia do not have an appropriate concept of safety (Berger, 2008). Although several Saudi Arabian construction companies have tried to manage the high costs of accidents and to decrease any delays in their projects because of accidents, they appear to lack a fuller appreciation of the reasons behind ineffective working and how to start tackling safety issues. The situation of a know-how gap informed the present study which is seeking to find a conceptual framework to enhance the performance of health and safety in construction sites in Saudi Arabia. This framework is intended to be used to implement successful construction safety programmes and to develop an effective safety policy for the construction industry in Saudi Arabia.

### 3.5 Work injury statistics in Saudi Arabia

The law applied by the General Organization for Social Insurance (GOSI), which is called the Social Insurance Law, states that a manager has to pay 2% of the payments associated with an injured worker. These payments must be recorded in the Occupational Hazards Branch (OHB) of the Social Insurance Scheme. Therefore, GOSI is in charge of covering the costs of shareholders’ treatment under the scheme and compensating them according to the approved schedules of occupational inability. In the case of an establishment’s inability to fulfil the needs of the health and safety industry, even after visits by inspectors, GOSI may increase the speed of the contributions made under OHB and then send out a final warning letter to the establishment. Many tasks have been undertaken by GOSI such as: compensating and handling work injuries under OHB; participating in the preparation of occupational health and safety regulations and laws in the KSA; developing and modernising plans for occupational diseases according to the related international enactments and rules; ensuring that establishments comply with occupational health and safety requirements by systematic site visits; building up a safety culture and concentrating on decreasing the numbers of occupational injuries; making an annual statistical report concerning occupational injuries in the Kingdom of Saudi Arabia; producing publications and handbooks in order to
improve the response to occupational dangers; training and attracting engineering and medical staff in order to improve occupational health and safety; and conducting specific field studies on the impacts of specific modern and chemical equipment. The number of work injuries in attributable to different economic activities provides explanations of the fatality rates for some industries. For example, in 2009, the main reason for the work injuries was linked to the lack of commitment of contractors to observe safety regulations. This ties in with the finding of Tam (2008) who suggested that the performance of contractors who had poorer levels of safety management was often justified by the simple argument that there was a shortage in the provision of personal protective tools. As well as the inadequacy of protective tools, there was also a lack of regular safety training and meetings.

Overview of work injury statistics in the KSA according to GOSI as at the end of 2009.

- Number of contributors in the Occupational Hazards Branch (3,900,234).
- Number of establishments registered with GOSI (192,685).
- Total number of injuries (93,285). A number of (3,675) cases of that total ended with disability, and (646) cases ended with death.

Table 3.2 below shows the number of work injuries by economic activity.

**Table 3.2: Number of work injuries distributed by economic activity GOSI (2009)**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post and Communications</td>
<td>2014</td>
<td>2.2</td>
</tr>
<tr>
<td>Trade</td>
<td>20766</td>
<td>22.3</td>
</tr>
<tr>
<td>Construction</td>
<td>44430</td>
<td>47.6</td>
</tr>
<tr>
<td>Mining and Quarry</td>
<td>1410</td>
<td>1.5</td>
</tr>
<tr>
<td>Social Services</td>
<td>2960</td>
<td>3.2</td>
</tr>
<tr>
<td>Agriculture and Fishing</td>
<td>848</td>
<td>0.9</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>17741</td>
<td>19</td>
</tr>
<tr>
<td>Electricity and Water</td>
<td>1454</td>
<td>1.6</td>
</tr>
<tr>
<td>Finance and Real Estate</td>
<td>1662</td>
<td>1.8</td>
</tr>
</tbody>
</table>
3.6 Occupational Safety and Health Act (OSHA) of Saudi Arabia

In Saudi Arabia there is no National Centre for Healthy Working People which carries a database of information and can advise employers and workers about workplace health and safety matters such as HSE in the UK and OSHA in the USA. However, Saudi Arabia is developing enormously within the economic and industrial sectors; this is a direct result of the introduction and use of contemporary machinery as well as modern equipment and chemicals. This has led to an increase in workers and factories but has also led to an increase in occupational injuries and diseases which can impact the overall development of the economic and industrial sectors. As a result, better health and safety in the workplace in Saudi Arabia has been recognised as vital so that development within the country can continue steadily. The Kingdom of Saudi Arabia has introduced laws to ensure that employees are protected at worksites and that regulations have been put in place so that employees are compensated and protected from any risk where possible whilst at work. Furthermore, the Saudi government has enlisted the assistance of several governmental bodies to protect and compensate workers. These governmental organisations are:

- The Ministry of Labour.
- The Ministry of Health.
- The High Commission for Industrial Security.
- The Royal Commission for Jubail and Yanbu.
- The General Directorate of Civil Defence.

Table 3.3 below shows the comparative analysis of Occupational Safety and Health of Saudi Arabia and HSE in the UK and OSHA in the USA.
Table 3.3: comparative analysis of Occupational Safety and Health of KSA and HSE and OSHA

<table>
<thead>
<tr>
<th>Country</th>
<th>KSA</th>
<th>UK</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Provision</strong></td>
<td>• Public Sector Policy</td>
<td>• CDM</td>
<td>• OSHA</td>
</tr>
</tbody>
</table>
| **Body** | • General Organization for Social Insurance (GOSI).  
• Ministry of Labour.  
• Ministry of Health.  
• High Commission for Industrial Security.  
• Royal Commission for Jubail and Yanbu.  
• General Directorate of Civil Defence. | • HSE | • NASI |
| **Purpose** | Laws to ensure that employees are protected at worksites and that regulation have been put in place so that employees are compensated and protected from any risk where possible whilst at work. | Avoid, minimise and combat health and safety risks suffered by workers or others engaged in all types of construction work or those affected by their work. | The OSHA enacted laws to protect elements of basic production, including the labor force. It also Avoid, minimise and combat health and safety risks. |

The role played by each of the organisations is outlined in the sub-sections below to demonstrate how they could influence safety improvement in Saudi Arabia.

**3.6.1 Ministry of Labour**

The Ministry of Labour uses inspectors to examine worksites so that all health and safety needs are met. The inspectors carry out the following:

Visit industrial organisations regularly to check the work environment.
Make sure that workers have a medical file that contains the results of initial and continuous medical examinations.

Raise awareness of occupational health and safety issues by visiting worksites regularly, handing out leaflets and publications on occupational safety and turning up to establishments without prior notice to make sure that requirements are met at all times.

Ensure that employers provide medical cover for workers, as well as personal protection, so that occupational accidents are minimized.

Communicate efficiently with authorities in preparing rules and regulations on occupational health and safety.

### 3.6.2 General Organization for Social Insurance (GOSI)

GOSI has the following responsibilities:

- Treating and compensating workers for work injuries covered under the Occupational Hazards Branch (OHB).
- Participating in drafting rules and regulations on occupational health and safety.
- Developing and revising schedules of occupational diseases related to appropriate international laws.
- Ensuring all establishments meet the terms of occupational health and safety needs by paying consistent visits to the sites.
- Encouraging health and safety well-being and recognising how important safety requirements by industrial establishments are via the mass media, as well as holding conferences, seminars and events.
- Developing leaflets and periodic publications to highlight the importance of occupational risks.
- Training expert medical and engineering teams to boost occupational health and safety.
- Conducting research regarding the effects of various chemicals and contemporary equipment.
- Creating necessary environmental measures to provide a safe working environment.
- Applying the Occupational Health Regulations and Occupational Disability Degrees instituted by GOSI.
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The Social Insurance Law initiated by GOSI specifies that employers must pay 2% of the employee’s salary as part of the OHB registration for the Social Insurance Scheme. In addition, GOSI therefore covers treatment costs for those injured under this scheme and hands out compensation according to its guidelines. However, if employers do not adhere to their health and safety obligations, even after inspectors have visited them, GOSI has the right to increase the rate of contribution under the OHB as well as send a formal final warning to employers. It is important to note that an increase in the rate of contribution is not applied if GOSI inspectors confirm that employers have indeed met occupational health and safety needs.

3.6.3 Ministry of Health

Health facilities associated with the Ministry of Health have put into practice health and safety programmes such as the treatment of medical waste, radiation protection and infection control. The Ministry of Health has joined forces with the Ministry of Labour and GOSI in implementing further programmes related to occupational health and safety as well as occupational medicine. In addition, the following have also been incorporated:

Preparing laws on occupational health and safety offering primary health care and first-aid for accidents at work via health care centres on industrial sites.

Being a part of committees which focus on occupational disability percentages, as well as establishing work injuries.

Submitting numerous proposals to develop programmes already in place regarding occupational health and safety. These must be handed to the Health Insurance Council (i.e. those regarding the periodic medical examinations for employees in different professions which relate to insurance policy), and the Ministry of Labour (regarding the preparation of a general framework for occupational health and safety).

Involving experts from the World Health Organization to implement occupational health and safety programmes where visits are made to all industries concerned to provide stages for developing health and safety programmes. If any health facility worker suffers an occupational disease, they must be treated according to the Civil Service Law and Schedule of Diseases.

The Saudi government has for many years been of the view that occupational health should be synchronized and delivered by the government in the same way as any other safety- and
health-related issue. Recently, there has been a shift in the Kingdom of Saudi Arabia to take a far more holistic approach to workplace safety and health, focusing on wider well-being with health programmes shifting towards the adoption of best practices for Saudi people. In his article, Ibrahim (2007) noted that the Saudi occupational health systems have developed over the last decades, by focusing on health interventions to ensure that workers have suitable work-related health support, and helping them to adapt to the psychological and physical demands which workplaces put on them, especially as they get older.

Occupational health and safety in Saudi has never been mainstreamed into the wider health agenda, maintaining instead the responsibility for occupational health and safety with the factories and employers. This situation continues to this day although the Saudi Ministry of Health is attempting to implement occupational health services for all employees, with some exceptions for some private sector employers. At the same time, other workers have taken advantage of the growing number of private sector companies, taking the decision to outsource the issues of workplace health and safety on the grounds of cost.

All individuals or agencies involved in this matter have to consider how to contribute to the debate on workplace health and safety, ensuring the issue of occupational health does not become confused in the wider health improvement agenda in Saudi Arabia while, at the same time, recognising the importance of improving Saudi’s general health and the impact that both could have on the Saudi economy at large.

The Saudi Ministry of Health also keeps working with a broad range of stakeholders to promote and improve workplace health and safety for the working population. However, although these initiatives are welcome in the Kingdom, others believe that this is still a long way from the comprehensive occupational health service that should be delivered to the working Saudi population. Given the wider ongoing attentions to health and safety, it is a suitable time to examine health provision and to consider how the Ministry of Labour and the Ministry of Commerce and Industry can be involved in shaping work-related health and safety in the future, as well as examining current occupational health resources and services and considering how these can be developed.

There are some principles that the Saudi Ministry of Health could consider with regard to the comprehensive occupational health and safety system it is planning to implement and develop in the future:

- Managing and avoiding all health risks in the workplace
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- Creating high-quality health for workers
- Diminishing the effect of unhealthy practice in all workplaces
- Offering assistance to workers who may have work-related injuries or illnesses
- Making it possible for workers to return to the workplace after a work-related illness or injury

Everly (1986) pointed out that the responsibility for the implementation of safety in the workplace is the employer’s. Roughton (2010) shared this opinion with the idea that it is the employer’s main responsibility and obligation to prevent all workplace accidents and incidents. Therefore, employers have a legal responsibility to protect the safety and the health of their employees, as mentioned in the article “Hazardous Work” (2012). Unfortunately, many Saudi employers are ignoring, either unintentionally or otherwise, their legal and ethical obligations toward their employees.

There are some essential components that can be utilized when assessing occupational health and workplace safety and its effectiveness, as highlighted in the Health and Safety Executive (2009) Guide to Safety and Health Regulations. These components are:

- First, hazard identification
- Second, risk management
- Third, provision of information

The Saudi Ministry of Health recognizes the link between good health and productivity, and the role that comprehensive and accessible occupational health and safety policies can play in ensuring the safety of individuals in the workplace. It is imperative that all Saudi companies and businesses are ready to implement all the international occupational health and safety guidelines in order to give self-confidence and assurance to workers while protecting the right of employers to regulate work-related policies.

Royal Decree No. M/21, dated 6 Ramadan 1389 (1969), clearly pointed out that the Ministry of Labour and the Ministry of Commerce and Industry in Saudi Arabia are equally obligated to reduce, to the minimum level possible, the number of skilled workers who lose their jobs every year due to workplace injuries. In line with the Royal Decree, the Ministry of Labour has requested Saudi employers to develop and maintain positive workplace health and safety practices in order to maintain their trained and experienced workers. Therefore, Saudi
companies should consult occupational health and safety experts and explore advice on making reasonable adjustments or adopting suitable alternative measures to ensure the safety of their employees while recognizing the cost effectiveness of implementing proper high-quality policies that are designed in a fair and constructive manner.

3.7 Saudi Arabia and the nationality of the workforce

Labour immigration in the KSA dates back to the 1930s when oil exploration stimulated the inflow of both labourers and foreign experts from neighbouring poorer Arab countries and Western nations. At that time, foreign workers shared the labour market with unskilled nationals and this caused several strikes in the oil fields during the 1950s. After 1973, the first oil boom led to economic diversification and a great deal of building to improve the nation’s infrastructure which, in turn, led to the large influx of many skilled and semi-skilled workers into the KSA many of whom were hired on short-term contracts and had no political or social rights; in addition, some Saudi citizens obtained revenue from the trade in labour visas. Hence, labour recruitment became disconnected from the needs of the market; clandestine pools of migrants developed, many of whom were unaccounted for by establishments; and many more were exploited for needs of short-term businesses.

From December 2011, in response to a previous spurt in the recruitment of foreign labour in the middle of 2000s, a Saudi government policy was introduced to decrease the number of foreign workers and replace these with Saudi nationals in order to limit the existence of irregular residents. However, as of 2013, expatriates, mostly coming from South Asia, counted for around 32% of Saudi Arabia’s population (about 9,723,214 people from the total population of 29,994,272 citizens); this was about 89% of the workforce in the private sector as illustrated in Figure 3.2.
A campaign was initiated in April 2013 which permitted 4,700,000 foreign workers to stay in the Kingdom while an ongoing crackdown on illegal immigrants forced 1 million to leave the KSA in 2013 and a further 547,000 were also deported. The Saudi government also attempted to manage the passage of migrants from Yemen by building an iron fence about 1,800 km in length along the border between the nations.

In 2013, around 26.5% of foreign labourers were employed in the construction industry, 22.3% in the wholesale and retail fields, and 15% in the private households’ field, while 2.6% and 3.6% were employed in the education and health sectors respectively. Moreover, non-nationals constituted about 52% of specialists and managers. The construction sector had a relatively high growth rate and had increased its contribution to Saudi’s gross domestic product, making it one of the most vital productive sectors driving development, especially in the expansion of the Kingdom’s infrastructure. As a result, urban development and other areas of the civil construction sector grew at an annual average of 38.7% during the First Five-year Plan, and then rose to 50% during the Second Development Plan.

The Saudi authorities do not formally publish data regarding the breakdown of the nationalities of foreign residents. However, in 2012, the World Bank evaluated the following nations as earning most from Saudi Arabia. They were: Pakistan and Egypt ($5.7 billion), India ($8.4 billion) and ($3 billion). Thus, it is probable that the majority of foreign labour come from these countries. According to estimates published in the press in 2013, Indian
nationals made up about 2,080,000 million. Table 3.4 below shows estimated non-national populations in Saudi Arabia (2013).
Table 3.4: Estimated non-national populations in Saudi Arabia (2013)

<table>
<thead>
<tr>
<th>Country of citizenship</th>
<th>lower est.</th>
<th>upper est.</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>2,000,000</td>
<td>2,800,000</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>1,000,000</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Syria</td>
<td></td>
<td>1,000,000</td>
</tr>
<tr>
<td>Sudan</td>
<td>500,000</td>
<td>900,000</td>
</tr>
<tr>
<td>Yemen</td>
<td>800,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Philippines</td>
<td>670,000</td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>550,000</td>
<td></td>
</tr>
<tr>
<td>Afghanistan</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td>Nepal</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td>Palestine (holders of travel documents)</td>
<td>500,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Burma</td>
<td>250,000</td>
<td>600,000</td>
</tr>
<tr>
<td>Jordan (workers only)</td>
<td>250,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Lebanon (2009)</td>
<td></td>
<td>160,000</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>&gt;150,000</td>
<td>700,000</td>
</tr>
<tr>
<td>Somalia-Eritrea</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>

Source: Saudi Press, unless stated otherwise

The figures quoted reflect most recent rough estimates released in press conferences and interviews by Saudi government officials and sending countries’ diplomatic missions. They reflect the stocks of non-nationals before the completion of the regularisation and crackdowns campaigns targeting foreigners in irregular situation.

Compared with the authorized total of 9,700,000 in 2013, this information seems to prove there was a serious problem with regard to unlawful migration into Saudi Arabia at this time. As well as both the permitted and illegal immigrants into the Kingdom, the numbers of second and third generation staying in the country was thought to place significant pressure on the facilities and benefits offered to citizens. Furthermore, the labour joining the nation’s workforce during the period 2005 – 2011 has not been shown to result in a significant increase in skilled manpower or high-level qualifications. Actually, workers in high-skilled categories (from clerical workers to reach management positions) constitute about 12.8% of all the work permit holders during this period as depicted in Figure 3.3.
In fact, the number of work permits granted doubled between 2005 and 2011 and over the last six years, about 2.5 million jobs have been generated, to the benefit of foreign workers. This increase was sustained until 2012 as shown in Figure 3.4, when the Ministry of Labour gave permission to increase the numbers of work permits in all sub-divisions, including the government administration sector.
These patterns of labour flow seemed in conflict with the measures taken to address the problem of unemployed nationals. However, unemployment among Saudis was improved by increasing the endeavours of private sector companies in the economy, as well as the need to attract foreign investment and development once Saudi Arabia became a member of the World Trade Organisation in 2005; this gave the Kingdom a motive to ease the entry of foreign workers and investors. In addition, because of increases in oil prices, huge infrastructure projects, which increased in scope after the Arab Spring, were undertaken in the mid-2000s. Many housing projects were also needed to accommodate the large numbers of foreign labourers since Saudis nationals did not seem keen to engage in this type of work.

Figure 3.5 depicts the approvals by the Saudi Interior Ministry in granting more residency permits, these almost doubling from 411,688 in 2000 to 765,903 in 2011. While only professionals at managerial levels were allowed to apply for permanent visas for their families, highly skilled non-Saudis benefited significantly from the increases in the import of labour after 2005.
However, as mentioned previously, from 2013, the government, via the Interior Ministry and the Ministry of Labour clamped down on irregular and undocumented residents, foreigners without permits for work or residency, or those whose work differed from that described on their permit. Figure 3.6 shows the levels of such deportations over the recent past.

A reprieve later that year permitted 4.7 million foreign labourers to rectify their situation but it also lead to the expulsion of about one million more with some being deported (200,000 of these were from Yemen). New quotas of non-nationals were defined for several sectors. This left a number of illegal immigrants stranded since they had no legal personal documents; this prevented them both from leaving the country or attempting to follow correct procedures to secure their status. The scale of the problem highlighted serious issues concerning the duties countries have towards their own citizens once out of the country.

After the amnesty, the Ministry of Labour organised a large-scale operation to round up remaining illegal workers and a further 208,000 deportations were carried out after the amnesty period. However, stateless persons (Palestinians and Biduns, for example) and citizens from war-torn countries (for example, those from Burma and Syria) were spared expulsion.
Figure 3.4: Deportations of irregular residents by month (3/2011 to 11/2013)

Since the KSA is a major source of revenue for many Asian and Arab countries, these exiles may have a serious economic effect on their nations’ already fragile economies. For instance, the deportation of Yemenis might, according to IOM, result in a decrease in income payments of than two billion Dollars a year, therefore deepening levels of poverty in a country which is already unstable and economically ravaged.

It is not yet clear how this purge against illegal workers will affect the Saudi labour market in the long term. As mentioned previously, a relatively small number of Indian labourers left Saudi during the clampdown campaign compared to other nationalities. In addition, during 2013, the Saudi Arabian and Indian governments signed an agreement to streamline recruitment processes and halt the role of middlemen delaying Indian labourers on their way to Saudi Arabia.

Therefore, Saudi Arabia is likely to remain a major player in migration and its need for changing skills’ profiles is not likely to decrease the number of foreign labourers working in Saudi Arabia in the future.
3.8 Challenges facing health and safety in Saudi Arabia

According to Al-Eqtisadiah (2003), the number of registered contractors in Saudi Arabia reached 130,000, which included 25,000 participants in the business of construction. Since OSH development in the industry of construction seems to depend on the project’s scale, Baig (2001) argues that safety levels in Saudi Arabia differ according to the size of the project or the company. In addition, large organisations have better safety and health provision compared to small and medium scale organisations. Moreover, regulations on safety issues must be developed because of the absence of Saudi Arabian legislation governing OSH. Construction projects in the Middle East face a huge challenge with regard to safety, especially in the construction industry, which is related to cooperation with global parties. Mahalingam and Levitt (2007) mentioned that construction projects which have global participants face conflicts and delays because of the cultural acceptance of safety levels by different participants in projects. Current literature is still researching the costs, extent and origins of such delays, as well as trying to figure out ways to minimise or eradicate them in international projects.

3.8.1 Multi-cultural work forces

Culture is considered as a wide term that has a significant influence on both safety and health; therefore, behaviour and the attitudes of humans are closely inter-related with health and safety. According to Jannadi (1995), research on both the construction and maintenance crews of the pipeline in Dhahran and Saudi Arabia showed that the performance of safety for every single worker depended on his attitude to his employers, foreman and fellow employees. Managing a mixed work force is considered as one of the most difficult barriers that can be faced, specifically in countries such as Saudi Arabia, because jobs in the construction industry require foreign employees. In 2004, the number of migrant employees in construction work in the Kingdom reached 500,000; this led the Human Rights Watch to consider that the number of migrant employees in the construction industry might reach at least 600,000 employees, with many centred on the construction works in Dhahran.

In 2005, the numbers of employees in Saudi Arabia in the construction business reached 304,983 while the number of construction companies in Riyadh reached 5,938, with the vast majority (76 per cent) being small organisations that hired fewer than 20 employees. Human Rights Watch (2006) confirmed that no statistics are available with regard to a breakdown of these employees in terms of their country of origin, but the information available describes
the majority of migrant employees in the construction industry in Saudi Arabia as coming from Sri Lanka, Bangladesh, Pakistan and India. Both language and culture are considered as crucial factors in the management of safety and health in construction workforces. According to Morris (2002), barriers and misunderstandings stemming from language and culture give rise to inefficient communication, as well as difficulties in the workplace including issues related to safety. Ethnic variety is considered to be a new reality in workplaces in Saudi Arabia and therefore trainers, workforce educators, employers and other human resource professionals must recognize both the cultural differences and the language barriers among employees from different backgrounds. This recognition will enable health and safety practitioners to implement more efficiently the safety and health regulations among multicultural workforces on construction sites. By doing so, smoother progress will be made in construction projects without the number of accidents that often occur during the setting up of work sites. Morris (2002) demonstrated that this recognition will also increase the advancement, retention, hiring and recruitment of immigrant employees. Finally, it will create more competitive businesses because of the safety, productivity and stability of the workforce.

3.8.2 Different perceptions of safety standards

Construction industry has never been free from disputes and arguments. Safety is one of the areas which come under constant disputes especially when it comes to an international collaboration. The international contractors and the local contractors had very different mindsets when it came to dealing with safety on these projects. The local groups did not pay much attention to safety while the international players felt that safety was a very important consideration on such projects. Apart from the accidents, the international contractors were also irritated by normal day-to-day safety violations such as the failure to wear safety gear or the absence of safety harnesses. They therefore lodged frequent complaints to the local subcontractors and fought with the crews on site.

In several cases, the alterations on site were quite direct and the international contractors or the consultants stopped the work that was being performed until the safety violation was rectified (Mahalingam and Levitt, 2007). Violations of safety procedures often susceptible to penalties which leads to work stoppages. This stoppage could lead to heated arguments, delays and disputes as the parties involved will rarely admit their violations. Mahalingam and Levitt (2007), confirmed on this by stating stoppages delayed due safety violation of the
subcontractors’ progress and made them susceptible to penalties due to delayed completion of the work. The international contractors hoped that this would offer incentives to feel that such stoppages were unfair to them and rarely accepted such productivity losses without protest. They frequently argued with the international contractors and in some instances turned physical the local contractors to avoid safety violations. Some practice which is acceptable to local contractors.

Foreign contractor who are operating in Middle East might not long term projects there, since OSH development is long term process this contractor might not see the importance of investing in safety and health programs. This indirectly could become another challenge for contractors to practice or implementing safety and health. As stated by Mahalingam and Levitt (2007), educating workers in developing countries to follow safe work practices is very difficult to achieve on global projects, since changing safety behaviour is a slow process. International contractors who may not have long-term plans of working in a particular country do not have incentives to invest significant amounts of time on safety education, as their projects in developing countries are short, onetime occurrences and these contractors may not necessarily conduct future work in these locations. They may therefore not be able to reap the future benefits of their efforts.

As a result, in regions where safety infrastructure is quite poor, safety enforcement strategy is the most likely to succeed. In fact, international construction firms entering such environments on one-off projects might be advised to directly enforce coercive measures to improve safety and not to expend resources on the more difficult task of education. Proactive action by local contractors and regulators in improving safety might also serve as a competitive advantage in attracting infrastructure investment into developing regions countries.

3.8.3 Climate change

Construction is considered as one of the most dangerous and dirtiest activities; it also requires working with extreme conditions such as the weather. Although construction can take place on different sites in a moderate climate, it may still be considered uncomfortable for workers. It is worth knowing that working under the sun can create health problems as well as delays in the work. MSN Microsoft Encarta Online Encyclopaedia (2009) confirmed that, in the Middle East, the temperature can range from 24 to 45 degrees Celsius, sometimes more on specific days. According to JKKP Heat Stress Guidelines (2006), constant changes of
climate can create health problems such as heat stress and heat stroke. Employees can suffer from heat stress because of changes in the weather. Therefore, works that involve high humidity, radiant heat sources, high air temperatures, and direct physical contact with strenuous physical activities or hot objects, may cause heat stress in those who work in these jobs. Some sites may have smelters and steam tunnels, or may be mining sites, chemical plants, food canneries, commercial kitchens, laundries, confectioneries, bakeries, electrical utilities (particularly boiler rooms), rubber products factories, glass products facilities, ceramic plants, brick-firing, non-ferrous foundries, or steel and iron foundries, as the U.S Department Of Labour Occupational Safety and Health administration (2008) stated. Saudi Arabian construction sites are considered to be among the hottest places where construction takes place in the whole world and such countries have recorded many fatalities on construction sites. The Rashid Hospital Trauma Centre (2007) stated that in July 2007 it recorded 82 heat cases over the previous month and most of these were employees carrying out indoor labour. Although employees can work in a shaded environment, they still face heat stress or heat because of high temperature and/or humidity, and poor ventilation which has a significant role in managing heat problems within construction sites. Also, as stated by Muslim (2007), both of inactivity and working in the shade are conditions that may cause workers to suffer from heat-related problems.

Workers must work in balanced conditions that allow body mechanisms to cool in order to prevent illnesses related to heat. According to JKKP Heat Stress Guidelines (2006), acclimatization is a term related to a cheap and simple practice that can be implemented by local contractors in countries with a hot climate. This can be used by new employees who can then expose themselves to the hot climate at intervals or periodically.

3.8.4 Safety and health regulations

According to Wagner (2008), migrant employees consider the power house of construction in the Middle East, and especially in Saudi Arabia, as an attractive prospect. As a result, 50% of the work force is composed of migrants who have reached a total of almost 6 million. In allowing this, Saudi Arabia has violated labour laws and human rights and has been criticized by other nations as a result, as Human Rights Watch (2003) confirmed. To compare Saudi Arabia and the United Arab Emirates in terms of construction, especially in terms of safety and health regulations, it appears that UAE follows legal requirements more stringently than Saudi Arabia. Husain (2005), a project manager in the Ali A Tamani Company, confirmed
this in his report which concluded that there was an absence of safety standards within the construction industry in Saudi Arabia. Husain’s results were extracted in 2005 and 2006 and related to visits he made to a number of places in Saudi Arabia in order to carry out his research. In his study, he found that 25% of contractors did not provide employees with safety directions, 25% who did not give employees any personal protective tools, 25% who did not provide first aid kits on site, and 38% offered no personal safety train. Also, this research, conducted in 2005, compared accidents in the UK and Saudi Arabia and found that 493 employees had died and more than 100,000 employees were injured in construction sites and workplaces in Saudi Arabia. The magnitude of the Saudi safety data is best appreciated by comparing it with data from the United Kingdom which shows that 28 employees died and 3,760 employees were injured there in the same year. In addition, this research paid significant attention to the poor infrastructure of Jeddah that contained crumbling sidewalks, dilapidated pedestrian bridges, and exposed electrical wiring (Al Omani, 2006). Foreign contractors who work in Saudi Arabia, especially in the construction industry, find it extremely difficult to apply their own safety standards among companies, joint venture partners, or local sub-contractors because of the absence of appropriate tools, especially in the safety and health section.

3.9 Centre for healthy working people

In Saudi Arabia there should be National Centre for Healthy Working People which carries a database of information and can advise employers and workers about workplace health and safety matters. The Centre also might provide access to a database of occupational health specialists, counselling and complementary therapies.

However, while it is the duty of the employer to provide employees with “such health services as is appropriate”, the Saudi Ministry of Health and Labour, the Ministry of Commerce and Industry, workforce stakeholders and the labour market should work towards establishing a Foundation of Occupational Health and Safety. This institution could collaborate with other international organisations, HSE in the UK and OSHA in the USA, as well as other partners and clients to achieve the following goals:

- Manage workplace hazards as a part of national practices and corporate risk management.
- Create innovative, invigorated and healthy work communities.
- Educate Saudi workers with the knowledge of occupational health and safety.
• Provide database information to promote national occupational safety and health.

• Develop workplace training, consultation and workplace safety methods and tools that are safe and easy to use.

• Control occupational chemical hazards while exploiting new opportunities.

To achieve these goals, there should be:

A wider-based campaign to focus on the issues of workplace health and safety and raise awareness of all hazardous conditions, as well as making people aware of the cost to the Saudi economy and society of health-related problems in the workplace.

A research group in the Saudi universities to develop future workplace safety and preventative strategies.

The Saudi Ministry of Health and Labour should engage with other academics and related groups to identify the possible health and safety risks posed by new technologies, such as exposure to non-material; adequate health screening procedures should then be implemented.

3.10 What works for Saudi Arabia?

There is no replacement for the capacity and engagement of Saudi stakeholders in developing comprehensive, occupational workplace health and safety. Saudi stakeholders should embark on introducing a number of new and more modern regulations to develop a national occupational health service, involving investors, employers, the government and health services.

Jannadi and Al-Sudairi (1995) in their research stated that the duty of providing health and safety on any construction places should be shared between the owner, the architect and the contractor. Therefore, Saudi stakeholders should focus on changing the work environment, identifying the potential for rapid change in the industrial map of the country caused by the introduction of nanotechnologies and the move towards new industries. Most importantly, they must recognise the importance of the repercussions in the work environment caused by rapid and permanent industrial change.

3.11 Summary

This chapter has discussed the national context of the Kingdom of Saudi Arabia (KSA) and some cases with regard to construction which have pinpointed the need for improvements in the Kingdom’s occupational health and safety performance. It was established that the
construction industry in Saudi Arabia has a high level of fatal and non-fatal accidents which create a need for improving its safety performance. There are important gaps in the coverage of workplace safety, and in the training and services that are accessible to Saudi workers. This indicates a need for a safety code in Saudi Arabia to monitor health and safety requirements in the workplace. According to the statistics concerning work injuries in Saudi Arabia, the main causative factors of accidents were found to stem from the worker themselves and from the working teams involved in the accidents. Targeting the behaviour of individuals as a way of addressing latent failures in performance means that the root causes of unsafe acts get overlooked and that crews are unfairly blamed for accidents and incidents. It is worth mentioning that this thesis examines the psychological issues that might affect the safety performance levels within construction sites by focusing on the contribution construction workers make to safety performance by exploring their safety behaviour. Understanding the safety behaviour of construction workers should provide opportunities for improvements beyond traditional practices in safety management. This aspect is focused on in the next chapter.
CHAPTER 4
RELATIONSHIP BETWEEN WORKER PERSONALITY AND SAFETY PERFORMANCE

4.1 Overview
This chapter focuses on the contribution that construction workers make to safety performance by exploring their safety behaviour. This is achieved by examining the relationship between the personality attributes of construction workers and the incident rate. The rationale for exploring such a connection is to establish opportunities for identifying factors that might affect the safety performance level within construction. This chapter also provides the theoretical foundation on which the empirical and practical study will be based.

4.2 Background
From a safety and health perspective, the global construction industry still suffers unacceptable levels of accidents and reportable incidents which contribute to its negative image of a dangerous work environment (Ferjencik, 2011). In the UK, it has been argued by the Health and Safety Executive (HSE) that construction has a relatively high level of fatal and non-fatal accidents which needs improving to bring its safety performance in line with other progressive industries (HSE, 2006). However, many construction organisations recognise the huge challenge involved in maintaining a health and safety regime for construction activities (HSE, 2006). Notwithstanding the efforts to reduce construction accidents, injuries and fatalities, the level of these adverse events remains unacceptably high in many countries (Smallwood and Haupt, 2005). The problem of improving safety performance would appear to lie outside the current efforts of safety management deployed by construction organisations. This calls for a radical alternative to the current approaches for managing safety. Such a radical look would not only cover the planning, implementation and management of safety in construction, but also pay attention to aspects beyond the traditional practices of safety management for improving performance. Preventing accidents is usually made the prime responsibility of the top management in the organisation. Construction organisations have decreased the rates of accidents on sites for humanitarian reasons, as well as for financial benefits which follow from achieving safety in the workplace. In order to for the construction environment to prevent financial losses and
accidents which lead to death, all health and safety initiatives must depend on human involvement so the attitudes and behaviours of employees must be accounted as major factors in maintaining, adopting and devising strategies. The main goal of this work is to explore the attitudes and actions of employees in the light of the fact that the attitudes and behaviours of employees are considered to be the values and norms of the group in an implicit way. Thus, the behavioural issues of safety are considered to be a significant issue in this respect. Concentrating on the safety behaviours of individuals can make the desired changes which will lead to changes in attitude and thence to behavioural change. In this phase, the nature of the safety behaviours and personality traits are tested with regard to construction employees in the construction industry. Incident causation is also represented to find the relationship between them in order to improve health and safety performance in the construction industry.

4.3 Safety Behaviour

According to Cooper and Phillips (2004), safety behaviour concentrates on how people behave; it then analyses the reason they behave as they do, and then applies a research-supported intervention method to improve people’s behaviour. Safety behaviour, at its very core, is based on a larger scientific field that is known as Organizational Behaviour Analysis. Dester and Blockley (1995) defined safety behaviour as a group of social roles, attitudes, norms, and beliefs and practices that focus on increasing an individual’s exposure inside and outside the organisation to dangerous and injurious conditions. Accidents can be considered as an incubation period, while social factors, safety culture, management and behaviour can be considered as potential hazards. Every behaviour, attitude and belief of construction clients, researchers, educationalists, consultants, designers and managers appear in the behaviours, attitudes and beliefs of construction workers. Within this thesis, the researcher has argued for a focus on the safety behaviour of workers as an added dimension for improving safety performance. The notion of safety behaviour re-positions the management of safety from an organisational (corporate or project) activity to an individual worker pursuit, from where, within construction, accidents and incidents often emanate.

Reducing incidents caused by unsafe or risky behaviours is the main purpose of a behavioural safety process. In order to achieve this, specific behavioural problems are specified by focusing on incidents that have resulted from connections between people and their working environment. According to Cooper (1998), this might require and include the presence, functioning and quality of different safety and non-safety management systems, the quality of
leadership, the availability of financial and non-financial resources, and the overall safety culture. Many institutes have dedicated a great deal of time and effort to improve safety, mainly by resolving hardware problems and installing safety management systems that consist of regular (for example, monthly) line management safety audits. After a number of years these efforts tend to cause significant reductions in accident rates. However, a plateau of minor accidents that remains seems to be stubbornly resistant to all attempts to reduce it. Although many of these accidents are caused by peoples' carelessness or immature safety attitudes, most are caused by deeply ingrained unsafe behaviours. Behavioural Safety addresses these issues by taking advantage of proven management techniques which almost always result in a positive step towards changing safety performance and attitudes. It has been argued that unsafe acts or behaviours are a major causal factor in workplace accidents/injuries and that improved safety behaviour reduces the frequency of work related accidents and injuries. The literature suggests that a range of factors explains safety behaviour. Accident proneness theory, for example, suggests that certain individuals possess relatively permanent idiosyncrasies which increase their likelihood of having an accident. McKenna (1983) has challenged the accident proneness theory and argues that if such an explanation is accepted, the underlying assumption is also accepted that all employees are exposed to the same job and environmental conditions. A restrictive and far more realistic interpretation of this theory has emerged to the effect that employees are more or less prone to accidents in given situations and that this proneness is not permanent but changes over time (Porter, 1988). A number of studies have sought to categorize safety behaviours. Ray and Frey (1999) grouped safety behaviours into five categories: house-keeping, personal protective clothing, personal clothing, material handling and operations. Hofmann and Stetzer (1996) suggested six broad categories of behaviour: improper tool use, improper work strategies at risk to self, failure to wear personal protective equipment, improper storage of tools, and improper storage of tools by others, and improper work strategies with risk to others. The study which resulted in the thesis utilized a number of the Hofmann and Stetzer categories of safety behaviour to determine the variable list for conducting the data elicitation of this research study.

4.4 Behavioural Modelling and Attitudes to Change

It is quite common to find in accident reports statements such as 'Operative-A should take more care!', that is, with better attitudes and safety awareness, such accidents would not happen. Changing unsafe behaviour depends on the belief of that behaviour can be
determined by attitudes. Publicity campaigns and safety training have the potential to change the attitudes of people and thus influence their behaviour. However, in spite of having a positive attitude, there is always the risk that this does not translate into behaviour. Bearing in mind that attitude is driven by, and/or connected to, feeling (emotions), thinking (cognitive) and intention (commitment), it is important that an effort to change an attitude must target every single element of these for each employee; this is a complicated task (BBS 2012). In this thesis, the attitude of employees is identified individually by determining the personal characteristics of each employee in the organisation. This leads to dealing with personalities, as well as attempting to change them to suit the organisation’s target, reduce accidents and avoid the consequences of accidents. According to Behaviour Based Safety (BBS 2012), the link between changing behaviour and changing an attitude is strong enough so that if behaviour changes consciously it will lead to a change in attitude and belief to suit the new behaviour. This happens because individuals attempt to decrease tensions related to the differences between their behaviours and their attitudes. Thus, changing behaviour results in new systems of belief and attitudes which support the new behaviour (ISS, 2007). Thus, the foundation of safety behaviour stems, to a significant degree, from the personality of each employee.

4.5 Personality and Safety Behaviour

In this study, safety behaviour is defined as the group of factors comprising social roles, attitudes, norms and beliefs, characteristics and practices that focus on increasing an individual’s exposure, inside and outside the organisation, to dangerous and injurious conditions. Safety behaviour places a huge emphasis on people’s attitudes, beliefs and interactions with their socio-cultural environment. Such emphasis is influenced by current behavioural models which assume that individuals are the main factors that account for incidents in the workplace. This can be contrasted with the perspective of situational models that adopt the view of the connection between the environment, individuals and conditions of the operation being performed as the key sources of incidents. It is very difficult to punish individuals who violate safety rules (like not using a hard hat) in a constant way without solving the problems: although it is uncomfortable to use a hard hat, for example, it makes the job safer). Trying to look behind the implementation of safety rules is better than punishing the violators; moreover, offering supportive solutions is better than inflicting punishment. Therefore, there must be a deep understanding of the employee’s character so that it can be changed and supported. Personality is defined as a distinct organisation of
behaviours, feelings and thoughts that differ in every person; this then determines the interactions of every person with the environment. The environment consists of human and non-human aspects, such as the physical environment, work conditions and organisational demands. Gatewood and Field (2001) defined a trait as a constant dimension where differences in people can be assessed by the degree of the characteristics that the individual exhibits.

From the points outlined previously, it appears that there is a connection between an individual’s characteristics and safety performance which leads to the fundamental need to study this relationship as well as introducing it into the field of construction in the future.

4.6 Safety Behaviour in Construction
Dester and Blockley (1995) demonstrated that the beliefs, attitudes and behaviours of construction managers, designers, consultants, educationalists, researchers and clients are shown in the beliefs, attitudes and behaviours of construction employees. According to HSE (2010), it appears from the literature review that both behavioural safety and the notion of safety culture in the constructional field have grown in the past 10 years. Thus, it is a fact that accidents are generated from unsafe behaviour since many organisations have demonstrated that 75 to 90 per cent of accidents have been generated from this. It appears from both the behavioural safety programme and the work of operatives, which identified unsafe behaviours, that individuals can notice unsafe behaviour and offer feedback to the workforce. The behaviours change programme was generated to confront and change the perceptions of individuals towards their way of thinking and working. Also, these programmes work with both the management and the workforce to discover the causes of accidents and so such programmes can find indicators, such as habits, attitudes, perceptions of risk, lack of sleep and fatigue, which cause accidents. According to Construction News (2009), there must be a concentration on both safety and health strategies in order to enhance performance. From here comes the idea of working to enhance safety performance by gaining a deep understanding of employees’ characteristics and how to deal with them.

4.7 Individual Worker’s Influence on Safety
Given the large economic and social costs of work-related accidents and injuries it is not surprising that organisations strive to reduce them (Barling and Frone, 2004). Some researchers have suggested that 90% of accidents can be attributed to human error (McKenna, 1983) while the study of the relationship between individual differences and
accidents and injuries has received less attention. Rather, most safety researchers have focused on organisational influences to further reduce the costs of occupational accidents and injuries (Shannon, Mayr, and Haines, 1997). Landy and Conte (2004) described the personal approach to reducing accidents and injuries which involves finding individual differences related to accidents and injuries and using that information when making decisions about hiring and job placement. Hansen (1988) discusses a number of individual difference variables that could be related to accidents and injuries. These include the physical characteristics of workers, their education, marital status, perceptual and mental abilities, and personality traits. In their model of factors that contribute to workplace accidents, Sanders and McCormick (1993) suggest that a variety of worker characteristics mediate the effects of organisational factors, the physical environment, equipment design, the design of work, and the social-psychological environment on unsafe behaviour and accidents. Sanders and McCormick (1993) provide a list of worker characteristics that includes ability level, personality, motivation, off-the-job pressures, and distractions. Other authors, such as George (1992), suggest that individual differences such as personality traits are dominant factors that moderate the effects of a situation on individual states and behaviours.

4.8 Worker Personality Traits

In psychology, personality refers to the essential characteristics of a person and reflects such features as social class and status, education, vocation, religious and philosophical background (Allport, 1937; Borgatta, 1964). The emergence of the concept of a safety culture, defined as “the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the organisation's safety performance” has prompted researchers to pay more attention to human factors, including personality traits (Cooper, 2003). Current research in safety performance within the construction industry has failed to reflect the growing interest that surrounds the role of personality in organisational behaviour and performance that is generally observable in other sectors (Al-Shehri et al., 2012). While there is a body of empirical work exploring the links between personality traits and accidents/incidents, the studies do not address the construction context. A review of the existing literature on the connection between personality and safety performance in construction indicates evidence that can be construed as contradictory and rather unclear (Al-Shehri et al., 2012). There is a body of empirical work exploring the links between personality traits and accident/incident involvement. However, reviews of the existing literature have highlighted the empirical evidence as contradictory and confusing.
One of the difficulties with previously conducted personality studies is that they have lacked a coherent taxonomy, resulting in a wide variety of personality traits being measured, and utilising a mixture of different types of methodology. One means of clarifying the existing literature would be to re-categorise these data by applying a clear theoretical framework to describe personality traits. The emergence of the Big Five Personality Model by McCrae and Costa (1990) has been widely accepted as a valid and reasonably generalisable taxonomy for personality structure (Digman, 1990; Goldberg, 1992). The model has been used by numerous researchers as a framework to explore the criterion-related validity of personality in relation to job performance (Barrick and Mount, 1991). The re-categorisation of the personality traits measured by empirical studies into the Big Five of extraversion (or surgency), agreeableness, conscientiousness, emotional stability (or low neuroticism), and openness to experience (or intellect/imagination) allows an overview of the relationship between fundamental dimensions of personality and accident/incident involvement. Each of these fundamental dimensions is addressed in more detail in the subsequent sub-sections.

4.8.1 Neuroticism
Neuroticism reflects a personality that is characterized by anxiety, hostility, depression, self-consciousness and impulsiveness. According to Eysenck (1971), individuals with high levels of neuroticism tend to be more accident-prone or display more safety incident-related behaviours. Hansen (1989) suggests that the increased accident/incident predisposition of neurotics is due to the ease with which they get distracted by external activities. In addition, neurotics tend to be preoccupied with their own anxieties and worries and therefore often lack the ability to focus on the task at hand.

4.8.2 Extraversion
Extraversion reflects a personality that is talkative, extrovert with people, strong, enthusiastic, social, brave, bold, enterprising, energetic, annoying, dominant, boasting and active. Several empirical studies have supported a positive relationship between extraversion and accident/incident involvement. For example, in their investigation of mill workers, Powell et al. (1971) established that the number of accidents or recorded incidents experienced by employees was significantly higher for extraverts.
**4.8.3 Conscientiousness**
Conscientiousness reflects a personality that is organized, well-versed, trusted, tolerant responsible, accurate, hard-working, blueprint, influential, reliable, practical and careful. The definition of conscientiousness reflects a number of different characteristics, including competence, order, dutifulness, achievement, striving, self-discipline and deliberateness. There is evidence that personalities with low scores on conscientiousness are significantly associated with accidents or display behaviours consistent with incident causation. The current evidence suggests a role for conscientiousness in safety performance, with empirical studies supporting significant negative correlations between conscientiousness and the degree of propensity to accident and incident (Arthur and Graziano, 1996; Cellar et al., 2001).

**4.8.4 Agreeableness**
Agreeableness reflects a personality that can be described as sympathetic, soft, reliable, useful, tolerant and friendly. People who are high on agreeableness are pleasant, tolerant, tactful, helpful, not defensive and generally easy to get along with (Hough, 1992). There is empirical evidence to support a negative relationship between agreeableness and accident/incident involvement (Cellar et al., 2001) although other studies have denied this relationship (Arthur and Graziano, 1996).

**4.8.5 Openness**
Openness reflects a personality that has diverse interests, is intelligent, innovative and logical, and with the ability to bind things. Openness is one of the least studied of the Big Five personality dimensions in terms of job performance. Likewise, there are fewer studies that focus on openness and accident/incident involvement compared with the other personality dimensions. Arthur and Graziano (1996) found little evidence of a relationship between openness and self-reported traffic accident/incidents.

The dominant category in an assessment defines the personality archetype of the worker. In general, no individual worker reflects only a single trait. Workers combine varying degrees of the various categories that make them dominant in a particular personality type. Individual personality types influence safety behaviour and hence the safety performance of the worker.

**4.9 Safety Behaviour and Safety Performance**
Organisations typically see safety behaviour as employee compliance with safety routines. Safety compliance comprises safety activities that are part of formal work procedures such as
using personal protection equipment correctly; properly using lock-out, tag-out and try-out procedures; applying appropriate work practices to reduce exposure to potential hazards and injury; and generally following safety policies and procedures. Consistent with recent theoretical models of safety performance in the likes of Burke et al. (2002), Griffin and Neal (2000), and Hofman et al. (2003), safety behaviour is commonly dichotomized into two key components: safety compliance and proactive safety participation. Proactive safety behaviour involves helping to teach safety procedures to new crew members, assisting others to make sure they perform their work safely, and making safety-related recommendations. Often, proactive safety behaviours are seen by supervisors and workers as practices that extend beyond their normal role requirements, reflecting a more discretionary individual behaviour not explicitly recognised by job descriptions or formal reward systems and therefore, often idiosyncratic, unconventional and challenging (Grant et al., 2009). Proactive safety behaviours are becoming more important in modern workplaces due to their potential benefits. Grant and Ashford (2008) suggest that proactive safety behaviours have been studied less extensively than compliance behaviours, and few studies have focused simultaneously on both. Griffin and Neal studied the relationships of safety motivation with safety compliance and safety participation. They considered safety compliance (for example, wearing personal protective equipment) as core safety behaviours required to perform the job and ensure workplace safety, whilst safety participation was deemed by them to be behaviours beyond those required by the job that promoted an environment of safety (for example, attending safety meetings). Marchand et al. (1988) similarly explored safety behaviours in terms of required compliance to rules and more discretionary initiative behaviours. In addition to Griffin and Neal’s work, Burke et al. (2002) and Hofmann et al. (1996) have investigated task and contextual safety behaviours respectively.

Burke et al. (2002) elaborated task safety performance as core safety behaviours central to health and safety. These behaviours are performed in almost all jobs and consist of using protective equipment, engaging in work practices to reduce risk, communicating health and safety information, and exercising employee rights and responsibilities. Following the conceptualisation of citizenship behaviour, Hofmann et al. (1996) described safety citizenship behaviours as volunteering for safety committees, raising safety concerns during planning sessions, protecting fellow crew members from safety hazards, reporting crew members who violate safety procedures, attending optional safety meetings, or trying to
improve safety procedures. These behaviours, which represent contextual performance in the safety realm, are generally performed with greater latitude.

4.10 Models of Safety Performance
A number of outcome measures have been utilised to evaluate the effects of the safety climate on safety performance. These include: unsafe behaviours (Hofmann and Stetzer, 1996); involvement in safety activities (Cheyne et al., 1998); “micro-accidents” or minor injuries (Zohar, 2000) and observations of safe behaviour (Cooper and Phillips, 2004; Glendon and Litherland, 2001). Marchand et al. (1988) argued that a uni-dimensional model of safety performance, which focused on workers’ compliance to safety rules and procedures, was inappropriate. They proposed an expanded model that included workers' safety initiatives. Neal and Griffin (1997), Griffin and Neal (2000) and Neal et al. (2000) also developed a two-dimensional model distinguishing between task and contextual performance. This comprises: (a) safety compliance, defined as: “adhering to safety procedures and carrying out work in a safe manner” and (b) safety participation, defined as: “helping co-workers, promoting the safety program within the workplace, demonstrating initiative, and putting effort into improving safety in the workplace”. Although safety compliance involves engaging in behaviours that would be viewed as part of an employee’s work role, safety participation involves a greater voluntary element, including behaviours beyond the employee’s formal role, that can be considered as an extra role or organisational citizenship behaviours. Within social exchange theory, such behaviours are promoted through the norm of reciprocity (Gouldner, 1960) where employees feel obligated to return favours in the light of positive treatment from others (Blau, 1964). In the safety context, when managers and supervisors demonstrate their commitment toward safety and show concern for employees’ well-being, employees are more willing to reciprocate by broadening their role definitions to include safety-related OCBs (Hofmann et al., 2003).

4.11 Personality Links to Safety Performance
Preventing accidents often refers to placing responsibility on the organisation and top management. Construction organisations have decreased the accident rates on sites for humanitarian reasons as well as for financial benefits. In this study, unsafe acts or behaviours are argued to be a major causal factor in workplace accidents and injuries, and that improved safety behaviour could reduce the frequency of accidents and injuries. The literature suggests that a range of factors explain safety behaviour. The Accident-Proneness theory, for example, suggests that certain individuals possess relatively permanent irregularities which
increase their chances of having an accident (Cooper, 2003; Cooper and Philips, 2004). McKenna (1983) challenged the Accident-Proneness theory and suggested that such an explanation, assumes an underlying notion that all employees are exposed to the same work and environmental conditions. A more realistic interpretation of the proneness theory suggests that employees are more or less prone to accidents in given situations and that such proneness is not permanent but changes over time (Porter, 1988). It would therefore, appear that safety performance of the worker can be associated with the work environment, and personality traits that moderate the extent to which a worker can attain safety as shown in Figure 4.6.
Figure 4.6: Concept of relationships between the variables of the study
4.12 Summary

The chapter has established that the effort of safety management needs to shift from managing and monitoring accidents to managing and monitoring incidents to ensure a safe working environment in construction; such a safe working environment can be achieved by focusing attention on incidents as a means of avoiding accidents. Also, some very important findings were provided about individuals who can be said to be the main factor in the cause of incidents while the situational models provide a link between individuals, the environment and conditions about the procedure of incidents. The review has yielded information that suggests a strong link between changing behaviour and changing attitudes. This means that if individuals can modify their attitudes to match new aspirations and behaviours by changing their current safety behaviours, then the improved safety performance could be attained to reduce the frequency of work-related accidents and injuries. It also means that understanding an individual’s personality and attitudes could open up opportunities for improving safety performance. Such opportunities imply an understanding of accident and incident theories, and how such an understanding can lead to safety improvements at the individual worker level. The next chapter discusses these theories and how safety standards might be improved, and provides a connection to how individual personalities and attitudes fit within the theories and models on accident causation.
5.1 Overview
This chapter explores ways of improving safety standards for construction sites in the KSA by reviewing different accident causation theories as well as models that offer explanations of why accidents or unpleasant incidents happen. Accidents and incident theories, and the relationship between them are explored and discussed in an attempt to demonstrate the causes of accidents to provide an avenue for examining options to improve safety performance in KSA.

The chapter has been developed on the premise that a majority of accidents happen when employees disregard safety rules (that is take actions that result in hazards; moreover, management may ignore the existence of such acts and hazardous situations). In addition, the chapter draws on the notion that both the physical and mental situation of a person, ecological forces, as well as supervisory safety performance, are indirect causes of accidents.

5.2 Definitions: Accident and Incident
Construction is often considered as having very unsafe operations compared with those in other industries. Working conditions can change on a daily basis and often these present challenges to the workforce. In addition, construction activities on site are considered as inherently dangerous, as well as involving high levels of risk (Hinze and Olbina, 2008). In many national industries across the globe, construction often records high accident rates. Hinze (2005), for instance, argued that the only other industry in the world which has a worse accident record compared to construction is the mining industry. Within the construction industry, policy makers are aware of the unenviable and unfortunate reputation related to its high level of accidents and deaths, and there is no shortage of initiatives to improve the situation (Huang and Hinze, 2006). However, establishments such as the UK Health and Safety Executive clearly recognise the huge challenges involved in maintaining a health and safety regime for most construction activities (HSE, 2006). Notwithstanding the efforts to reduce construction accidents, injuries and fatalities, the level of these adverse events remains relatively high (Ferjencik, 2011; Smallwood and Haupt, 2005). The concept of an accident has been defined by the Health and Safety Executive in the UK as an unwanted or undesired situation which leads to injury or ill health (HSE, 2006). It further provides that an incident,
which is the focus of the research that underpins this thesis, is an unwanted or undesired situation, event or episode, which can potentially lead to an accident. The close relationship between the two concepts can be represented as a finely balanced system, as shown in Figure 5.1. Untreated incident situations often tip the balance towards more accidents. A proactive treatment of incident causal factors prevents such a tip.

![Figure 5.1: Accidents and incidents](image)

There is wide agreement on the effect that incident mitigation has on construction safety performance. Notwithstanding such awareness, relatively limited research attention has been given to creating preventive solutions that take advantage of incidents as a mechanism for improving safety in the industry. Within this thesis, the author focuses on the need to shift safety management from managing and monitoring accidents to managing and monitoring incidents. This calls for a greater understanding of incident causation in the industry. The thesis presents a review of relevant incident-related studies and proposes a new concept for more proactive incident mitigation in construction.

5.3 Construction Accident Causation Theories

In their article on major theories, Seyyed et al. (2012) focused in detail on a number of construction theories, which are addressed in the next sub-sections below.

5.3.1 Heinrich Domino Theory of Accident Causation

The Accident Causation Theory was propounded by Herbert William Heinrich (1886-1962) who explained in his analysis in 1959 that an accident is an unintentional and uncontrolled happening in which the action or reaction of an object, substance, person or radiation results in individual injury or the likelihood of it (Seyyed et al., 2012). Approximately 88% of accidents occur due to the dangerous, unsafe and risky actions of workers while 10% of accidents are related to hazardous situations and 2% of the total number of accidents are related to ‘unpredictable’ natural disasters (Heinrich, 1959). The Accidents Causation Theory
suggests that there are six areas under which accidents fall. These are: man and machine association; frequency and intensity relations; causes of hazardous acts; the role of management in accident prevention; the cost of accidents; and the influence of safety on competence (see Figure 5.2).

![Figure 5.2: Heinrich's Domino Model of Accident Causation](image)

Heinrich (1959) recognised the ‘Domino theory’ which is based on five sequential aspects. These are:

Ancestry and heritage, alongside social environment, constitute the process of attaining knowledge associated with the traditions and skills of the workplace. Being short of the skills and knowledge required to perform the job, in addition to unfortunate or unsuitable social and environmental conditions, will lead to an understanding that an accident will be a mistake and the fault of the person (Seyyed et al., 2012). Accidents can also occur because of the negative personality traits of an individual such as carelessness and a display of carelessness may lead to dangerous situations.

Hazardous acts and/or mechanical or physical situations, leaving aside human error, can occur as a result of faulty equipment or a technical failure leading to an accident, dangerous actions and/or hazardous situations. Hazardous acts, the fault of a person or hazardous situations may lead to the occurrence of accidents which, in turn, lead to injuries, which are the post-accident occurrences or outcomes of the accidents.

In Heinrich’s Domino Theory, he referred to these five aspects mentioned above as standing dominos which will fall one after the other if the very first domino (ancestry, heritage and...
social environment) falls. An accident can be prevented only if the chain of sequence is disturbed. For example, if the hazardous act/situation can be removed, the accidents’ domino will remain standing as will the injuries’ domino. In short, Heinrich’s accident causation theory can organized into two major causes of accidents: the first is workers/employees/labourers, who are the main factor behind the occurrence of accidents, and the second is the ‘Administration’ which holds the power and authority to prevent accidents form occurring. Heinrich’s Domino Theory was accused of over-simplification as it confined the causes of accidents to human behaviour. However, many other studies on accident causation were later established based on Heinrich’s Domino Theory where emphasis was placed on the part played by administrations in accident prevention. These studies came to be known as the Management Model or Domino’s Updated Model where it is widely believed that management systems are solely responsible for managing and mitigating the occurrence of accidents (Seyyed et al., 2012).

5.3.2 Management-Based theories

Despite criticism of and argument about Heinrich’s theory, many researchers have used it as a base for further development. Heinrich’s Domino Theory has been tailored and updated over the years by placing greater emphasis on management as the original source and root cause of accidents. The updated versions of Heinrich’s Domino Theory, as mentioned above, were named ‘Management-based Theories’ or ‘Updated Domino Models’. The philosophy of the Management-based theories is that management is responsible for causing accidents and that effort needs to be directed towards distinguishing failures within the management system. Some examples of the Updated Domino Models and Management-based theories include the Updated Domino Sequence (Bird, 1974), the Adams Updated Sequence (Adams, 1976) and the Weaver Updated Dominoes (Weaver, 1971). There are also other management-based theories which are not based on the Heinrich Domino Theory such as the Stair Step Model (Crowe, 1976) and the Multiple Causation Model (Petersen, 1971).

5.3.2.1 Weaver Updated Dominoes (Weaver, 1971)

Weaver developed an accident theory based on Heinrich’s Domino Theory by placing emphasis on the management part of the system. Weaver regarded numbers three, four and five of Heinrich’s dominoes as errors caused by operation. Weaver tried to reveal the part played by operational errors, not only by determining the cause of an accident, but also, in addition, by identifying why the hazardous act was allowed to continue, as well as
determining whether the management had the safety knowledge to avoid the occurrence of accident. Weaver set questions in order to clarify the underlying causes of accidents. For example, if management had knowledge about safety and, moreover, relevant standards of work, why was the worker confused and allowed to continue to work in a hazardous situation? The answers to the questions could reveal the underlying operational errors which caused the accident.

5.3.2.2 Updated Domino Sequence (Bird, 1974: Domino-Based Model)

Bird and Loftus (1974) updated the Domino Theory which also included reflection on the role of management systems in the sequence and causes of accidents, as explained by Heinrich’s Domino-based Model as shown in Figure 5.3. The updated and adapted order of events in Bird’s model is as follows:

Lack of control/management (inadequate programme, inadequate programme standard and inadequate compliance to standards)

Basic causes/origins (basic causes: 1-personal aspects, 2-job aspects)

Immediate causes/symptoms (sub-standard act and situation)

Incident (contact by means of energy as well as substance)

Loss (property, people, process)

![Figure 5.3: The Updated Domino Sequence Theory](image)

The Updated Domino sequence can be utilized and applied to all types of accidents and is also useful in loss control management.

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5.3.4 Multiple Causation Model
Heinrich’s Domino Theory is built around the idea that there is a single reason associated with the fault of an individual(s) which leads to the occurrence of an accident. Figure 5.4 shows an alternative model developed by Petersen (1971) that is based on multiple reasons associated with the management system. Petersen (1971) presented the view that there are two major keys to the events which lead to an accident: a hazardous act and a hazardous situation. However, there are numerous reasons which contribute or lead to hazardous acts and situations which eventually result in the occurrence of an accident. Unlike the simple Domino Theory, there are causes and sub-causes (factors) that need to come together for an accident to happen. By identifying of these multiple contributory factors, the hazardous actions and/or situations can be avoided before a mishap takes place.

5.4 Human Error Models
In the following subsections, an overview is presented with regard to Human Errors Models. These include Behaviour Models, Goal Freedom Alertness Theory, Human Factor Models, and Ferrell Theory.

5.4.1 Behaviour Models
Behaviour models suggest that the hazardous behaviour of humans is the main reason why accidents occur. Based on this concept, it is argued that errors are likely to be made by humans subjected to varied environmental situations. Human errors are explained as ‘actions that exceed a number of limits of acceptability’ (Rigby, 1970). Behaviour models are principally underpinned by Accident Likeliness Theory, indicating that different people have different attributes, qualities, traits and specific characteristics which make some of them more susceptible to accidents than others. Many behaviour models established by research
attempt to provide explanations on the causes for repeat accidents. These include: Goals Freedom Alertness Theory (Kerr, 1957) and the Motivation Reward Satisfaction Model (Petersen, 1975).

5.4.2 Goals Freedom Alertness Theory
Goals Freedom Alertness Theory suggests that psychological satisfaction and a desirable work environment lead to safe performance as well as having a positive impact on individual performance. The fundamental basis of the theory suggests that accidents are ‘low-quality’ acts, and occur because of an unpleasant work environment from a psychological viewpoint. In this regard, a psychologically satisfying work environment is a place where the workers are encouraged to give their best performance by playing their part in arranging attainable goals and using innovative methods to achieve those goals. Workers are given the liberty to participate and to identify as well as solve work problems; thus, the management system allows workers to define and achieve goals for themselves. In addition, management can make the work environment better for workers by using, for example, appropriate managerial techniques and participative methods, and by setting explained goals for workers. The argument that underpins the theory appears to suggest that, the more freedom individual workers have in setting their goals, the fewer accidents or incidents will occur.

5.4.3 Human Factor Models
Human Aspect Models are based on the idea that human mistakes are the key source of accidents. Humans’ hazardous behaviour and poor design of the workplace or environment are also causal aspects of accidents. The literature on human factor models include several dominant alternatives such as Ferrell theory (Ferrell, 1977), the Human-error Causation Model (Petersen, 1982), the McClay Model (McClay, 1989) and the Dejoy Model (Dejoy, 1990).

5.4.4 Ferrell Theory
Ferrell (1997) based this theory of accident causation on a series of human factors, as shown in Figure 5.5. The foundation of the theory is that human error is the main element behind the occurrence of incidents in the workplace and are caused by three elements: namely, overload, incorrect responses, and improper activities. Each of these elements is addressed in more detail below.
Overload can refer to work overload when too much responsibility is assigned to one person; it can also occur because of external loads and outside pressure. Task overload can occur because of an individual’s lack of ability to absorb or a number of tasks at a time. The outcome of such a mismatch is anxiety, pressure, fatigue and intensified emotions. This can be further intensified by the effects of the physical work environment such as pollution, dust, light, noise and fumes.

An incorrect response by a person may be caused by: unacceptable work circumstances and/or position; a lack of understanding between co-workers; or hesitation in communicating with colleagues and subordinates.

An improper activity may be executed by a person if an activity is carried out inappropriately or inefficiently, either due to lack of knowledge of the subject under which activity is conducted, or due to an intentional risk-taking approach.

According to Ferrel (1997), any of the three elements or a combination of them could lead to an accident.

5.4.5 Framework of accident causation: Reason
Mishaps that impact on individuals and those that affect organisations are two recognised types of undesired occurrences in construction. Incidents that centre around people are described as individual- or people-centric tragedies (Reason, 1997). According to Reason (1997), people-centric tragedies have been observed in construction for many years. In more
recent times however, incidents involving corporations and their affiliates have grown with technological progress. Reason (1997) presented a basic framework that is presented in Figure 5.6, which illustrates the relationship between hazards, defences and losses. The framework proposes that when an individual performs an unsafe act, which breaches defences or occurs in the absence of defences, an accident occurs. Reason (1997) modelled only what happens with accidents. The adopted position of Reason in modelling only accidents and does not provide much opportunity for a cyclical approach to allow feedback and learning.

Human, technical and organisational errors are the three major reasons why lapses in protection occur. However, human error has a bigger role than the other two since the cause of tragedies can be divided into dynamic failures and idle failures. The former has a sudden effect while the other is a psychological effect that can be present for a long period of time and then be triggered by an active failure which breaches the safety defences, allowing protection to lapse. The unsafe acts (whether dynamic or idle) are failures to maintain guards or protective activities (plates); these cause or fuel an incident.
Gibb et al. (2006) applied the model devised by Reason to form the ConCA model. The guards, placed alternately, are prompts which then become shaping factors or originating influences as shown in Figure 5.7.

Figure 5.7: ConCA model (after Reason)

It is argued that this model can be utilised to disentangle the challenges facing the construction industry in terms of accident and incident rates. Gibb et al. (2006) stated that: ‘the site team, who are largely responsible for the immediate circumstances, need to concentrate on reducing their own holes (i.e. site environment, workplace, worker and tools and equipment issues). The project management team and detailed designers (the main influencers of the shaping factors) should ensure that they work at the preconstruction planning and design aspects to reduce risk and hence close holes in their plate. Finally, the client team, concept designers and others who have influence over the industry as a whole can work to reduce risk both at a project and at an industry level.’ To improve safety performance by testing personality and safety behaviour could be included permanently in design work, thus adding an additional defence to close more holes in this plate (referring to the originating influences).

5.4.6 Distraction Theory: Hinze

Hinze (1996) suggested three components of a distraction theory that is depicted by Figure 5.8.

The first is the probability of injury occurrence and is plotted along the y axis.

The second is a measure of the probability of achieving a work task, which is measured along the x-axis; this is referred to as a measure of productivity. According to Hinze (1996), the diagram can indicate that performance can either be ideal (safe and productive), poor (unsafe and unproductive), productive but not safe, or safe but not productive.
The third component is the mental distractions experienced by workers. Hinze (1996) argues that unsafe physical conditions are dynamic variables where a worker may, or may not be, influenced by a distraction. The extent to which the worker is influenced may be determined by the extent to which he/she is focused on the distraction.

**Figure 5.8: Distraction theory (Hinze, 1996)**

When the worker is aware of the unsafe act, good safety performance will be achieved but if the worker has little regard for the unsafe condition, then that worker is likely to be productive but at an increased risk of suffering an accident.

This theory, where unsafe physical conditions contribute to distractions as shown in Figure 5.9, indicates that in the presence of serious hazards, productivity and safety are not mutually achievable.

**Figure 5.9: Influence of hazards on productivity and safety (Hinze, 1996)**
When serious hazards exist, interventions are employed to reduce the opportunity of an accident; this can have the effect of reducing productivity as the worker devotes more attention to the hazards. The above relates to situations where distractions occur due to serious hazards. Hinze (1996) also proposes that there are other distractions, such as issues or concerns the worker may bring to the workplace or those which result from conditions at work as reflected by Figure 5.10.

**Figure 5.10: Influence of diversions on productivity and safety (Hinze, 1996)**

The greater the mental distraction, the more attention will be drawn from the work task and hence productivity will reduce. The attention paid to the distraction will divert attention from the work environment and hence increase the chance of injury. Safety and productivity are jointly compromised by mental diversions, provided that the distraction is not related to physical hazards in the workplace. This theory can assist in relating accident causation to productivity.

### 5.4.7 Basic model of accident causation: Whittington et al., 1992

Whittington et al. (1992) described data, from which a model of accident causation was developed, as: “A detailed analysis of 30 serious accidents which identified failures at a policy, site and individual level. Interviews with safety managers and company, project and site managers from 24 different construction companies. A postal survey of a further 21
construction companies. Interviews with representatives of a number of major clients.” The model, which is presented in Figure 2.11, illustrates how unsafe behaviour can be propagated over a project’s lifecycle. The starting point of the model is where safety management has been assumed by a main contractor. Whittington et al. (1992) asserted that poor management decision-making and inadequate management control are major contributors to many construction accidents. The accident causation process is simplified into a sequence of failure initiations; these are termed as individual failures, site management failures, project management failures and policy failures.

Figure 5.11: Basic model of accident causation (Whittington et al., 1992)

Whittington et al. (1992: 28) describe the four main levels at which failure can occur while they note that “Failures at level 1 will increase the probability of failures at level 2 and so on.”

1. at a company policy level: for example, inadequate training policies or poor methods of procurement;
2. at a project management level: for example, lack of planning, poor scheduling of work or choice of inappropriate construction methods;
3. at a site management level: for example, poor communications, lack of supervision or failure to segregate work adequately;
4. at an individual level: for example, use of wrong equipment or failure to comply with an agreed method of work’.

A number of additional aspects are discussed regarding this approach ‘it discriminates between those failures that occur immediately before the accident (so called “active failures” usually committed by those at the sharp end) and those failures that may lie dormant until an active failure subsequently reveals them (so called “latent failures” which are by definition present in the organisation long before the accident happens). Generally speaking, projects which are large, complex or novel are likely to be particularly vulnerable to latent failures occurring at levels 1 and 2 whereas accidents on smaller traditional sites are more likely to result from failures at the site management or individual level’. In addition, it is indicated that unsafe acts do not always lead to injury; the environment in which the work is performed is often tolerant of repeated risk taking. The model can be useful in the development of connections between management control and the intermediate preconditions for safe performance. It can be used to provide a background for investigation into accidents and to suggest routes by which unsafe behaviour can be prevented. It can also be used to develop specific performance indicators which can be used for organisational, project and site audits.

5.4.8 Generic health and safety causation model: Haslam et al., 2003

The research project Construction Accident Causality (ConCA) (Haslam et al., 2003) was funded by the UK Health and Safety Executive (HSE). Employing an ergonomics systems approach, it used a combination of focus groups and a study of 100 accidents to identify where and why safety was compromised. The aims of the project were to collect data on the factors involved in a large sample of construction accidents, and to describe the process of accident causation, including the contribution of management, project, site and individual factors. It then summarized the identified influences which operate to cause construction accidents. The ConCA model indicates the hierarchy of influences in construction accidents as shown in Figure 5.12. The model describes how accidents arise due to failures in the interactions between the work team, their workplace, and the materials and equipment (including tools and PPE) that they use. Gibb et al. (2006) explained the model thus:
5.5 Human Personality and Accident Causation

This section considers where locations and personality traits fit within these accident causation models. One particularly appealing approach to the genesis of human error is the one proposed by James Reason (1990). Generally referred to as the “Swiss cheese” model of human error, Reason describes four levels of human failure, with each preceding level influencing the next. The Reason model was previously addressed in Figure 5.7. Working backwards in time from the accident, the first level depicts the unsafe acts of operators that ultimately led to the accident. More commonly referred to in aviation as worker error, this level is where most accident investigations have focused their efforts and consequently where most causal factors are uncovered. Reason (1997) does not include a consideration of design and pre-construction. Design does not feature in any of these models as they are concerned mainly with problems on site, lack of control and personal factors. The models could be extended to include a pre-construction design phase with the opportunity to use personality testing. In addition, the models are episodic in nature and need a feedback loop. ConCA
models the accident within the episode and attempts to discover what has happened; it offers little in the way of examining what will be done and what was learned from the accident. The models consider the accident but should also include an audit process to provide an opportunity to learn from the accident and to give information prior to the accident about the management process. In commenting on the ConCA model with regard to personality, the decision to use human personality is concerned with the work design and project management. The originating influences, client requirements, economic climate and construction processes are what influence the decision to use a personality test. It is clear that the construction processes, safety culture and risk management are significantly affected by personality, as indicated in the rectangular area in Figure 5.13 while changes to the shaping factors are commented on as follows: the worker factors will include significantly fewer workers on site for the personality traits solution and therefore there are fewer opportunities for accidents to occur. Using a personality test would reduce the amount of human errors on site. In connection with work team, Attitudes/motivations Knowledge/skills Supervision Health/fatigue (Figure 5.13).

Figure 5.13: ConCA model (Haslam et al., 2003)
5.6 Summary
This chapter has discussed accident causation theories and also models which offer explanations of why accidents and unpleasant incidents occur. It has established that all the construction accident causation theories and models that have been developed have significantly amplified the understanding of accidents and how they occur. They place a strong emphasis on the part played by human error which has resulted in a greater awareness of the need for training and the education of workers in order to expand competencies as well as safety awareness. However, there is a basic dilemma surrounding the different understandings of risk, safety and the degree of risk which can be accommodated in order to achieve satisfactory safety performance. People are likely to believe that once an action has been executed in reaction to a hazard, the situation is safe or safe enough. The weakness of these accident causation theories is that they do not offer extensive strategic guidelines for managers or supervisors to significantly reduce risks in construction workplaces. Moreover, these theories have suggested, inaptly, that accidents in workplaces might be prevented if human error is eradicated; however, since hazard (or human error eradication) is currently beyond human capacity, and thus prompting the notion that not all accidents are avoidable. Strategies need to be improved in order to manage risk; also, workers need to be aware of these. A huge number of accidents might be prevented if safety management systems reflected both natural human error as well as inherent dangers presented by individual personal traits. By concentrating on the safety behaviours of individuals, the researcher provides an alternative that could facilitate the desired changes in attitude and behaviour that are required for safety improvement. Within this research, a conceptual model is proposed for conducting such a study with a view to developing application tools from the results of investigations. The next chapter discusses the methodology adopted by the researcher to complete this research and methods of achieving the objectives of the study.
CHAPTER 6
RESEARCH METHODOLOGY

6.1 Overview
This chapter presents the primary principles and concepts that underpin the research methodology employed for this study. Moreover, this chapter describes the strategy adopted for the current research to achieve its aims and objectives. In addition, this chapter describes in detail the research methodology, which is a quantitative approach, its definitions, strengths and weaknesses; the philosophical assumptions underlying the quantitative methodology; the differences and similarities between quantitative and qualitative approaches; and the appropriateness of the method chosen for the current study. Also, the chapter describes the procedures undertaken to identify the population of the study, and the steps taken to select the sample “participants” and determine the sample size. It also describes the participants in terms of age, nationality, level of education, type of work and other demographic variables. The chapter contains a description of the instruments used and explains how the researcher estimated their validity and reliability.

6.2 Fundamental Concepts
This section gives an outline of the principle philosophical ideas considered by the study. The reasoning behind the configuration of exploration has been widely audited in the literature (Bryman, 2004; Creswell, 2003). The following sections consider the concepts of epistemology, ontology, methodology and axiology which provide a contextual background for the research approach, as discussed in Section 6.6.

6.2.1 Epistemology
Walliman (2005) describes epistemology as the hypothesis of information, particularly about its approval and the systems; how one sees and understands the world is associated with one's epistemological viewpoint. With regards to sociological research, an epistemological issue concerns inquiry into what is to be viewed as worth learning. Bryman (2004), in the context of social science research, suggests that ‘an epistemological issue concerns the question of what is (or should be) regarded as acceptable knowledge in a discipline. A particular central issue in this context is the question of whether the social world can and should be studied according to the same principles, procedures, and ethos as the natural sciences. The position
that affirms the importance of imitating the natural sciences is invariably associated with an epistemological position known as positivism’. A precise definition of positivism is difficult to obtain, as Bryman (2004) states, ‘the doctrine of positivism is extremely difficult to pin down and therefore to outline in a precise manner, because it is used in a number of ways by authors. For some writers it is a descriptive category – one that describes a philosophical position that can be discerned by research – though there are still disagreements about what it comprises; for others, it is a pejorative term used to describe crude and often superficial data collection’. Bryman (2004) goes on to state that ‘positivism is an epistemological position that advocates the application of the methods of the natural sciences to the study of social reality and beyond’ while the term interpretivism is described as ‘a term that usually denotes an alternative to positivist orthodoxy that has held sway for decades. It is predicated upon the view that a strategy is required that respects the differences between people and the objects of the natural sciences and therefore requires the social scientist to grasp the subjective meaning of social action’ (Bryman, 2004).

6.2.2 Ontology
In terms of social science research, Bryman (2004) states that ‘questions of social ontology are concerned with the nature of social entities. The central point of orientation here is the question of whether social entities can and should be considered objective entities that have a reality external to social actors, or whether they can and should be considered social constructions built up from perceptions and actions of social actors. These positions are frequently referred to respectively as objectivism and constructivism’.

6.2.3 Methodology
Fellows and Liu (2003: 31) state that ‘research methodology refers to the principles and procedures of logical thought processes which are applied to a scientific investigation’. A research method is distinct from a methodology which ‘concerns the techniques which are available and those which are actually employed in a research project’ (Fellows and Liu, 2003).

6.2.4 Axiology
Axiology is defined by the OED (2009c) as ‘the theory and study of quality or values’. In simple terms, Creswell (2003: 6) stated that ‘researchers make claims about what is
knowledge (ontology), how we know it (epistemology), what values go into it (axiology) and the process for studying it (methodology)’. This study used a quantitative methodology, as discussed in Section 6.4.

6.3 Philosophy of Quantitative Research

Philosophy, from the Greek, means love of wisdom (Cavalier, 1990). Philosophy includes the processes of thinking about certain questions, giving explanations, innovating ideas, formulating effective discussions, and questioning the working of concepts (Ruona, 2000). By the middle of the twentieth century, quantitative research was well established within the academic world. Quantitative research is based on the philosophical premise that all meaningful statements are either analytical or conclusively verifiable and this movement or stance was called Positivism. Everything in positivism must be confirmable by observation and experiment; metaphysical theories are meaningless (Ryan, 2006; Trochim, 2006). The three major philosophical approaches to quantitative research are positivism, epistemology and axiology (Creswell, 2002). Positivism ontology is the study of the nature of reality and positivist researchers believe there is a single reality comprised of objects that are contiguous, but essentially separate in time and space. Consequently, in this quantitative study, observations were carried out objectively from a distance, and were measured on all sides. Epistemology examines the relationship of the knower to the known. Positivists believe that the knower and the known are independent.

6.4 Research Approach

Bryman (2008) highlights the usefulness of distinguishing between quantitative and qualitative research. However, Layder (1993) states that, to some, this differentiation seems unclear while others view it as useless. In the same way, Baumard and Ibert (2001) point out that the differentiation between qualitative and quantitative approaches is both unclear and equivocal in accordance with a multiplicity of criteria, none of which allow complete differentiation to be made. Conversely, Bryman (2008) states that qualitative and quantitative approaches symbolise dissimilar research strategies, each offering significant differences in terms of theoretical roles, ontological concerns and epistemological issues. The explanation of the method that a researcher uses while performing the research, the different methods adopted and the specific style, define the research approach while the research method refers to the literature, as Yin (2009) stated. Selecting a suitable research approach has to be based on the following: the nature of the study's questions and the kind of questions asked; the
extent of the researcher’s control over real behavioural events, and the level of concentration on modern actions.

6.4.1 Qualitative research

According to Creswell (2007), qualitative research is an attempt to achieve an understanding derived from different methodological habits of investigation that explain human or social experience. Qualitative approaches of study obey an inductive approach and were primarily developed in the social sciences to allow researchers to focus on cultural and social phenomena in their studies. Bryman and Bell (2007) argue that researchers place emphasis on words instead of collecting, quantifying and analysing data. Bryman (2008) says that a qualitative research approach might be selected once the following is found: there are no data concerning the issue under scrutiny and the most suitable unit of measurement is unclear. Research concepts are evaluated on a nominal range, with unclear delimitation and engage reconnoitring attitudes or performance.

Perry (1994) pointed that the nature of qualitative research is exploratory and is inclined to try to find answers to 'why?' and 'how?' questions. Thus, the main concern in this study was to classify the variables involved in answering the research questions and counselled that study's case methodology inclines to be adhered. In addition, Creswell (2007) concentrated on the researcher's situation in choosing a qualitative approach as most suitable. He mentioned that a qualitative approach is most suitable: when the problem requires exploration in detail; when a complex problem needs to be understood; when there is a requirement for authorised persons to participate by telling their stories; and when attitudes need to be listened to or examined. Qualitative research, however, must reduce the power that can arise from the relationship between the participants and the researcher and must be written in a flexible, literary way that tells stories while avoiding the limitations of academic or official writing styles. It must also understand the settings or circumstances in which the members of the study speak about an issue or problem when the quantitative study is followed up, as well as clarifying the linkages or mechanisms in fundamental models or theories. Moreover, it must develop theories when the theories presented for specific samples and populations are inadequate or partial or when they do not sufficiently explain the difficulties of the study's problem. Statistical analyses and quantitative measures are simply not appropriate to shed light on some issues and this is when a qualitative approach is more appropriate, as it is on this study. Bryman (2008) pointed out that the major steps in a qualitative study, which are
explained in Figure 6.1, are "non-linear" and the questions of the study will be mostly determined by examining theoretical cases or issues, which will then lead data gathering and analysis.

**Figure 6.1: Outline of the qualitative process (Bryman, 2008)**

### 6.4.2 Quantitative Research

Fellows and Liu (2008) defined quantitative research as study that is interconnected with positivism, tries to collect truthful data and attempts to investigate relations among information and facts. It studies the way that relationships and facts deal with the findings and theories of earlier prepared study. Methods of quantitative research were initially developed in the natural sciences in order to understand natural phenomena and so quantitative approaches apply the norms and practices of the model of the natural sciences. Positivism mainly describes society as an objective, external reality. It exploits the use of statistical and mathematical methods to recognise causal relationships and facts, as Naoum (2002) pointed out. In addition, quantitative approaches are objective and rely on examining theories or hypotheses that consists of variables (Fitzgerald and Howcroft, 1998; Naoum, 2002. Selecting a quantitative research approach is decided in accordance with the following conditions, as mentioned by Naoum (2002): To find out facts concerned with certain questions, attributes or concepts or to collect evidence or facts then study relationships among these facts with the purpose of testing a specific hypothesis or theory. Bryman (2008) stated the main steps followed in a quantitative study and stressed that these symbolise a perfect explanation of what that research must achieve. However, regardless of the not so
linear appearance of the series of the process, a quantitative approach offers powerful signs of the interconnections among the major steps in the research, as seen in Figure 6.2. However, using quantitative research on a large scale is criticised by the community of researcher and the following criticisms were mentioned by Bryman (2008): its inability to distinguish between social institutions and people who come from the world of reality; it is a non-natural measurement process; and accuracy and correctness cannot be assumed from a claimed source.

**Figure 6.2: Quantitative research process (Bryman, 2008)**

A quantitative approach also depends on procedures and instruments that impede the relationship between everyday life and the research. It takes a static viewpoint of social life that does not depend on the lives of real people when analysing the relations among variables. Bryman and Bell (2007) also criticised the quantitative research approach and its limitations in terms of the following points:

**Limitation of sampling:** the nature of any sample means it does not have the ability to be similar to the whole population which is a limitation in terms of generalising the study's results and outcomes.

**Limitation of non-responsibility:** non-responsibility may influence the way the sample of a study is represented for its population; this may influence any possible generalisation of the study's results.
Errors of data gathering: errors and limitations can be related to the way data are gathered; for instance, unclear questions or variations in responses may be created from the diverse ways that data may be gathered ways.

Errors in data processing: The large amounts of data that may be involved in the analysis of a quantitative approach can result in errors of data processing. Glesne (2006) called a quantitative approach “research designed with the intention of making generalizations about some social phenomena, creating predictions about those phenomena, and providing causal explanations” whereas a qualitative approach is less about generalisations and more about understanding the phenomenon from the perspectives of those involved. Lather (1986) noted that the quantitative approach has been described as the “correct method” in scientific study but one that does not necessarily “guarantee true results”. Like all methods of research, the quantitative approach has its strengths and weaknesses. Johnson and Onwuegbuzie (2004) outlined the strengths and weaknesses of the quantitative research as follows:

6.4.2.1 The Strengths
Testing and validating already constructed theories about how (and to a lesser degree, why) phenomena occur.
Testing hypotheses that are constructed before the data are collected.
Generalising research findings when the data are based on random samples of sufficient size.
Generalising a research finding when it has been replicated on many different populations and subpopulations.
Obtaining data that allow quantitative predictions to be made.
The researcher may also construct a situation that eliminates the confounding influence of many variables, allowing one to assess more credibly cause and effect relationships.
Data collection using some quantitative methods is relatively quick (e.g., telephone interviews).
It provides precise, quantitative, numerical data.
Data analysis is relatively less time consuming (using statistical software).
The research results are relatively independent of the researcher (e.g., effect size and statistical significance).
It may have higher credibility with many people in power (e.g., administrators, politicians, people who fund programs).

It is useful for studying large numbers of people.

The knowledge produced may be too abstract and general for direct application to specific local situations, contexts and individuals.

6.4.2.2 The Weaknesses

The researcher’s categories that are used may not reflect local constituencies’ understandings.

The researcher may miss out on phenomena occurring because of the focus on theory or hypothesis testing rather than on theory or hypothesis generation (called the confirmation bias).

6.4.3 Mixed method (triangulation).

According to Amaratunga and others (2002), triangulation is related to group of approaches in the research that are combined together to form one phenomenon. Triangulation uses several methods and data sources to examine phenomena in social science studies, as Bryman (2008) stated. Both Baumard and Ibert (2001) demonstrated that mixing quantitative and qualitative approaches together helps researchers since these two approaches, when combined, offer their own advantages and qualities. Thus, the process of triangulation is based on collecting evidence from multiple sources and then using it to shed light on a particular perspective or theme, as Creswell (2007) demonstrated. According to Jick (1979), triangulation provides the researcher with an opportunity to use the advantages of the two approaches since the defects of one are balanced by the qualities of the other. Fellows and Liu (2008) illustrated that studies using triangulation employed more than two techniques (qualitative and quantitative) in order to decrease or eradicate the disadvantages of a single approach while gaining their advantages individually or together. Using both a qualitative and a quantitative approach together provides clear results; it also helps in producing inferences or obtaining conclusions, as Figure 6.3 shows.

Easterby-Smith and others (2002) illustrated that triangulation has four different groups: 

Theoretical triangulation contains models borrowed from a single discipline to illustrate the situation for other disciplines. Data triangulation contains data collected from different sources or time frames. Investigator triangulation contains data collected from different people within the same situation and then compares the results. Methodological triangulation
works with both qualitative and the quantitative approaches to collect data from sources such as telephone surveys, interviews, questionnaires and other field studies.

Figure 6.3: Triangulation of quantitative and qualitative (Fellows and Liu 2008)

6.5 The Adopted Research Approach

After reviewing qualitative, quantitative and mixed method research and determining the features and limitation of all the methods, a quantitative method was chosen for use in this study. The ontological assumption of separateness that proposes to be true knowledge (Creswell, 2003). Furthermore, a quantitative study allowed objectives to be measured accurately and to be compared with observed reality. Axiology explains, in this study, the role of value in inquiry and while positivists believe that inquiry is value-free, measurement, being objective, is universal and therefore verifiable. There is no need to resort to negotiation which means that values and starting points exist (Creswell, 2003). In sum, quantitative research includes the following philosophical assumptions:

a) Social phenomena have an objective reality that can be measured;

b) Investigators must remain unbiased and impartial;

c) Theoretical dependent and independent variables can be quantified and tested;

d) The randomisation of subjects is feasible;

e) Human subject research activities involve ethical considerations that must be approved by institutional review boards within authorising organisations;
f) Participants will provide informed consent;
g) Quantifiable standardised questionnaires and instruments must be used for data collection; and
h) Data analysis will employ statistical tests.

The methodological assumptions of quantitative research also require that reliable findings will be measured using a number of statistical tests (Mertens, 2005). The research methodology selected had to be appropriate for the scope of the study and applicable to its purpose so, based on the direction of the study, the quantitative approach was selected. This decision was taken for four main reasons:

Firstly, the quantitative approach in this study allowed the collected data to be thoroughly interpreted. Collecting data needs to be ethical and respectful and Creswell (2009) noted that researchers should respect the participants and the research sites. The quantitative approach used in this study allowed respect for the participants to be maintained because the participants were not identified and the sampling of the population was undertaken without violating any ethical issues. Secondly, the quantitative methodology was appropriate to this study because a large number of samples was required from the population being studied. Since there are many factors that influence incident rates, some factors had to be held constant in order to relate incident rates to safety performance. When conducting research with multiple variables, a quantitative methodology using a statistical instrument was able to show how personality traits mediated the relationship between incident rates and safety performance, thus allowing the data to be clarified and interpreted correctly and thoroughly. For this purpose, the Statistical Package for the Social Sciences (SPSS) software was used. Using an instrument that could represent the data in a logical and efficient way helped to eliminate researcher bias.

Thirdly, Creswell (2009) noted that the instrument used in a study must establish validity and reliability. The quantitative approach employed in this study allowed validity and reliability to be established because the instrument was precise and efficient and because it was able to include data input and compute standard deviations that allowed the researcher to determine if the results were consistent. A quantitative methodology was selected because it was efficient in collecting data and in population sampling and, as mentioned above, it involved the use of the SPSS statistical instrumentation which helped to eliminate researcher bias. Finally, a quantitative approach was used because it allowed the study to be conducted in the
most efficient and thorough way by testing the relationship between incident rates and safety behaviour, and different personality traits.

**6.6 Research Design**

Once the researcher had identified the most suitable method to work with, the next step was to identify the research design. It is worth mentioning that research design is different from data collection. According to Fellows and Liu (2008), methods describe the techniques that are available and the techniques which are implemented in the research project. Thus, Crotty (1998) demonstrates that there are four questions in the domain of designing a research proposal: what kind of epistemology, the knowledge theory which is embedded within the theoretical perspective, is addressed through the research (such as subjectivism or objectivism)? What theoretical perspective or philosophical attitude works with the questions of the methodology (such as critical theory, interpretivism, post positivism or positivism)? What methodology (for instance, action, technique or plan that connects the methods with the results) determines the selection of the methods (such as ethnography, survey research and experimental research)? And what methods, procedures or strategies must be used (such as focus groups, interviews or questionnaires) will be used to collect the data? Creswell (2003) conceptualised this model and demonstrated the inquiry’s elements: strategies of inquiry, alternative knowledge claims and methods; these are grouped together to offer different approaches of research design, as Figure 6.4 demonstrates. There are a number of different research designs that researchers can use to gain information on questions about construction management research and social science, as Blismas (2001) described.

![Figure 6.4: Elements and approaches leading to the design processes of research](image-url)
Bryman (2008) argued that a research design provides an outline for collecting and analysing information. Fellows and Liu (2008) also demonstrated that there must be several indications to confirm that the research design chosen increases the opportunities of recognising its objectives, such as it being the most suitable analysis method and research questions, and that it will elicit the required information. According to Royer and Zarlowski (2001), the design stage shows the researcher has chosen the most appropriate methodological approach and this choice will include the observational field, and analysis and data collection methods. Moreover, the design stage directs the course of the research, as well as avoiding some barriers in the research’s last stages. Sekaran (2003) demonstrated that a research design must contains a series of rational choices based on decisions about the research’s aims (hypothesis testing, descriptive and/or exploratory type), location (study setting), type of investigation, extent of the researcher’s interference, units of analysis, and the time horizon.

6.6.1 Adopted Research Process

Research is a dynamic operation and so it must be flexible which means that a contingency approach can be adopted in order to facilitate this. According to Bhagat and Kedia (1996), using a particular approach in a study provides for both change and development. Therefore, there must be a proposed process for this study concerning the ability of the method to explore whether traits of personality can enhance the performance of safety in construction sites in Saudi Arabia, as Figure 6.5 explains. This thesis focuses on the contribution construction workers make to safety performance by exploring their safety behaviour. Understanding the safety behaviour of construction workers should provide opportunities for improvements to be made beyond traditional practices in safety management.
Figure 6.5: Research process adopted for the study

6.6.1.1 Literature Review
According to Fellows and Liu (2008), a literature review is considered as a mission that mentions previous theories and the results of other studies and specific applications of relevant theory. In addition, a literature review is a logical and clear presentation of related studies that have been carried out in the area of the study. Sekaran (2003) argued that the main aims of a literature review are to define and concentrate on critical variables, as well as to document particular results of earlier studies to obtain a theoretical foundation for the present subjects or to address gaps within the knowledge which then enhance the performance of the project. Both Leedy and Ormrod (2005) demonstrated that the literature mentions theoretical views and earlier results relating to the study’s problems in order to view the performance of others in the same subject or field of study. In this study, the literature review (as mentioned in Chapters two, three, four and five) describes the equipment that is used to enhance performance in the construction field and the nature of the industry of construction; it discusses safety performance in the construction industry in general and, significantly, health and safety in construction sites in Saudi Arabia; it also describes
attitudes to safety behaviour and personality traits; and it offers an overview of the Saudi construction industry and the current performance of health and safety in construction. This review therefore has three important roles: acting as a basis for the foundation of the current framework; shedding light on current matters, knowledge and practices, and concentrating on filling gaps; and providing a strong basis for this study by focusing on related matters.

6.6.1.2 Data Collection

According to Yin (2008), using different sources of data collection helps sources to complete each other. There are six recommended data sources which are: physical artefacts, participant-observation, direct observation, interviews, archival records and documentation. In this study, a questionnaire survey was used to collect case-specific data to address the research objectives. The questionnaire had three sections. The respondents were first required to provide background information in the following sections: demographic information, an incident checklist, how many times in the last 6 months they had experienced certain accidents/incidents at work, and the number of injuries and near misses experienced (a near miss being an accident that almost happened). The next section sought to collect data for The Big Five Personality Traits that were measured using a short version of the NEO-Five Factor Inventory (Costa & McCrae, 1992); this version consisted of 60 items. Here, participants rate each item on a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The last section sought to collect data on safety performance. A great deal of attention was paid to collecting data in the construction industry in Saudi Arabia in order to focus specifically on this location, as well as to achieve the research’s aims and objectives. 300 copies of the questionnaire were distributed and 223 were returned with 219 being complete and valid for statistical analysis. The final sample consisted of 219 participants from five construction firms in Saudi Arabia and the variables were selected keeping in mind the vast nature of the topic and the importance of returning with ample information to support the facts and figures. This was a reasonable response to the study as it allowed the researcher to work on the data and analyze them so that the output could show clear results that focused on improvements in the construction industry from the perspective of health and safety standards, as well as from an economic point of view.

6.6.1.3 Data Analysis

After data have been collected from participants, the next step in quantitative research is to analyze the information in order to answer the research questions. Zikmund et al. (2010) demonstrated that data analysis has four phases: data editing, coding, filing, and analysis.
Editing data is the operation that creates more reliable, complete, legible and consistent data; it also prepares the data to be coded which is considered the next step in analyzing the data. Also, editing provides more efficient checking and avoids mistakes caused by respondents’ lack of understanding of any item in the questionnaire and problems that must be adjusted or fixed to obtain concise and reliable data. Editing must be conducted on the same day the data are collected in order to offer further information or explanation to respondents to allow them to complete the questionnaire, as Robertson et al. (1999) showed. The next step is coding the data which involves dividing the edited information into numerical scores or symbols in order to carry out a computer analysis easily and quickly. Coding data must be conducted carefully to avoid any errors of repetition, as Zikmund et al. (2010) illustrated. The third step is the filing of the data to save information in a spreadsheet for the next phase of the analysis.

The earlier phases are conducted to check for errors in the data before they are analysed. Zikmund et al. (2010) have proposed four types of analysis: multivariate, bivariate, univariate, and descriptive for addressing research at this level of study. Descriptive analysis or using statistics are operations that change raw data by describing their main features such as variability, distribution and tendency (Zikmund et al., 2010). Analyzing the connections among the collected information creates a logical organisation which allows for better understanding. Univariate analysis is conducted by analyzing information or exploring the hypotheses according to one variable, as mentioned by Bryman and Bell (2007) while Zikmund et al. (2010) noted that bivariate analyses provide access to information by exploring the interaction between two variables while multivariate analysis assesses information according to more than three variables or a group of variables. These kinds of analysis reveal connections between variables to offer evidence about variations in one variable compared with variations in other variables. Connections between variables can be evaluated by using different techniques that deal with the nature of the variables that are being analyzed (Bryman and Bell, 2007). According to Zikmund et al. (2010), techniques that work in the multivariate method can be combined, such as dependence techniques that deal with discriminant analysis, different forms of regression analysis, and Structural Equation Modelling and interdependent techniques that deal with multidimensional scaling, cluster analysis, and factor analysis. Selecting suitable techniques will provide a statistical and theoretical basis that will work with the assessment scales used for the collected data.

Each respondent answered three major sets of questions for the following three elements:
• Personality traits,
• Safety behaviour,
• Accident and incident rates.

The connection between the respondents’ attitudes to safety behaviour and incident rates is explored in this study. This is followed by a critical discussion concerning how personality traits affect safety behavior and a study of the Big Five Personality Model in order to answer the six quantitative research questions proposed below:

• Is there a relationship between safety behaviour (safety participation, safety compliance and safety motivation) and incident rated?
• Does conscientiousness moderate the relationship between safety behaviour and the incident rate?
• Does openness moderate the relationship between safety behaviour and the incident rate?
• Does neuroticism moderate the relationship between safety behaviour and the incident rate?
• Does agreeableness moderate the relationship between safety behaviour and the incident rate?
• Does extraversion moderate the relationship between safety behaviour and the incident rate?

Since this research involved multiple variables that lent themselves to real number characteristics, the quantitative methodology was adopted to show how the personality traits mediated the relationship between incident rates and safety behaviour. This was achieved by using a statistical instrument that helped to clarify and interpret the data correctly and thoroughly. The Statistical Package for the Social Sciences (SPSS) software was used in this study as a tool of quantitative analysis. Using an instrument that can represent data in a logical and efficient way helps to eliminate researcher bias.

6.6.1.4 Conceptual framework

Miles and Huberman (1994) defined a conceptual framework as determining the primary variables, constructs and factors, and the presumed connections between them. The conceptual framework offers not only a causal/analytical setting, but also an mechanism for
interpreting the results from the study to respond appropriately to the research question and aim. As such it presents both hard factual knowledge, as well as a “soft interpretation of intentions” (Levering, 2002).

6.7 Population and Sampling
The following subsections concern the population which was used by the researcher of the current study; the method used for selecting the research sample and how the sample size was determined are also examined.

6.7.1 Population
The population of the current study consisted of five construction firms in Saudi Arabia.

6.7.2 Sampling
In this section, the researcher describes the research sample was selected and how the sample size was determined.

6.7.2.1 Sample selection technique
The sampling technique used with the population of this study was purposive sampling. Creswell (2009) stated that purposive sampling is a method in which researchers seek, from the representative population, participants who possess specific traits and qualities.

6.7.2.2 Preliminary Power Analysis
Cohen’s (1988) discussion of statistical power guided the determination of an adequate sample size for this study. Cohen (1988) offered a power level of .80 as suitable for most social science research designs; he also established some conventional cut-off points for interpreting effect sizes. Specifically, Cohen suggested that a Pearson r of .10, .30 and .50 or standardised mean differences (Cohen’s d) of .20, .50 and .80 corresponded to small, medium and large effects, respectively. For the proposed study, the goal was to detect any r > .20 and any d >.35, using the p < .01 one-tailed significance level. Based on Cohen’s (1988) tables, 247 usable cases were needed to conduct a meaningful analysis according to these specifications. The power analysis technique was utilised to perform the analysis in the light of Cohen’s study so as to ensure that the facts, figures and the views of participants were presented in an easy and understandable manner.

6.7.2.3 Participants and Procedure
Based on the research objectives, the researcher determined that the research population would consist of all the construction companies in Saudi Arabia. The participants were
selected randomly by using stratified sampling and the researcher distributed 300 copies of the research questionnaire. 223 copies were returned and 219 copies were completed and valid for statistical analysis. The final sample therefore consisted of 219 participants from five construction firms in Saudi Arabia. The mean age of the participants was 34 and the standard deviation (sd) was 8.47 as set out in Table 6.1.

Table 6.1: Descriptive statistics of age

<table>
<thead>
<tr>
<th>n</th>
<th>mean</th>
<th>sd</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>219</td>
<td>33.89</td>
<td>8.47</td>
<td>32</td>
<td>21</td>
<td>58</td>
</tr>
</tbody>
</table>

**Levels of Education**

As shown in Table 6.2, the majority of the participants were educated to high school level (41%) or college degree level (33%).

Table 6.2: Frequencies of participants according to education

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literacy</td>
<td>2</td>
</tr>
<tr>
<td>Primary School</td>
<td>8</td>
</tr>
<tr>
<td>Middle School</td>
<td>47</td>
</tr>
<tr>
<td>High School</td>
<td>88</td>
</tr>
<tr>
<td>College</td>
<td>72</td>
</tr>
<tr>
<td>Missing Values</td>
<td>2</td>
</tr>
</tbody>
</table>

On the other hand, only two participants were able to read and write at a basic level of literacy, and two participants failed to provide their level of education.

**Nationality**

As shown in Table 6.3, the majority of the participants were from East Asia as Filipino participants represented 34%, Indian participants represented 20% and Pakistani participants represented 17%. Only three Saudis participated in the current study.
Table 6.3: Frequencies of participants according to nationality

<table>
<thead>
<tr>
<th>Nationality</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filipino</td>
<td>71</td>
</tr>
<tr>
<td>Indian</td>
<td>43</td>
</tr>
<tr>
<td>Pakistani</td>
<td>38</td>
</tr>
<tr>
<td>Nepalese</td>
<td>6</td>
</tr>
<tr>
<td>Sri Lankan</td>
<td>11</td>
</tr>
<tr>
<td>Bangladeshi</td>
<td>5</td>
</tr>
<tr>
<td>Yemeni</td>
<td>2</td>
</tr>
<tr>
<td>Syrian</td>
<td>6</td>
</tr>
<tr>
<td>Egyptian</td>
<td>29</td>
</tr>
<tr>
<td>Iraqi</td>
<td>1</td>
</tr>
<tr>
<td>Saudi</td>
<td>3</td>
</tr>
<tr>
<td>Sudanese</td>
<td>4</td>
</tr>
</tbody>
</table>

**Type of Work**

As shown in Table 6.4, there were many different types of participant according to their type of work. Electricians (13%), Technicians (12%), and Duct fabricators (11%) represented the highest number of workers participating in the current study.

Table 6.4: Frequencies of participants according to type of work

<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrician</td>
<td>28</td>
</tr>
<tr>
<td>Technician</td>
<td>26</td>
</tr>
<tr>
<td>Duct Fabricator</td>
<td>23</td>
</tr>
<tr>
<td>Plumber</td>
<td>16</td>
</tr>
<tr>
<td>Civil Engineer</td>
<td>14</td>
</tr>
<tr>
<td>Carpenter</td>
<td>14</td>
</tr>
<tr>
<td>Maintainer</td>
<td>11</td>
</tr>
<tr>
<td>Skilled Worker</td>
<td>10</td>
</tr>
<tr>
<td>Worker</td>
<td>8</td>
</tr>
<tr>
<td>Blacksmith</td>
<td>8</td>
</tr>
<tr>
<td>Labourer</td>
<td>7</td>
</tr>
<tr>
<td>Field Consultant</td>
<td>6</td>
</tr>
<tr>
<td>Welder</td>
<td>5</td>
</tr>
<tr>
<td>Tech. Airfield Lighting</td>
<td>5</td>
</tr>
<tr>
<td>Supervisor</td>
<td>5</td>
</tr>
<tr>
<td>Tea Boy</td>
<td>4</td>
</tr>
<tr>
<td>Store Keeper</td>
<td>4</td>
</tr>
<tr>
<td>Machine Mechanical</td>
<td>3</td>
</tr>
<tr>
<td>Heavy Equipment Operator</td>
<td>3</td>
</tr>
<tr>
<td>Driver</td>
<td>2</td>
</tr>
<tr>
<td>Doctor’s Assistant</td>
<td>2</td>
</tr>
<tr>
<td>Field Communication</td>
<td>2</td>
</tr>
<tr>
<td>Secretary</td>
<td>2</td>
</tr>
<tr>
<td>Sales Man</td>
<td>2</td>
</tr>
<tr>
<td>Auto/Cad</td>
<td>2</td>
</tr>
<tr>
<td>Auto Diesel Mechanic</td>
<td>1</td>
</tr>
<tr>
<td>Power Plant Technician</td>
<td>1</td>
</tr>
<tr>
<td>Structural Consultant</td>
<td>1</td>
</tr>
<tr>
<td>Teacher</td>
<td>1</td>
</tr>
<tr>
<td>Civil Worker</td>
<td>1</td>
</tr>
<tr>
<td>Mechanical Engineer</td>
<td>1</td>
</tr>
<tr>
<td>Printing Press Operator</td>
<td>1</td>
</tr>
</tbody>
</table>

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Of course, these different types of participant could be classified in more homogenous subgroups.

**Years of experience in the current work**

As shown in Table 6.5, about half of the participants had fewer than 5 years of experience in their current work while the smallest percentage (of 13%) was for participants whose years of experience totalled 15 years and above.

<table>
<thead>
<tr>
<th>Year of Experience</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 years</td>
<td>111</td>
</tr>
<tr>
<td>From 5 and less than 10 years</td>
<td>49</td>
</tr>
<tr>
<td>From 10 and less than 15 years</td>
<td>32</td>
</tr>
<tr>
<td>15 years and above</td>
<td>27</td>
</tr>
</tbody>
</table>

### 6.8 Summary

The research methods adopted by the researcher in order to carry out this research were discussed in this chapter. This was done in order to provide valid reasons and inform the reader why these research methods were adopted and why other methods were not selected. The researcher selected objectivism as his ontological position and specific positivism as his position of epistemology in a generally quantitative study philosophy. The reason behind the selection of these positions was to obtain answers to the research questions which involved relations between measurable variables with the intention of predicting, controlling and explaining phenomena. This research adhered to a quantitative approach as its method. And the research process that was followed included a literature review, preliminary study, the development of a framework, and validation. Three tools sources: an incident rates checklist, The NEO Five-Factor Inventory, a Safety Behaviour Scale, (see Appendix B) were used as data collection techniques to measure the actual status of safety on construction sites in Saudi Arabia in order to understand the causes of incidents faced by construction workers. The research also evaluated the relationships between the behaviours of individual workers on construction sites to identify how personality traits affected safety performance and incident rates. The collected data were analysed using the Statistical Package for the Social Sciences (SPSS) software and the framework design and development were also discussed in this
chapter, as well as the framework’s validation. This validation was conducted through a workshop which included a focus group of stakeholders. Finally, the research methodology for the selection of the population and sampling was discussed, with the participants coming from construction companies in Saudi Arabia. The majority of the participants had high school degree, 32.42% of the participants were Filipinos whereas only three Saudi workers participated in the study. Electricians and technicians represented about 24% of the participants. The following chapter presents the results of the concerning the safety standards of construction workers in Saudi Arabia
CHAPTER 7

RESULTS OF SAFETY PERFORMANCE STUDY OF CONSTRUCTION WORKERS IN SAUDI ARABIA

7.1 Overview
This chapter presents the results from the data collection of the study. The first section covers data management issues and addresses aspects such as the treatment of outliers, as well as the general organisation of the returned data for the specific analysis required. In the second section, the general profile of the returned data, including missing data and univariate normality, were examined for each of the principal variables employed in the study. As part of the general profile of the dataset, comprehensive descriptive statistics which included basic measures such as mean, standard deviation and variance were computed for the continuous variables (personality dimensions and safety performance) while frequencies and percentiles were computed for the discrete or categorical variables. In the third section, Pearson Correlation Coefficients between the research variables were computed to investigate the type and strength of the associations among them.

7.2 Instruments
This section addresses the fundamental of any data set and provides the basis for characterising the elicited data for this study.

7.2.1 Demographic variables
The questionnaire contains a list of demographic variables which includes: age, nationality, level of education, years in current work, type of work, and number of working hours per day.

7.2.1.1 Incident rate checklist
The researcher constructed an incident rate checklist which consisted of 21 possible injuries. Two columns were placed in front of each possible injury with two different headings to indicate accidents and incidents (near-misses). The researcher adopted the following definition of incident: “An incident is an unplanned event that does not cause injury or damage, but could have done so.”
7.2.1.2 The NEO Five-Factor Inventory

NEO-FFI (Costa & McCrae, 1992) is a 60-item list which consists of 5 scales and 12 subscales. It is answered by choosing one alternative from the 5-point Likert-style instrument that measures each of the Big Five personality factors. The instrument is a shortened form consisting of the psychometrically strongest items from the revised NEO Personality Inventory (NEO PI-R). Costa and McCrae (1992) offer an extensive discussion of the reliability and validity of the NEO PI-R and FFI. Respective internal consistency Alphas of .86, .77, .73, .68, and .81 were obtained for the NEO-FFI Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness scales respectively, while test-retest correlations undertaken after three months ranged from .75 to .83. Evidence of the validity of the NEO-FFI includes independent self and observer agreement, predictions of real-world behaviour such as alcohol consumption, GPA (Paunonen, 2003), and discriminant and convergent correlations with similar instruments. Thus, insofar as the NEO-FFI is derived from the strongest NEO-PI-R items, the shortened form used in this study is likely to embody much of the evidence of validity associated with its parent measure.

7.2.1.3 Safety Behaviour Scale

The researcher constructed a safety behaviour performance scale to estimate the extent to which participants complied with safety procedures in their construction firm. The researcher defined safety behaviour performance as “the extent to which the worker adheres to the construction safety regulations, has a positive attitude towards safety regulations, and participates voluntarily in the safety culture inside the organisation”. The scale consists of 19 items which take a Likert format, a type of psychometric scale frequently used in psychology questionnaires developed by and named after the organisational psychologist, Rensis Likert. There are the following five choices of each item: strongly disagree, disagree, neutral, agree, and strongly agree. The scoring procedure is based on strongly disagree=1, disagree=2, neutral=3, agree=4, strongly agree=5.

7.2.2 Informed Consent

The privacy of participants’ data is integral to the informed consent of the sample which participates in the study. Participants received a thorough briefing on the measures that would be taken to safeguard the privacy of participants’ data, as well as what was expected of the participants themselves during the study. Participants completed an Informed Consent
Agreement which had to be completed and signed by participants before they could participate in the study. Participants filled out the form and detached the bottom for their own records. The bottom of the form contained the researcher’s name, the date and contact information. This Informed Consent Agreement provided detailed information with regard to protecting the identity and privacy of the participants and the eventual destruction of the materials. Only the researcher had access to participants’ data at any time during the study.

7.2.3 Confidentiality
Protecting the rights of study participants and their personal data is an important responsibility for researchers. Confidentiality means the strict nondisclosure of personal or context-specific information about participants that has been collected during the conduct of a study (Creswell, 2005) while, at the same time, ensuring that all data entrusted to the researcher is completely confidential engenders confidence and establishes a spirit of trust between the researcher and participants (Fowler, 2008). Participation in the study was strictly voluntary and the researcher employed several methods to ensure the privacy of the participants. They received a thorough briefing on the nature and intentions of the study, and a timeline for the distribution and collection of materials and forms. In addition, the researcher notified participants at the initial briefing on the complete confidentiality of their responses to any questions. The researcher reiterated at the briefing information about the confidentiality of the findings, use of the data, and the destruction of all study materials three years after the conclusion of the study.

7.3 The Psychometric Properties of the Instruments
Three instruments were utilised to collect the data: the Incident Rate Checklist, the Big-Five Personality Traits, and a Safety Behaviour Performance questionnaire.

7.3.1 The Incident Rate Checklist
Table 7.1 displays the factor loadings of the two factors which illustrate the correlations among incident rate items.
Table 7.1: Factor loadings of the accident and near miss factors

<table>
<thead>
<tr>
<th>Item</th>
<th>Accident</th>
<th>Incident (near miss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.78</td>
<td>0.69</td>
</tr>
<tr>
<td>2</td>
<td>0.59</td>
<td>0.75</td>
</tr>
<tr>
<td>3</td>
<td>0.56</td>
<td>0.73</td>
</tr>
<tr>
<td>4</td>
<td>0.63</td>
<td>0.56</td>
</tr>
<tr>
<td>5</td>
<td>0.69</td>
<td>0.71</td>
</tr>
<tr>
<td>6</td>
<td>0.68</td>
<td>0.50</td>
</tr>
<tr>
<td>7</td>
<td>0.70</td>
<td>0.68</td>
</tr>
<tr>
<td>8</td>
<td>0.71</td>
<td>0.71</td>
</tr>
<tr>
<td>9</td>
<td>0.81</td>
<td>0.52</td>
</tr>
<tr>
<td>10</td>
<td>0.43</td>
<td>0.26</td>
</tr>
<tr>
<td>11</td>
<td>0.71</td>
<td>0.56</td>
</tr>
<tr>
<td>12</td>
<td>0.77</td>
<td>0.73</td>
</tr>
<tr>
<td>13</td>
<td>0.62</td>
<td>0.60</td>
</tr>
<tr>
<td>14</td>
<td>0.58</td>
<td>0.44</td>
</tr>
<tr>
<td>15</td>
<td>0.74</td>
<td>0.74</td>
</tr>
<tr>
<td>16</td>
<td>0.74</td>
<td>0.68</td>
</tr>
<tr>
<td>17</td>
<td>0.49</td>
<td>0.68</td>
</tr>
<tr>
<td>18</td>
<td>0.51</td>
<td>0.68</td>
</tr>
<tr>
<td>19</td>
<td>0.81</td>
<td>0.73</td>
</tr>
<tr>
<td>20</td>
<td>0.52</td>
<td>0.66</td>
</tr>
<tr>
<td>21</td>
<td>0.81</td>
<td>0.77</td>
</tr>
</tbody>
</table>
7.3.2 The NEO Five-Factor Inventory

Table 7.2 below displays the factor loadings of the exploratory factor analysis.

<table>
<thead>
<tr>
<th>Item</th>
<th>Neuroticism</th>
<th>Extraversion</th>
<th>Openness</th>
<th>Agreeableness</th>
<th>Conscientiousness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.60</td>
<td>0.46</td>
<td>0.37</td>
<td>0.36</td>
<td>0.48</td>
</tr>
<tr>
<td>2</td>
<td>0.32</td>
<td>0.37</td>
<td>0.28</td>
<td>0.55</td>
<td>0.54</td>
</tr>
<tr>
<td>3</td>
<td>0.32</td>
<td>0.42</td>
<td>0.37</td>
<td>0.32</td>
<td>0.35</td>
</tr>
<tr>
<td>4</td>
<td>0.65</td>
<td>0.55</td>
<td>0.31</td>
<td>0.32</td>
<td>0.63</td>
</tr>
<tr>
<td>5</td>
<td>0.70</td>
<td>0.65</td>
<td>0.57</td>
<td>0.40</td>
<td>0.41</td>
</tr>
<tr>
<td>6</td>
<td>0.44</td>
<td>0.59</td>
<td>0.51</td>
<td>0.33</td>
<td>0.60</td>
</tr>
<tr>
<td>7</td>
<td>0.60</td>
<td>0.54</td>
<td>0.35</td>
<td>0.36</td>
<td>0.51</td>
</tr>
<tr>
<td>8</td>
<td>0.48</td>
<td>0.42</td>
<td>0.56</td>
<td>0.62</td>
<td>0.53</td>
</tr>
<tr>
<td>9</td>
<td>0.31</td>
<td>0.24</td>
<td>0.55</td>
<td>0.72</td>
<td>0.50</td>
</tr>
<tr>
<td>10</td>
<td>0.51</td>
<td>0.56</td>
<td>0.57</td>
<td>0.36</td>
<td>0.53</td>
</tr>
<tr>
<td>11</td>
<td>0.61</td>
<td>0.37</td>
<td>0.23</td>
<td>0.37</td>
<td>0.36</td>
</tr>
<tr>
<td>12</td>
<td>0.68</td>
<td>0.59</td>
<td>0.53</td>
<td>0.37</td>
<td>0.50</td>
</tr>
</tbody>
</table>

As shown in Table 7.2, N represents Neuroticism, E represents Extraversion, O represents openness, A represents Agreeableness, and C represents Conscientiousness with each personality dimension being represented by six items. As shown in Table 7.2, all the factor loadings were greater than .40 which indicates an acceptable level since the higher the factor loadings values, the better they represent the factor. The goal of factor analysis is to explore those factors that are responsible for correlations among the items and the goal is to find those factors which are less than the number of items to explain correlations among them.
7.3.3 Safety Behaviour Performance Scale

Table 7.3 displays the factor loadings of the general factors.

Table 7.3: Factor loadings of the safety performance scale

<table>
<thead>
<tr>
<th>Items of the scale</th>
<th>Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>I use all the necessary safety equipment to do my job.</td>
<td>0.85</td>
</tr>
<tr>
<td>I use the correct safety procedures for carrying out my job.</td>
<td>0.91</td>
</tr>
<tr>
<td>I ensure the highest level of safety when I carry out my job.</td>
<td>0.88</td>
</tr>
<tr>
<td>I promote the safety programme within the organisation.</td>
<td>0.86</td>
</tr>
<tr>
<td>I put in extra effort to improve the safety of the workplace.</td>
<td>0.85</td>
</tr>
<tr>
<td>I voluntarily carry out tasks or activities that help to improve workplace.</td>
<td>0.87</td>
</tr>
<tr>
<td>Safety on the job is something I value highly.</td>
<td>0.88</td>
</tr>
<tr>
<td>It is important to avoid accidents at work.</td>
<td>0.89</td>
</tr>
<tr>
<td>Job safety is important to me.</td>
<td>0.89</td>
</tr>
<tr>
<td>Safety is an important work goal.</td>
<td>0.88</td>
</tr>
<tr>
<td>If I perform all necessary safety procedures, it will lead to a safe working</td>
<td>0.92</td>
</tr>
<tr>
<td>If I stick to the safety rules, I can avoid accidents.</td>
<td>0.91</td>
</tr>
<tr>
<td>How accurately I perform given safety procedures will affect whether</td>
<td>0.90</td>
</tr>
<tr>
<td>I can create a safe work environment if I carry out safety procedures.</td>
<td>0.91</td>
</tr>
<tr>
<td>The more safety procedures I perform, the more likely I am to avoid accidents.</td>
<td>0.89</td>
</tr>
<tr>
<td>I can perform the safety procedures if I try.</td>
<td>0.90</td>
</tr>
<tr>
<td>In my work setting, I can actually perform the suggested safety procedures.</td>
<td>0.87</td>
</tr>
<tr>
<td>If I put in the effort, I am able to engage in safe behaviours at work.</td>
<td>0.89</td>
</tr>
<tr>
<td>If I make an effort, I am able to comply with safety procedures.</td>
<td>0.74</td>
</tr>
</tbody>
</table>

As shown in Table 7.3, all the items had high factor loadings greater than .40, indicating that the scale is valid. The factor loadings indicate the relationship between the factor and the items; as the value increases, the item better represents the factor.

7.4 Reliability of the Instruments

Reliability refers to the consistency of the instrument being used to gather the data. In the current study, Cronbach’s Alpha Coefficient, the most popular internal consistency estimation technique (Carmines and Zeller, 1979), was used to estimate the reliability coefficients of each scale. Table 7.4 displays the results of this step.
Chapter 7

Table 7.4: Cronbach’s Alpha Coefficients for each subscale

<table>
<thead>
<tr>
<th>Scale</th>
<th>na</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicate Rates Checklist (Incidents)</td>
<td>21</td>
<td>0.91</td>
</tr>
<tr>
<td>Indicate Rates Checklist (Near Misses)</td>
<td>21</td>
<td>0.89</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>12</td>
<td>0.81</td>
</tr>
<tr>
<td>Extraversion</td>
<td>12</td>
<td>0.80</td>
</tr>
<tr>
<td>Openness</td>
<td>12</td>
<td>0.85</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>12</td>
<td>0.83</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>12</td>
<td>0.88</td>
</tr>
<tr>
<td>Safety Performance Questionnaire</td>
<td>19</td>
<td>0.98</td>
</tr>
</tbody>
</table>

a n is the number of items; b the value of the reliability coefficients

As shown in Table 7.4, all the reliability coefficients were greater than .07 which is the cut-off value for appropriate reliability coefficients (Nunnally, 1978).

7.5 Data Preparation

The data were examined prior to model testing to judge the extent to which they met important assumptions; this is necessary when using regression-based methods and path analysis. To verify the assumption of normality, the data were checked for potential outliers and skewness; they were also examined for the potential presence of multi-collinearity among the variables. Finally, the amount and patterns of missing data were checked.

7.4.1 Search for Outliers

Two methods were used to search for outliers in the data:

Looking at z-scores with values higher than 3 or lower than -3;

Obtaining the Mahalanobis Distance (MD), as recommended by Raykov and Marcoulides (2008). Z-scores were computed using the following equation:

\[ z = rac{x - \mu}{\sigma} \]
\[ z = \frac{x - m}{sd} \]  

Eqn (7.1)

Where \( m \) = mean and \( sd \) = standard deviation.

Table 7.5 displays the minimum and maximum values of the \( z \)-scores of the dependent and independent variables.

**Table 7.5: Z-score range of the predictors and outcomes**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>-3.85</td>
<td>2.36</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-3.25</td>
<td>2.35</td>
</tr>
<tr>
<td>Openness</td>
<td>-2.53</td>
<td>2.52</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-3.68</td>
<td>2.31</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-3.45</td>
<td>3.09</td>
</tr>
<tr>
<td>Safety compliance</td>
<td>-2.1</td>
<td>1.08</td>
</tr>
<tr>
<td>Safety motivation</td>
<td>-2.31</td>
<td>0.93</td>
</tr>
<tr>
<td>Safety participation</td>
<td>-2.56</td>
<td>1.05</td>
</tr>
<tr>
<td>Accident rate</td>
<td>-0.74</td>
<td>2.95</td>
</tr>
<tr>
<td>Incident rate</td>
<td>-0.72</td>
<td>4.42</td>
</tr>
</tbody>
</table>

As shown in Table 7.5, both accident and incident rates were positively skewed, and the ranges for Neuroticism, Extraversion, Agreeableness, Conscientiousness, Openness, and incident rates were located outside the acceptable range of the data without outliers. Although the analysis suggested the existence of many outliers in the data, especially for Neuroticism and incident rate, the researcher decided to keep those participant cases for model testing. This was done because to eliminate such a large number of participants from the dataset would result in a large loss of information.

The cases in question appeared to reflect a legitimate variability in the studied population. Moreover, after thoroughly checking for coding or typographical errors that might have caused extreme values for the identified cases, preliminary analyses showed no significant
changes in the magnitude or direction of the correlation coefficients between predictors (Personality and Safety Behaviour variables) and outcome variables (Incident and Accident Rates) when comparing the results by both including and excluding outliers.

### 7.4.2 Missing data

An initial inspection of the data indicated that a large amount was missing from the condition variables. Therefore, the researcher decided, after a discussion with his supervisor, to eliminate this variable from the subsequent analysis. The other variables in the data had a limited number of missing data. Although there are different techniques to handle missing data, the researcher decided to use the multiple imputation method to replace missing data because of its ability to maximise power and its advantage over more traditional methods (e.g., case deletion, mean substitution, regression and single imputation) (Widaman, 2006). Accordingly, five complete data sets were generated for each of the samples with an incomplete data set. All the results presented in the analyses below, therefore, represent pooled parameters from these five data sets.

### 7.4.3 Normality assumption

The researcher examined the presence of kurtosis and skewness as well as the distribution of the variables using Q-Q plots. A moderately conservative rule to follow in order to assess normality is that a variable is considered not normally distributed if the skewness and kurtosis indices exceed ±2 in magnitude (Finney and DiStefano, 2006). Table 7.6 shows the kurtosis and skewness values for each continuous variable in the dataset. Normality can also be graphically assessed by looking at histograms and quantile-quantile (Q-Q) plots. The Q-Q plots show the values of a variable with quantiles of the theoretical normal distribution. If two distributions match, the points on the plot should form a linear pattern passing through the origin with a unit slope (Raykov and Marcoulides, 2008). Figure 7.1, Figure 7.2 and Figure 7.3 show the Q-Q plots for each predictor (Personality and Safety Behaviour) and outcomes (Accident rates and Incident rates) respectively in the datasets.
### Table 7.6: Skewness and Kurtosis of the predictors and outcomes

<table>
<thead>
<tr>
<th></th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>-0.83</td>
<td>1.34</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-0.32</td>
<td>0.29</td>
</tr>
<tr>
<td>Openness</td>
<td>-0.57</td>
<td>-0.05</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-0.49</td>
<td>0.57</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-0.35</td>
<td>0.7</td>
</tr>
<tr>
<td>Safety compliance</td>
<td>-0.71</td>
<td>-0.8</td>
</tr>
<tr>
<td>Safety motivation</td>
<td>-0.93</td>
<td>-0.51</td>
</tr>
<tr>
<td>Safety participation</td>
<td>-0.73</td>
<td>-0.63</td>
</tr>
<tr>
<td>Accident rate</td>
<td>1.1</td>
<td>-0.3</td>
</tr>
<tr>
<td>Incident rate</td>
<td>1.43</td>
<td>1.41</td>
</tr>
</tbody>
</table>

![Figure 7.1: QQ plots of the Personality dimensions](image-url)
Figure 7.2: QQ plots of the Safety Behaviour dimensions

Figure 7.3: QQ plots of the Accident and Incident rates
7.5 The descriptive statistics

Table 7.7 displays the descriptive statistics (mean, standard deviations, variances, minimum, maximum and range) for each continuous variable in the dataset.

| Table 7.7: Descriptive statistics of the predictors and outcomes in the dataset |
|--------------------------------|-----------|---------|---------|---------|---------|
|                                | Mean      | sd      | min     | Max     | range   |
| Neuroticism                    | 2.86      | 0.38    | 1.42    | 3.75    | 2.33    |
| Extraversion                   | 3.35      | 0.31    | 2.33    | 4.08    | 1.75    |
| Openness                       | 2.79      | 0.35    | 1.92    | 3.67    | 1.75    |
| Agreeableness                  | 3.33      | 0.36    | 2.00    | 4.17    | 2.17    |
| Conscientiousness              | 3.66      | 0.43    | 2.17    | 5       | 2.83    |
| Safety compliance              | 3.76      | 1.16    | 1.33    | 5       | 3.67    |
| Safety motivation              | 3.95      | 1.13    | 1.33    | 5       | 3.67    |
| Safety participation           | 3.91      | 1.04    | 1.25    | 5       | 3.75    |
| Accident rate                  | 5.2       | 7.04    | 0       | 26      | 26      |
| Incident rate                  | 5.17      | 7.2     | 0       | 37      | 37      |

The values of each personality trait and each dimension of safety behaviour were divided by the number of items; this put every trait and dimension on the same five-point scale. This step was important to compare the dimensions of safety behaviour.

Standard deviation (sd) was computed using the following equation:

\[
\text{sd} = \sqrt{\frac{\sum_{i=1}^{i=n} (x - \text{mean})^2}{n - 1}} \quad \text{Eqn 7.2}
\]

Where \( n \) is the sample size.

Figures 7.4, 7.5 and 7.6 display the boxplots of the personality traits, safety behaviour dimensions, and accident and incident rates respectively.
Figure 7.4: The boxplots of the Personality dimensions

As shown in Figure 7.4, the ranges of the five personality dimensions were narrow which means that the participants are homogenous. The mean of Conscientiousness was the highest, whereas the means of Neuroticism and Openness were the smallest. Using boxplots is a good method for detecting outliers. As shown in Figure 7.4, most of the potential outliers were in the lowest sections for all personality dimensions.

Figure 7.5: The boxplots of the Safety Behaviour dimensions
Chapter 7

As shown in Figure 7.5, the participants were homogeneous in terms of their scores for safety performance which means they are almost identical to each other. There were no potential outliers based on the boxplot.

![Boxplot of Accident and Incident Rates](image)

**Figure 7.6: The boxplots of the Accident and Incident Rates**

Figure 7.6 indicates that accident and incident rates were close to zero so both were homogeneous.

As shown in Table 7.3 and Figure 7.3, Conscientiousness had the highest mean while Openness had the lowest. On the other hand, Neuroticism had the highest variance level and Extraversion the lowest. Regarding Safety Behaviour, safety motivation had the highest mean and safety compliance the lowest while the variances of the three components were very close to each other. In the case of accident and incident rates, the values of the two means and the two variances were very close.

### 7.6 The Problem of Multi-collinearity

To explore the relationship between the variables in the dataset, scatter plots and Pearson Correlation Coefficients were computed for each group of variables; these are displayed in Figures 7.7, 7.8 and 7.9.

As shown in Figure 7.7, the correlation coefficients among personality traits ranged from small to medium. Three correlation coefficients were statistically significant between Neuroticism and Extraversion, Agreeableness and Conscientiousness respectively; these three
correlation coefficients were negative. Extraversion and Agreeableness were statistically positively correlated with Conscientiousness while Openness failed to correlate strongly with any of the other personality traits. The overall values of the correlation coefficients among the personality traits indicated that the problem of multi-collinearity did not exist.

Figure 7.7: Scatter plots and correlation coefficients for Personality

Figure 7.8: Scatter plots and correlation coefficients for Safety Behaviour
On the other hand, the correlation coefficients among the Safety Behaviour components were very strong, as shown in Figure 7.8. Safety Compliance had a strong relationship with Safety Motivation \((r=.913)\) and Safety Participation \((r=.874)\). Similarly, the correlation coefficient between Safety Motivation and Safety Participation \((r=.882)\) was strong. These large correlation coefficient values revealed that Safety Behaviour components had a multicollinearity problem. Finally, the correlation coefficient between Accident Rate and Incident Rate was medium \((r=.587)\) which indicated that the two variables shared a common variance of \((r^2) 34\%\). Thus, the two rates had a common variance but they also had a unique variance which justified studying them separately.

![Scatter plots and correlation coefficients for Accident and Incident Rates](image)

**Figure 7.9: Scatter plots and correlation coefficients for Accident and Incident Rates**

### 7.7 Summary

The results of this chapter indicated that the research tools had good psychometric properties and that the reliability and validity indicators were acceptable. The relationship among the personality dimensions indicated that there were statistically significant negative relationships between Neuroticism and each of Extraversion, Agreeableness and Conscientiousness. The results also indicated that there were positive strong relationships among the safety behaviour components. These results informed the methods that were used for collecting and generating the other part of the study, the results of the multiple linear regressions path analyses, which are reported in the next chapter.
CHAPTER 8
RESULTS OF SAFETY BEHAVIOUR ANALYSIS AND MODERATING EFFECTS OF PERSONALITY DIMENSIONS

8.1 Overview
This chapter presents the results of the principal analysis conducted for the study. The first section explains the multiple linear regressions that were used to predict accident and incident rates using the dimensions of safety behaviour, and to investigate the moderating effects of the personality dimensions on the relationship between incident and accident rates, and safety behaviour. In the second section, path analyses were used to explore the direct and indirect effects of the personality traits on the relationship between incident and accident rates, and safety behaviour.

8.2 The Results for the First Research Question
The first research question concerned the relationship between the predictors (personality traits and safety behaviour) and the outcomes (accident and incident rates) in the data set.

8.2.1 The relationship between personality traits and accident and incident rates
Pearson Correlation Coefficients were computed between personality traits and accident and incident rates using SPSS; the results are displayed in Table 8.1.

<table>
<thead>
<tr>
<th>Personality Traits</th>
<th>Accident R²</th>
<th>Incident R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>0.11</td>
<td>0.22**</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-0.23**</td>
<td>-0.29**</td>
</tr>
<tr>
<td>Openness</td>
<td>-0.28**</td>
<td>-0.14</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>-0.24**</td>
<td>-0.26**</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-0.07</td>
<td>-0.23**</td>
</tr>
</tbody>
</table>

**Correlation coefficients are statistically significant at .01
As shown in Table 8.1, there were statistically significant negative relationships between extraversion, openness and agreeableness, and accident rates: that is, the scores for these three traits increase as the accident rate decreases.

As shown in Figure 8.1, there was a negative relationship between extraversion and the accident rate. The Regression equation relating to extraversion as independent variable with the accident rate as a dependent variable was written as below in Equation 8.1

\[ \text{Accident Rate} = -0.207 \times \text{Extraversion} \]  
\[ \text{Eq. (8.1)} \]

As shown in Equation 8.1, as the extraversion increases by one point, the accident rate will decrease by .207.

As shown in Figure 8.2, there was a negative relationship between openness and the accident rate. The Regression equation relating to openness as independent variable with the accident rate as a dependent variable was written as below in Equation 8.2

\[ \text{Accident Rate} = -0.207 \times \text{Openness} \]  
\[ \text{Eq. (8.2)} \]

As shown in Equation 8.2, as the openness increases by one point, the accident rate will decrease by .207.
As shown in Figure 8.2, there was a negative relationship between the accident rate and openness. Equation 8.2 represents this relationship.

\[ \text{Accident Rate} = -0.319 \times \text{Openness} \quad \text{Eq. (8.2)} \]

Openness explained 10.1% of the variability in accident rates among participants. As shown by Equation 8.3, as openness increases by 1 point, the accident rates decreases by .319.

\[ \text{Accident Rate} = -0.264 \times \text{Agreeableness} \quad \text{Eq. (8.3)} \]

The results indicated that agreeableness explained 7% of the variability among participants in terms of the accident rate and, when agreeableness increases by only one degree, the accident rate decreases by .264.

Similarly, there was a negative relationship between agreeableness and the accident rate. Equation 8.3 represents the relationship between the accident rate as a dependent variable and agreeableness as an independent variable.

Neuroticism and conscientiousness did not show statistically significant relationships with accident rates. On the other hand, neuroticism had a positive statistically significant relationship with the incident rate; that is, as neuroticism increases, the incident rate increases. Conversely, there were statistically negative relationships between extraversion, agreeableness, conscientiousness and the incident rate.
As shown in Figure 8.4, there was a positive relationship between neuroticism and the incident rate. Equation 8.4 represents the linear regression equation between the two variables.

\[
\text{Incident Rate} = 0.174 \times \text{Neuroticism} \quad \text{Eq. (8.4)}
\]

As shown, neuroticism explained 3% of the variability among the participants with regard to the incident rate and, as neuroticism increased by one point, the incident rate increased by .174.

As shown in Figure 8.5, there was a negative relationship between extraversion and the incident rate. Equation 8.5 represents the linear regression equation between the two variables.
Incident Rate = -.291 * Extraversion  

Equation (8.5)

As shown, extraversion explained 8.5% of the variability among the participants in terms of the incident rate. As extraversion increases by one score, the incident rate decreases by .291.

Figure 8.6: Negative relationship between the incident rate and agreeableness

As shown in Figure 8.6, there was a negative relationship between agreeableness and the incident rate. Equation 8.6 represents the linear regression equation between the two variables.

Incident Rate = -.175 * Agreeableness  

Equation (8.6)

As shown, agreeableness explained 3% of the variability among the participants with regard to the incident rate and, as agreeableness increased by one point, the incident rate decreased by .175.

Figure 8.7: Negative relationship between the incident rate and conscientiousness

As shown in Figure 8.7, there was a negative relationship between conscientiousness and the incident rate. Equation 8.7 represents the linear regression equation between the two variables.
Incident Rate = -0.226*Conscientiousness  
Eq. (8.7)

As shown, conscientiousness explained 5.1% of the variability among the participants concerning the incident rate. As agreeableness increased by one point, the incident rate decreased by .226.

8.2.2 Relationship between safety behaviour and incident rates

In the following subsections the relationship between safety behaviour components and accident and incident rates were examined using Pearson Correlations. In the social sciences, .01 is adopted as a level of significance which means that, if the research were to be replicated 100 times, there would be a 99% confidence that the same result would be reached and a 1% level of doubt that there would be a different conclusion.

<table>
<thead>
<tr>
<th></th>
<th>Accident rate</th>
<th>Incident rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety compliance</td>
<td>-0.55**</td>
<td>-0.20**</td>
</tr>
<tr>
<td>Safety motivation</td>
<td>-0.53**</td>
<td>-0.28**</td>
</tr>
<tr>
<td>Safety participation</td>
<td>-0.53**</td>
<td>-0.23**</td>
</tr>
</tbody>
</table>

** Correlation coefficients are statistically significant at .01

As shown in Table 8.2, there were statistically significant negative relationships between the safety behaviour components and accident and incident rates: that is, as the workers’ scores on safety performance increased, their scores on the accident and incident rates decreased.

Figure 8.8: Negative relationship between the accident rate and safety behaviour
Figure 8.8 indicates that safety behaviour components have stronger effects on the accident rate than on the incident rates.

8.3 The results of the second research question

The second research question focused on the moderating effects of neuroticism on the relationship between the safety behaviour dimension and the outcomes (accident and incident rates) in the data set.

8.3.1. The moderating effect of neuroticism

To test the moderating effect of neuroticism on the relationship between the safety behaviour components and accident rates, simple and multiple linear regressions were used to predict accident and incident rates using the safety behaviour components.

8.3.1.1 The regression results for accident rates

Tables 8.3 and 8.4 display the results of the simple linear regressions.

Table 8.3: Simple linear regression analyses of accident rates

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety compliance</td>
<td>1</td>
<td>2323.826</td>
<td>2323.826</td>
<td>59.414</td>
<td>.001</td>
</tr>
<tr>
<td>Residuals</td>
<td>217</td>
<td>8487.334</td>
<td>39.112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety compliance</td>
<td>1</td>
<td>3029.244</td>
<td>3029.244</td>
<td>84.471</td>
<td>.001</td>
</tr>
<tr>
<td>Residuals1</td>
<td>217</td>
<td>7781.916</td>
<td>35.861</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety compliance</td>
<td>1</td>
<td>2793.891</td>
<td>2793.891</td>
<td>75.621</td>
<td>.001</td>
</tr>
<tr>
<td>Residuals2</td>
<td>217</td>
<td>8017.269</td>
<td>36.946</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.4: Parameters and the significance of the regression coefficients

<table>
<thead>
<tr>
<th>Safety components</th>
<th>Behaviour</th>
<th>R²</th>
<th>Adj R²</th>
<th>Estimate</th>
<th>Std...Error</th>
<th>t. value</th>
<th>Pr(&gt;t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety compliance</td>
<td></td>
<td>0.215</td>
<td>0.211</td>
<td>-2.824</td>
<td>0.366</td>
<td>-7.708</td>
<td>.001</td>
</tr>
<tr>
<td>Safety motivation</td>
<td></td>
<td>0.28</td>
<td>0.277</td>
<td>-3.292</td>
<td>0.358</td>
<td>-9.191</td>
<td>.001</td>
</tr>
<tr>
<td>Safety participation</td>
<td></td>
<td>0.258</td>
<td>0.255</td>
<td>-3.444</td>
<td>0.396</td>
<td>-8.696</td>
<td>.001</td>
</tr>
</tbody>
</table>
As shown in Tables 8.3 and 8.4, safety compliance explained 21.5% of the accident rates and safety motivation explained 28% whereas safety participation explained 25.8% of the variance in accident rates. The results in Table 8.3 indicate that these values were statistically significant. The results of the multiple linear regressions are displayed in Tables 8.5 and 8.6.

**Table 8.5: Multiple regression analyses of accident rates**

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components of Safety Behaviour</td>
<td>3</td>
<td>3191.86</td>
<td>1063.95</td>
<td>30.02</td>
<td>.001</td>
</tr>
<tr>
<td>Residuals</td>
<td>215</td>
<td>7619.3</td>
<td>35.44</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 8.6: Parameter estimates of regression coefficients**

|                          | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------|----------|------------|---------|---------|
| (Intercept)              | 19.33    | 1.58       | 12.21   | .001    |
| Safety compliance        | 1.36     | 0.92       | 1.49    | 0.14    |
| Safety motivation        | -3.16    | 0.96       | -3.28   | .001    |
| Safety participation     | -1.73    | 0.88       | -1.97   | 0.05    |

As shown in Tables 8.5 and 8.6, the three safety behaviour components explained 29.5% of the variance in the accident rates; this proportion of the variance was statistically significant (f=30.02), degree of freedom (df)=(3,215) and p-value=.001. The results in Table 8.6 indicate that both safety motivation and safety participation contributed significantly in predicting accident rates, whereas safety compliance failed to contribute in this regard. The regression equation was:

Accident rates=19.33+1.36×safety compliance -3.16×safety motivation -1.73×safety participation.  
Eq. (8.8)

To test the moderating effect of neuroticism on the relationship between safety behaviour and accident rates, an interaction term between the safety behaviour components and neuroticism was added to the regression equation. The results are displayed in Tables 8.7 and 8.8.
Table 8.7: Effect of neuroticism and behaviour components on the accident rate

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>3191.86</td>
<td>1063.95</td>
<td>30.67</td>
<td>.001</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>1</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.99</td>
</tr>
<tr>
<td>Safety Behaviour :</td>
<td>3</td>
<td>299.52</td>
<td>99.84</td>
<td>2.88</td>
<td>0.04</td>
</tr>
<tr>
<td>Neuroticism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>7319.76</td>
<td>34.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.8: Parameters of the interaction effect in the regression coefficients

|                                | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------------|----------|------------|---------|---------|
| (Intercept)                    | -36.12   | 22.94      | -1.57   | 0.12    |
| Safety compliance              | -4.1     | 5.35       | -0.77   | 0.44    |
| Safety motivation              | -3.89    | 8.37       | -0.46   | 0.64    |
| Safety participation           | 17.3     | 8.54       | 2.03    | 0.04    |
| Neuroticism                    | 18.37    | 7.53       | 2.44    | 0.02    |
| Safety compliance: Neuroticism | 1.81     | 1.78       | 1.02    | 0.31    |
| Safety motivation: Neuroticism | 0.4      | 2.77       | 0.14    | 0.89    |
| Safety participation: Neuroticism | -6.47   | 2.88       | -2.25   | 0.03    |

As shown in Table 8.7, the effect of neuroticism and safety participation was statistically significant, as shown in Table 8.8 in terms of t-value=2.25 with p-value=.03<.05. This interaction means that the relationship between safety compliance and accident rates depends on or varies as a function of neuroticism.

8.3.2 The results of the path analysis of accident rates

To test the direct and indirect effects of the safety behaviour components on the accident rates, path analysis was used, with AMOS being used to run the analysis. Path analysis is a
statistical technique to calculate the direct and indirect effects of independent variables on dependent variables. Several statistical software packages are available to compute these effects but AMOS is one of the most popular types of statistical software for performing path analysis and confirmatory factor analysis. IBM SPSS AMOS enables researchers to specify, estimate, assess and present models to show hypothesised relationships among variables. The software allows researchers build models more accurately than with standard multivariate statistical techniques. Users can choose either a graphical user interface or a non-graphical, programmatic interface. Figure 8.9 displays the path model.

![Figure 8.9: Path diagram of the effect of safety behaviour components on accidents](image)

The results of goodness of fit indices indicated that the model fitted the data. Figure 8.10 displays the parameter estimates of the path analysis.

![Figure 8.10: Standardised coefficients for the effect of safety behaviour on accidents](image)
As shown in Figure 8.10, safety compliance, safety motivation and safety participation all had a direct effect on accident rates.

### 8.3.2.1 The regression results for incident rates

Tables 8.9 and 8.10 display the results of the simple linear regression.

**Table 8.9: Simple linear regression analyses of incident rates**

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety compliance</td>
<td>1</td>
<td>62.347</td>
<td>62.347</td>
<td>1.202</td>
<td>0.274</td>
</tr>
<tr>
<td>Residuals</td>
<td>217</td>
<td>11253.06</td>
<td>51.857</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety compliance</td>
<td>1</td>
<td>311.101</td>
<td>311.101</td>
<td>6.135</td>
<td>0.014</td>
</tr>
<tr>
<td>Residuals 1</td>
<td>217</td>
<td>11004.306</td>
<td>50.711</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety compliance</td>
<td>1</td>
<td>187.722</td>
<td>187.722</td>
<td>3.661</td>
<td>0.057</td>
</tr>
<tr>
<td>Residuals 2</td>
<td>217</td>
<td>11127.685</td>
<td>51.28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 8.10: Parameter and significant of regression coefficients for incidents**

<table>
<thead>
<tr>
<th>Safety Behaviour</th>
<th>R²</th>
<th>Adj R²</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>t. value</th>
<th>Pr(&gt;t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety compliance</td>
<td>0.006</td>
<td>0.001</td>
<td>-0.463</td>
<td>0.422</td>
<td>-1.096</td>
<td>0.274</td>
</tr>
<tr>
<td>Safety motivation</td>
<td>0.027</td>
<td>0.023</td>
<td>-1.055</td>
<td>0.426</td>
<td>-2.477</td>
<td>0.014</td>
</tr>
<tr>
<td>Safety participation</td>
<td>0.017</td>
<td>0.012</td>
<td>-0.893</td>
<td>0.467</td>
<td>-1.913</td>
<td>0.057</td>
</tr>
</tbody>
</table>

As shown in Tables 8.9 and 8.10, safety compliance explained 0.1% of the accident rates, safety motivation explained 2.7% whereas safety participants explained 1.7% of the variance in accident rates. The results in Table 8.9 indicate that only the variance explained by safety motivation was statistically significant. The results of the multiple linear regressions are displayed in Tables 8.11 and 8.12.
Table 8.11: Multiple regression analyses of incidents

<table>
<thead>
<tr>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components of Safety Behaviour</td>
<td>3</td>
<td>728.03</td>
<td>242.68</td>
<td>4.93</td>
</tr>
<tr>
<td>Residuals</td>
<td>215</td>
<td>10587.38</td>
<td>49.24</td>
<td></td>
</tr>
</tbody>
</table>

Table 8.12: Parameters of regression coefficients of incidents

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|---------|
| (Intercept) | 9.47   | 1.87    | 5.08    | 0.001  |
| Safety compliance | 3.08 | 1.08    | 2.86    | 0.001  |
| Safety motivation   | -3.51  | 1.14    | -3.09   | 0.001  |
| Safety participation | -0.51 | 1.04    | -0.49   | 0.62   |

As shown in Tables 8.11 and 8.12, the three safety behaviour components explained 6.4% of the variance in the incident rates; this proportion of the variance was statistically significant at a \( \text{df} = 4.93 \) degree of freedom \( \text{df} = (3, 215) \) and \( p\)-value = .001. The results in Table 8.12 indicate that both safety compliance and safety motivation contributed significantly in predicting accident rates to such prediction. The regression equation is presented below:

\[
\text{Incident rates} = 9.47 + 3.08 \times \text{safety compliance} - 3.51 \times \text{safety motivation} - 0.51 \times \text{safety participation}
\]

Eq. (8.9)

To test the moderating effect of neuroticism on the relationship between safety behaviour and incident rates, an interaction term was added to the regression equation between the safety behaviour components and neuroticism. The results are displayed in Tables 8.13 and 8.14.
Table 8.13: Effect of neuroticism and behaviour components on incidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>728.03</td>
<td>242.68</td>
<td>4.92</td>
<td>.001</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>1</td>
<td>116.34</td>
<td>116.34</td>
<td>2.36</td>
<td>0.13</td>
</tr>
<tr>
<td>Safety Behaviour:</td>
<td>3</td>
<td>73.94</td>
<td>24.65</td>
<td>0.5</td>
<td>0.68</td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>10397.1</td>
<td>49.28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.14: Parameters of effect in the regression coefficients for incidents

|                                | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------------|----------|------------|---------|---------|
| (Intercept)                    | -19.55   | 27.33      | -0.72   | 0.48    |
| Safety compliance              | 7.55     | 6.38       | 1.18    | 0.24    |
| Safety motivation              | 0.17     | 9.97       | 0.02    | 0.99    |
| Safety participation           | -3.05    | 10.17      | -0.3    | 0.76    |
| Neuroticism                    | 9.42     | 8.97       | 1.05    | 0.30    |
| Safety compliance: Neuroticism | -1.61    | 2.12       | -0.76   | 0.45    |
| Safety motivation: Neuroticism | -1.01    | 3.3        | -0.31   | 0.76    |
| Safety participation: Neuroticism | 0.82   | 3.43       | 0.24    | 0.81    |

As shown in Table 8.13, the safety behaviour components had a statistically significant effect on the incident rates. As shown in Table 8.14, adding neuroticism altered the relationship between the safety behaviour components and the incident rates. Before adding neuroticism, safety compliance and safety motivation had a significant relationship with the incident rates, but after inserting neuroticism those two components lost their relationship with the rate of incidents. Thus, neuroticism moderated the relationship between the safety behaviour components and incident rates.

8.3.2.2 The results of the path analysis of incident rates

To test the direct and indirect effects of the safety behaviour components on incident rates, path analysis was used, with AMOS being used to run the analysis. Figure 8.11 displays the path model.
As shown in Figure 8.12, both safety compliance and safety motivation had a direct effect on the incident rates but these effects depended on neuroticism. On the other hand, safety participation had no direct effect on incident rates.

### 8.4 The results of the third research question

To answer the third research question regarding the moderating effects in the data set of extraversion on the relationship between the safety behaviour dimensions and the outcomes (accident and incident rates), multiple regression analysis was conducted. In this analysis, interaction terms concerning extraversion were added to the regression model. These results are presented in the next section.

#### 8.4.1 The moderating effects of extraversion on accident rates

The results of the multiple linear regression when fitting the moderating effect of extraversion into the relationship between the safety behaviour components and accident rates are displayed in Tables 8.15 and 8.16.
Table 8.15: Effect of extraversion and behaviour components on accidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>3191.86</td>
<td>1063.95</td>
<td>34.13</td>
<td>.001</td>
</tr>
<tr>
<td>Extraversion</td>
<td>1</td>
<td>533.41</td>
<td>533.41</td>
<td>17.11</td>
<td>.001</td>
</tr>
<tr>
<td>Safety Behaviour: Extraversion</td>
<td>3</td>
<td>507.51</td>
<td>169.17</td>
<td>5.43</td>
<td>.001</td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>6578.38</td>
<td>31.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.16: Parameters of effect in the regression coefficients for incidents

|                                | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------------|----------|------------|---------|---------|
| (Intercept)                    | -18.29   | 18.77      | -0.97   | 0.33    |
| Safety compliance              | 11.14    | 6.68       | 1.67    | 0.10    |
| Safety motivation              | 5.9      | 8.37       | 0.71    | 0.48    |
| Safety participation           | -5.76    | 7.22       | -0.8    | 0.43    |
| Extraversion                   | 11.05    | 5.53       | 2.0     | 0.05    |
| Safety compliance: Extraversion| -2.94    | 2.01       | -1.46   | 0.15    |
| Safety motivation: Extraversion| -2.57    | 2.52       | -1.02   | 0.31    |
| Safety participation: Extraversion| 1.13     | 2.18       | 0.52    | 0.60    |

As shown in Table 8.16, there were statistically significant interaction effects between extraversion and safety behaviour. Thus, the relationship between safety behaviour and accident rates differed based on the level of the extraversion.

8.4.2 The moderating effects of extraversion on incident rates

Table 8.17: Effect of extraversion and behaviour components on incidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>728.03</td>
<td>242.68</td>
<td>5.59</td>
<td>0.01</td>
</tr>
<tr>
<td>Extraversion</td>
<td>1</td>
<td>947.39</td>
<td>947.39</td>
<td>21.81</td>
<td>0.01</td>
</tr>
<tr>
<td>Safety Behaviour: Extraversion</td>
<td>3</td>
<td>472.83</td>
<td>157.61</td>
<td>3.63</td>
<td>0.01</td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>9167.16</td>
<td>43.45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As shown in Table 8.17, an interaction effect existed between safety behaviour and extraversion ($f=3.63$); this was statistically significant at a level of .01, that is, the relationship between safety behaviour and incident rates depends on the level of extraversion.

**Table 8.18: Parameters of effect in the regression coefficients for incidents**

|                        | Estimate | Std. Error | t value | Pr(>|t|) |
|------------------------|----------|------------|---------|----------|
| (Intercept)            | -26.77   | 22.16      | -1.21   | 0.23     |
| Safety compliance      | 9.16     | 7.88       | 1.16    | 0.25     |
| Safety motivation      | 7.15     | 9.88       | 0.72    | 0.47     |
| Safety participation   | -1.64    | 8.52       | -0.19   | 0.85     |
| Extraversion           | 10.67    | 6.53       | 1.63    | 0.10     |
| Safety compliance: Extraversion | -1.82   | 2.38       | -0.76   | 0.45     |
| Safety motivation: Extraversion | -3.04   | 2.97       | -1.02   | 0.31     |
| Safety participation: Extraversion | 0.22    | 2.58       | 0.09    | 0.93     |

As shown in Table 8.18, the relationship between incident rates and both safety compliance and safety motivation became statistically insignificant when extraversion was inserted into the regression model.

### 8.5 The results of the fourth research question

To address the fourth research question regarding the moderating effects of openness on the relationship between the safety behaviour dimensions and the outcomes (accident and incident rates) in the data set, multiple regression analysis with interaction terms regarding extraversion were added to the regression model. The results of this step are presented in the next section.

#### 8.5.1 The moderating effects of openness on accident rates

The results of the multiple linear regression when fitting in the moderating effect of openness on the relationship between the safety behaviour components and accident rates are displayed in Tables 8.19 and 8.20.
Table 8.19: Effect of openness and behaviour components on accidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>3191.86</td>
<td>1063.95</td>
<td>30.81</td>
<td>0.01</td>
</tr>
<tr>
<td>Openness</td>
<td>1</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.97</td>
</tr>
<tr>
<td>Safety Behaviour: Openness</td>
<td>3</td>
<td>333.74</td>
<td>111.25</td>
<td>3.22</td>
<td>0.02</td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>7285.5</td>
<td>34.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.20: Parameters of effect in the regression coefficients for accidents

|                          | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------|----------|------------|---------|---------|
| (Intercept)              | 48.41    | 11.1       | 4.36    | 0.01    |
| Safety compliance        | -3.32    | 9.42       | -0.35   | 0.72    |
| Safety motivation        | -1.76    | 9.77       | -0.18   | 0.86    |
| Safety participation     | -7.49    | 10.49      | -0.71   | 0.48    |
| Openness                 | -11.25   | 4.31       | -2.61   | 0.01    |
| Safety compliance: Openness | 1.63   | 3.38       | 0.48    | 0.63    |
| Safety motivation: Openness | -0.31  | 3.51       | -0.09   | 0.93    |
| Safety participation: Openness | 2.07   | 3.68       | 0.56    | 0.57    |

As shown in Table 8.19, the interaction effect between openness and the components of safety behaviour were statistically significant since the f-value=3.02 and the p-value=.02, which is less than .05. Thus, the relationship between the safety behaviour components and accident rates was moderated by the level of openness.

8.5.2 The moderating effects of openness on incident rates

Table 8.21: Effect of openness and behaviour components on incidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>728.03</td>
<td>242.68</td>
<td>4.92</td>
<td>0.01</td>
</tr>
<tr>
<td>Openness</td>
<td>1</td>
<td>21.6</td>
<td>21.6</td>
<td>0.44</td>
<td>0.51</td>
</tr>
<tr>
<td>Safety Behaviour: Openness</td>
<td>3</td>
<td>164.39</td>
<td>54.8</td>
<td>1.11</td>
<td>0.35</td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>10401.38</td>
<td>49.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As shown in Table 8.21, there were no statistically significant interaction effects between openness and the safety behaviour components where the f-value of the interaction term was .44 with p-value=.51, which is greater than .05.

### Table 8.22: Parameters of effect in the regression coefficients for incidents

|                          | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------|----------|------------|---------|----------|
| (Intercept)              | 29.6     | 13.27      | 2.23    | 0.03     |
| Safety compliance        | -1.65    | 11.26      | -0.15   | 0.88     |
| Safety motivation        | 13.86    | 11.68      | 1.19    | 0.24     |
| Safety participation     | -17.99   | 12.54      | -1.44   | 0.15     |
| Openness                 | -7.85    | 5.15       | -1.52   | 0.13     |
| Safety compliance: Openness | 1.81    | 4.03       | 0.45    | 0.65     |
| Safety motivation: Openness | -6.13   | 4.19       | -1.46   | 0.15     |
| Safety participation: Openness | 6.19    | 4.39       | 1.41    | 0.16     |

As shown in Table 7.22, the three of the interaction terms between the safety behaviour components and openness were not statistically significant since the p-values of the three interaction terms were greater than .01.

### 8.6. The results of the fifth research question

To respond to the fifth research question regarding the moderating effects of agreeableness on the relationship between the safety behaviour dimensions and the outcomes (accident and incident rates) in the data set, multiple regression analysis was used with interaction terms concerning agreeableness being added to the regression model. The results of these steps are presented the next section.

### 8.6.1 The moderating effects of agreeableness on accident rates

The results of the multiple linear regression when fitting the moderating effect of agreeableness into the relationship between the safety behaviour components and accident rates are displayed in Tables 8.23 and 8.24.
Table 8.23: Effect of agreeableness and behaviour components on incidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>3191.86</td>
<td>1063.95</td>
<td>34.13</td>
<td>.001</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>1</td>
<td>10.87</td>
<td>10.87</td>
<td>0.34</td>
<td>0.56</td>
</tr>
<tr>
<td>Safety Behaviour:</td>
<td>3</td>
<td>773.45</td>
<td>257.82</td>
<td>7.96</td>
<td>.001</td>
</tr>
<tr>
<td>Agreeableness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>6834.98</td>
<td>32.39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.24: Parameters of effect in the regression coefficients for incidents

|                          | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------|----------|------------|---------|---------|
| (Intercept)              | 120.75   | 21.23      | 5.69    | .001    |
| Safety compliance        | 9.32     | 8.03       | 1.16    | 0.25    |
| Safety motivation        | -15.83   | 8.33       | -1.9    | 0.06    |
| Safety participation     | -22.00   | 7.42       | -2.96   | 0.001   |
| Agreeableness            | -31.70   | 6.63       | -4.78   | 0.001   |
| Safety compliance:       | -2.44    | 2.33       | -1.05   | 0.30    |
| Agreeableness            | 4.06     | 2.48       | 1.64    | 0.10    |
| Safety participation:    | 6.10     | 2.25       | 2.71    | 0.01    |

Table 8.23 indicates the presence of a statistically significant interaction effect between agreeableness and the safety behaviour components since f=7.96 and p=.001. So, the relationship between the safety behaviour components and accident rates varied based on the levels of agreeableness. Table 8.24 shows that the level of safety participation depends on the level of agreeableness as t=2.71 with p=.01 which is less than .05. On the other hand, statistically significant interaction effects were found between agreeableness and both safety compliance and safety motivation.
8.6.2 The moderating effects of agreeableness on incident rates

Table 8.25: Effect of agreeableness and behaviour components on incidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>728.03</td>
<td>242.68</td>
<td>5.59</td>
<td>0.01</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>1</td>
<td>91.11</td>
<td>91.11</td>
<td>1.92</td>
<td>0.17</td>
</tr>
<tr>
<td>Safety Behaviour: Agreeableness</td>
<td>3</td>
<td>464.45</td>
<td>154.82</td>
<td>3.26</td>
<td>0.02</td>
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<tr>
<td>Residuals</td>
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<td>10031.82</td>
<td>47.54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.26: Parameters of effect in the regression coefficients for incidents

|                          | Estimate  | Std. Error | t value | Pr(>|t|) |
|--------------------------|-----------|------------|---------|------|
| (Intercept)              | 84.38     | 25.72      | 3.28    | 0    |
| Safety compliance        | 3.19      | 9.73       | 0.33    | 0.74 |
| Safety motivation        | -21.6     | 10.09      | -2.14   | 0.03 |
| Safety participation     | -0.07     | 8.99       | -0.01   | 0.99 |
| Agreeableness            | -23.69    | 8.03       | -2.95   | .001 |
| Safety compliance: Agreeableness | -0.12 | 2.82   | -0.04   | 0.97 |
| Safety motivation: Agreeableness | 5.8  | 3.01    | 1.93    | 0.06 |
| Safety participation: Agreeableness | -0.19 | 2.73   | -0.07   | 0.94 |

As shown in Table 8.25, the interaction effect between agreeableness and the safety behaviour components was statistically significant since \( f=3.26 \) and \( p\text{-value}=0.02 \) which is less than .05. Thus, the relationship between the safety behaviour components and incident rates varied according to the level of agreeableness. Table 8.26 displays the individual interaction effects between agreeableness and each component of safety behaviour.
8.7 The results of the sixth research question

To answer the sixth research question regarding the moderating effects of conscientiousness on the relationship between the safety behaviour dimensions and the outcomes (accident and incident rates) in the data set, multiple regression analysis with interaction terms for conscientiousness being added to the regression model. The results of these steps are presented in the next section.

8.7.1 The moderating effects of conscientiousness on accident rates

The results of the multiple linear regression when fitting the moderating effect of conscientiousness into the relationship between the safety behaviour components and accident rates are displayed in Tables 8.27 and 8.28.

Table 8.27: Effect of conscientiousness and behaviour components on incidents

<table>
<thead>
<tr>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>3191.86</td>
<td>1063.95</td>
<td>34.13</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>1</td>
<td>17.72</td>
<td>17.72</td>
<td>0.49</td>
</tr>
<tr>
<td>Safety Behaviour: Conscientiousness</td>
<td>3</td>
<td>37.55</td>
<td>12.52</td>
<td>0.35</td>
</tr>
<tr>
<td>Residuals</td>
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<td>35.85</td>
<td></td>
</tr>
</tbody>
</table>

Table 8.28: Parameters of effect in the regression coefficients for incidents

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|---------|
| (Intercept) | 28.65 | 14.64 | 1.96 | 0.05 |
| Safety compliance | 5.92 | 6.51 | 0.91 | 0.36 |
| Safety motivation | -2.89 | 7.83 | -0.37 | 0.71 |
| Safety participation | -7.9 | 7.11 | -1.11 | 0.27 |
| Conscientiousness | -2.66 | 4.03 | -0.66 | 0.51 |
| Safety compliance: Conscientiousness | -1.3 | 1.79 | -0.73 | 0.47 |
| Safety motivation: Conscientiousness | -0.03 | 2.13 | -0.02 | 0.99 |
| Safety participation: Conscientiousness | 1.73 | 1.97 | 0.88 | 0.38 |

Table 8.27 reveals that there were no statistically significant interaction effects between the safety behaviour components and conscientiousness, indicating that the relationship between safety behaviour and accident rates was not affected by levels of conscientiousness. The F-value of the interaction effect = .35 with p-value = .79 which is greater than .05. 

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8.7.2 The moderating effects of conscientiousness on incident rates

Table 8.29: Effect of conscientiousness and behaviour components on incidents

<table>
<thead>
<tr>
<th></th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean</th>
<th>F</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Behaviour</td>
<td>3</td>
<td>728.03</td>
<td>242.68</td>
<td>5.59</td>
<td>0.01</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>1</td>
<td>325.77</td>
<td>325.77</td>
<td>6.74</td>
<td>0.01</td>
</tr>
<tr>
<td>Safety Behaviour:</td>
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<td>64.19</td>
<td>21.4</td>
<td>0.44</td>
<td>0.72</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residuals</td>
<td>211</td>
<td>10197.42</td>
<td>48.33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.30: Parameters of effect in the regression coefficients for incidents

|                          | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------|----------|------------|---------|---------|
| (Intercept)              | 2.31     | 17         | 0.14    | 0.89    |
| Safety compliance        | 2.61     | 7.56       | 0.35    | 0.73    |
| Safety motivation        | 1.52     | 9.09       | 0.17    | 0.87    |
| Safety participation     | -0.37    | 8.26       | -0.05   | 0.96    |
| Conscientiousness        | 1.74     | 4.68       | 0.37    | 0.71    |
| Safety compliance:       | 0        | 2.08       | 0.01    | 0.97    |
| Conscientiousness        | -1.19    | 2.47       | -0.48   | 0.63    |
| Safety participation:    | -0.03    | 2.29       | -0.01   | 0.99    |

As shown in Table 8.29, the interaction term added between conscientiousness and safety behaviour was not statistically significant. So, the relationship between safety behaviour and incident rates did not depend on the level of the conscientiousness. On the other hand, conscientiousness affected the incident rates as f-value= (6.74) indicating that the effect of conscientiousness on the incident rate was statistically significant.

8.8 Summary

The results of this chapter indicated negative relationships between the safety behaviour components, and accident and incident rates: that is, when the levels of safety behaviour increased, the accident and incident rates decreased. The results also indicated that the safety behaviour components had a stronger effect on the accident rates than on the incident rates (see Figure 8.8). The results also showed that both safety motivation and safety participation affected the accident rates whereas safety compliance and safety motivation affected the
incident rates. It was found that personality traits moderated the effects of the safety behaviour components on the accident and incident rates. Neuroticism moderated the effect of safety compliance on the accident rates while extraversion and openness moderated the effects of safety participation on the accident and incident rates. The next chapter presents a discussion of these results and the emergent judgements.


9.1 Overview

This chapter presents a review of and discusses the essential objective of this study: to improve safety performance in the construction industry by understanding the moderating effects of personality traits on the relationships between both accident and incident rates, and safety performance. In the first section, the relationship between the predictors (personality traits and safety behaviour dimensions) and the outcomes (accident and incident rates) is discussed in detail; it is also interpreted in the light of the literature review. In the second section, the moderating effects of neuroticism on the relationship between safety performance components and both accident and incident rates are discussed in detail while, in the following sections (sections four, five and six), the moderating effects of extroversion, openness, agreeableness and conscientiousness are discussed in the same regard. In the final section, the framework is presented based on the results and discussion.

9.2 The effects of safety behaviour and personality traits on accident and incident rates

This section is divided into two subsections. In the first subsection, the relationships between the safety behaviour components and accident and incident rates are discussed in detail while, in the second subsection, the relationships between the five personality dimensions and accident and incident rates are explored.

9.2.1 The relationship between safety behaviour and accident and incident rates

Safety performance is multidimensional and encompasses behaviours that contribute to the safety of the individual, co-workers and the organisation as a whole. Safety performance is perhaps best defined by the extent to which an individual performs behaviours that increase the safety of these parties and avoids behaviours that decrease their safety. Safety performance therefore can refer to a metric for employees’ safety-related behaviours and researchers have used the term to refer to safety outcomes that are tangible events, or to results like incidents and accidents. Safety performance is important in terms of the psychological aspects of safety literature because safety behaviour is a measurable criterion that is more closely related to psychological factors than incidents or accidents are to injuries.
An additional benefit of examining safety performance as opposed to objective safety outcomes is that researchers can predict safety performance behaviours with greater accuracy since objective safety outcomes often have a low base rate and skewed distributions. Likewise, individuals may under-report accident and injury data because of social pressures. Therefore, it is important to distinguish between safety-related behaviours and the outcomes of those behaviours because the antecedents may affect each differently. The results from the previous chapter indicated that there were statistically significant negative relationships between the safety behaviour components, and accident and incident rates: that is, as workers’ participation, motivation and compliance with regard to the safety procedures in the construction companies increased, the number of accidents in the field decreased. Organisations typically see safety behaviours as employees’ compliance with behavioural safety routines.

The results indicated that the three components of safety performance (compliance, motivation and participation) have a medium negative relationship with accident rates since the three components showed negative correlation coefficients of around -.50. The correlation coefficients of the three components of safety performance ranged from -.55 for safety compliance and -.53 for both safety motivation and safety compliance. On the other hand, the three components had only a small negative relationship with incident rates as the components had correlation coefficients ranging from -.20 for safety compliance and -.28 for safety motivation. This means that safety compliance, safety motivation and safety participation had negative relationships with the number of accidents. Although the safety components showed negative relationships with both accident and incident rates, the relationships were stronger with accident rates than with incident rates. These results could be explained in several ways. First, many participants may have failed to understand the difference between accidents and incidents and may have given the same value in both the accident and incident columns. The researcher tried hard to explain the differences between the two concepts; however, in most cases, participants still gave the same responses for both columns. Secondly, the participants may have underestimated the number of incidents out of a sense of social desirability. Thirdly, the safety compliance behaviours comprised safety activities that are part of the formal work procedures; these included using personal protection equipment correctly; properly using lock-out, tag-out and try-out procedures; applying appropriate work practices to reduce exposure to potential hazards and injury; and generally following safety policies and procedures. Similarly, the researcher considered
safety compliance (e.g., wearing personal protective equipment) as consisting of the core safety behaviours required to perform the job and ensure workplace safety, while safety participation were considered to be behaviours that promoted an environment of safety (e.g., attending safety meetings) which were beyond those required by the job. The results also indicated that the three components of safety performance explained together 29.5% of the variance in the accident rates, each component making a unique contribution in the prediction of accident rates. Similarly, the three components explained 6.4% of the variance in incident rates among the participants. However, the results indicated that only safety compliance and safety motivation made a unique contribution in predicting incident rates. This means that safety motivation has a direct effect on injuries suffered in the workplace. (The researcher reminds readers here that accidents were defined to include actual reported accidents, unreported accidents and “near misses” (or incidents that could have caused an injury but did not).) So, it is clear that the focus of safety management needs to shift from managing and monitoring accidents to managing and monitoring incidents. This involves focusing on pre-incident conditions instead of managing post-incident situations which is often based on analyzing the causes of an incident. While safety compliance is clearly an important dimension of organisational safety, compliance alone does not necessarily lead an organisation to achieve an excellent safety record. Regulations issued by OSHA and other similar agencies, for example, state that organisations must protect employees from known hazards in the work environment so it stands to reason that established safety rules and procedures, which are developed largely in response to regulatory agencies, are designed to protect employees only from known hazards in the work environment.

Thus, employees who go no further than safety compliance will probably not be protected from new or previously unknown hazards in the work environment. However, if safety participation is also high, employees will vigilant about new hazards and will find better ways to protect themselves. A second reason that safety compliance alone will not necessarily protect employees is that safety is often impacted by situational pressures. In the construction industry, for example, contractors are under tremendous pressure to finish buildings and other structures as quickly as possible. As a result, the use of proper safety procedures is often perceived as a barrier to the project’s completion and employees may cut corners as a result. However, if safety participation in an organisation is also high, employees might be more likely to view safety as a part of their jobs and thus as a high organisational priority. The results of the current study found that the corrected correlation between safety
compliance and accident involvement was significantly weaker than the corrected correlation
with safety participation. Although this is not necessarily a surprising finding, this does
provide empirical evidence that safety participation is not only important conceptually but
may also have important practical implications for the safety records of organisations. The
results also indicated that the three safety performance components had direct effects on
accident rates whereas only safety compliance and safety motivation had a significant direct
effect on incident rates. These results could be explained in the light of the definition of
safety motivation which refers to an individual’s willingness to make an effort to act safely,
as well as the importance an individual places on behaving safely. Motivation can be
identified as a critical determinant of safety outcomes on the grounds that behaviour depends
on the motivation individuals demonstrate in a situation; it also determines the direction,
strength and duration of volitional behaviour. Consistent with this proposition, safety
motivation has been shown to influence a range of safety behaviours at work. This study has
also provided evidence that the Big Five personality traits are useful predictors of the
antecedents of accidents and injuries. The direct effects of the safety behaviour components
could also be explained based on the traditional methods of safety performance which rely
primarily on some form of accident or injury data. Moreover, safety-related behaviours, such
as safety compliance and safety participation, may also be considered as components of
safety performance since safety compliance represents the behaviour of employees in terms
of improving their own personal safety and health while safety participation represents the
behaviour of employees with regard to increasing the safety and health of co-workers and
supporting the organisation. The results of the current study found that safety compliance
(following rules in the performance of core job tasks) and safety participation (acting in ways
that enhance the safety of the organisation as a whole) have direct effects on incident and
accident rates, whereas safety motivation had an indirect effect on accidents and injuries.

9.2.2 The relationship between personality traits and accident and incident rates
The results of this study indicated that extraversion, openness and conscientiousness have
statistically negative relationships with accident rates: that is, as workers become more
talkative, social, assertive, adventurous and energetic (extraversion), they become less prone
to accidents. Similarly, workers who are characterised by imagination, artistic sensitivity,
intellectual curiosity, independence and broad interests (openness), they become less prone to
accidents. Finally, workers who tend to take responsibility, act in an orderly and well-planned
manner, are careful and persevering, work hard and are achievement-oriented (conscientiousness) are less likely to cause or suffer an accident.

On the other hand, neuroticism was found not to have a statistically significant relationship with accident rates since, although it did show a positive relationship in this regard, this relationship was not statistically significant. Conscientiousness also had a weak negative relationship with accident rates but, with respect to incident rates, neuroticism showed a statistically significant positive relationship while conscientiousness had a statistically significant negative relationship. The results also indicated that both extraversion and agreeableness have statistically negative relationships with both accident and incident rates. Only openness did not show as having a statistically significant relationship with incident rates. In summary, only three (extraversion, openness and agreeableness) out of the Big Five personality traits had statistically significant negative relationships with accident rates whereas four (neuroticism, extraversion, agreeableness and conscientiousness) had statistically significant relationships with incident rates. Figure 9.1 provides a graphic illustration of the interactions of aspects of personality traits and their effects on accident and incident rates. The results also indicated that only extraversion and agreeableness had statistically negative relationships with both accident and incident rates. The correlation coefficients of personality traits, and both accident and incident rates were small, ranging from -.07 for the relationship between conscientiousness and accident rates, to -.29 for the relationship between extraversion and incident rates. The results document reliable relationships between conscientiousness, extraversion, neuroticism, agreeableness and accidents at the level of individual workers. However, this is not always the case since there are a number of environmental and demographic variables that moderate the relationships. Nevertheless, it does appear that people who score high on conscientiousness tend to have fewer accidents, while people who score high on neuroticism tend to have more accidents.
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To summarise, individual workers characterised by conscientiousness, openness, high extraversion and low agreeableness are least likely to experience incidents, accidents and injuries at work. Such individuals are able to focus on their work tasks, believe they can affect their environment and make efforts to do so, and are not easily distracted by external or internal stimuli. On the other hand, an individual characterised by neuroticism is more likely to suffer incidents and accidents. These individuals have difficulty focusing on their work tasks, are easily distracted by external and internal stimuli, and tend not to believe they can affect their environment. The negative effects of these characteristics are likely to be exacerbated by stressful work situations, such as pressure to increase production or negative social interactions with supervisors and co-workers.

9.2.2.1 The moderating effects of neuroticism on the relationship between the safety performance components and both accident and incident rates

The results indicated that neuroticism had a moderating effect on the relationship between the safety performance components and accident rates. Neuroticism changed the type of relationship between two of the components of safety performance (safety motivation and safety participation) and accident rates while the relationship between safety motivation and accident rates became statistically insignificant. This indicates that any intervention to improve the safety motivation of the workers in order to improve the safety culture of the organisation and reduce the number of workplace injuries will be worthless if the levels of neuroticism of workers are not taken into consideration. Similarly, the relationship between safety participation and accident rates converted from being a statistically significant negative
relationship to a statistically significant positive one. This suggests that any efforts that are made to improve the safety participation of neurotic workers will result in increasing the number of accidents in the workplace. Therefore, it is very important to classify workers according to their personality traits before trying to implement any procedures to improve safety participation. In the case of neuroticism, any effort to increase safety participation without knowing the neurotic status of the workers is likely to produce the opposite result. The results of this study highlighted the importance of neuroticism as a moderator in the relationship between two components of safety performance and accident rates. On the other hand, the results also indicated that neuroticism has a moderating effect of the relationship between two components of safety performance (safety compliance and safety motivation) and incident rates. The relationships between incident rates and both safety compliance and safety motivation lost their significance among neurotic workers, suggesting that increasing safety compliance and safety motivation will not decrease the number of near-miss accidents among neurotic workers. Therefore, it is important to measure the levels of neuroticism among the workers prior to implementing any intervention to improve the safety performance components. To summarise, the results in this study might indicate that a certain amount of concern for personal safety and social norms is needed for is needed for safety initiative, but instability and moodiness may have a negative effect on driving. Similarly, the lack of concern and excessive trust expressed as low scores in terms of neuroticism might lead to risk-taking on a construction site. The above results could be explained in the light of the characteristics of neurotic workers.

9.2.2.2 The moderating effects of extraversion on the relationship between safety performance components and both accident and incident rates

The results indicated that extraversion had a statistically significant positive relationship with accident rates, indicating that, as workers’ scores on the extraversion scale increased, they became more liable to accidents. The results indicated that extraversion has a moderating effect on the relationship between the safety performance components and accident rates. Similar to neuroticism, extraversion changed the type of relationship between two components of safety performance (safety motivation and safety participation) and accident rates with the relationships between both safety motivation and safety participation and accident rates becoming statistically insignificant. This suggests that any intervention to improve the safety motivation or safety participation of workers to improve an organisation’s safety culture and reduce the number of injuries in the workplace will be worthless if the
extraversion levels of workers are not considered. Therefore, it is very important to classify workers according to their extraversion levels before trying to implement any procedures to improve safety participation.

On the other hand, extraversion modified the relationship between safety motivation, safety participation and incident rates, moving from statistically significant negative relationships to non-significant ones. Ignoring the personality characteristics of workers will result in making any effort to enhance safety performance and reduce near-miss accidents fruitless. Several empirical studies have supported the positive relationship between extraversion and accident involvement.

9.2.2.3 The moderating effects of openness on the relationship between safety performance components and both accident and incident rates.

The moderating effect of openness to experience was established in the current study where openness decreased the strength of the relationship between safety compliance, safety motivation and accident rates. The correlation coefficients of safety compliance and safety motivation became statistically not significant when workers’ scores on the openness scale were taken into consideration. The results indicated that as workers became more open to experiences, the relationship between safety compliance and safety motivation became weaker and finally became statistically not significant. In more practical terms, as workers demonstrate to a greater degree the following characteristics (active imagination, aesthetic sensitivity, attentiveness to inner feelings, preference for variety, intellectual curiosity and independence of judgment), their safety performance has a weaker relationship with accident rates: that is, it becomes impossible to predict accident rates by the safety performance of such workers.

Similarly, openness modified the relationships between safety motivation and safety participation and incident rates since the results indicated that the relationship between safety motivation and incident rates was highest for workers with a low level of openness to new experiences while the relationship was lowest for workers with high openness. In terms of safety compliance, the correlation coefficient with incident rate was strongest for workers with medium openness to experience and weakest for workers with high openness. The results of the current study indicated that openness had the largest mean validity in terms of accidents, indicating that workers who are more open to new experiences are more accident-prone. The findings suggest that this relationship is moderated. Thus, high openness would be desirable for developing a well-trained workforce. However, particularly in a routine working
environment where safety compliance is critical, imaginative, curious and unconventional individuals might be more liable to violate rules and to experiment and improvise. Those with low scores for openness would have an enhanced ability to focus on the task in hand and would therefore be less likely to become involved in an accident. Overall, there is no evidence to suggest that the relationship between openness and accident involvement would be moderated by context.

9.2.2.4 The moderating effects of agreeableness on the relationship between the safety performance components and both accident and incident rates.

The results indicated that agreeableness moderated the relationship between safety motivation, safety participation and accident rates. Moreover, the correlation coefficients between safety motivation, safety participation and accident rates became statistically not significant when agreeableness was included in the regression equation: that is, both safety motivation and safety participation failed to predict accident rates when agreeableness was included in the regression equation. The results indicated that the relationships between safety motivation, safety participation and accident rates were strongest for those workers with low agreeableness, whereas the relationships were weakest for workers who were highly agreeable. These results indicated that individuals with high scores in terms of agreeableness might be more compliant with safety rules and procedures. These inferences should be interpreted with caution given the relatively low magnitude of the correlations and the small amount of common variance.

On the other hand, the relationships between safety compliance, safety motivation and incident rates were statistically significant in terms of negative correlation coefficients for workers with low agreeableness scores, whereas the correlation coefficients for highly agreeable workers were positively statistically significant; they were not statistically significant for workers of medium agreeableness. Thus, agreeableness changed the type and strength of the relationships between safety motivation, safety participants and incident rates. These results could be explained based on personality characteristics since workers who show levels of agreeableness are pleasant, tolerant, tactful, helpful, not defensive and generally easy-going. The results showed a negative relationship between agreeableness and accident involvement. Agreeableness includes elements of trust, compliance and altruism, and studies examining personality and accidents have shown that agreeableness is most salient in situations that involve interactions or cooperation with others. This researcher found that agreeableness was related to job performance in occupations involving
interpersonal relations, particularly with regard to team-based working. Individuals who are low in agreeableness may be less able to cooperate with others effectively and more liable to respond aggressively to situations, thus increasing their accident liability.

**9.2.2.5 The moderating effects of conscientiousness on the relationship between the safety performance components and both accident and incident rates**

The results indicated that conscientiousness modified the relationship between safety motivation, safety participation and accident rates. Both safety motivation and safety participation failed to predict accident rates when conscientiousness was included in the regression equation. The regression coefficients for safety motivation and safety participation became statistically not significant when conscientiousness was added to the regression equation. The results indicated that the relationships between safety motivation, safety participation and accident rates were highest for workers with medium levels of conscientiousness whereas the relationships were smallest for workers with high scores in this area. This suggests that the relationships between safety motivation, safety participation and accident rates varied according to the levels of conscientiousness. On the other hand, conscientiousness affected the relationships between safety compliance, safety motivation and incident rates while the regression coefficients of both safety compliance and safety motivation became statistically not significant when conscientiousness was included in the regression equation for predicting incident rates. The results indicated that the relationships between safety compliance, safety motivation and incident rates were strongest for workers who were conscientiousness to a medium degree whereas they were lowest for workers with low levels of conscientiousness. Thus, both safety compliance and safety motivation failed to affect the incident rates of workers with high or low conscientiousness.

In general, the results report a tendency for conscientiousness to correlate well across measures of job performance. There is also evidence to suggest a role for conscientiousness in terms of safety performance since there is a negative correlation between conscientiousness and accidents. The characteristics of conscientiousness include the following: competence, order, dutifulness, striving to achieve, self-discipline and deliberation and there is evidence that several relevant personality traits which relate to low scores in terms of conscientiousness, such as carelessness and a lack of self-control, are significantly associated with accident involvement. A further aspect of conscientiousness, which is related to the characteristics of deliberation and order, is reflected in thoroughness in decision-making styles. Low thoroughness, which has been shown to correlate with accident risk, is
characterised by a lack of forward planning, absence of a logical or systematic approach to decision making, and inadequate cost-benefit analysis and contingency planning. Workers who demonstrate low conscientiousness exhibit behaviours that are characterised by a focus on satisfying immediate needs, regardless of future consequences for themselves or others; a lack of goal-setting and a failure to follow rules and regulations; and inadequate reflection relating to on-task processes. Furthermore, this study suggests that workers who are low on conscientiousness are more vulnerable to cognitive failure.

9.3 Summary
This chapter has presented and established the important role that individuals can have on projects’ safety performance. At the same time, the role of training to re-condition workers suggests that workers with a tendency to be unsafe can be turned around to improve overall safety performance. Much of such improvement would have to focus on the incident stage of safety management to make it effective and this could be done by concentrating on pre-incidents as part of human resources management. Also, the safety behaviours of individuals could be changed by first changing attitudes. Thus, the framework developed in this thesis is an attempt to discover the personality characteristics of workers before they begin work on a construction project. This phase would help human resource managers to select the most appropriate workers for specific sites and projects before hiring them. The overall purpose of the study from which this thesis was derived is to develop individuals’ contribution to safety as a means of improving the safety performance of construction organisations. Also, training and learning are of vital importance in controlling risk and safety supervisors should pay attention to this by trying to educate workers and training them to deal with heavy apparatus and the dangerous materials. Engineers must also be educated and trained in designing in such a way to control risk. Safety management systems are very significant in improving the safety of sites but unless safety becomes a culture the desired goals will not be achieved.

This thesis presents a conceptual framework that was developed to support the study; this focuses on the need to shift safety management from managing and monitoring accidents to managing and monitoring incidents. This calls for a greater understanding of incident causation in construction.

Finally, the levelling out of safety performance improvements is a matter of concern in Saudi Arabia and research attention is required to ensure safer working environments in the construction industry. Such safer working environments can be achieved by focusing attention on three phases as important aspects in controlling risks to ensure that safe working
environments are developed in the construction industry. The three phases are: human resource management to select appropriate workers before they start work on a construction project; safety training for workers on construction sites at all stages of a project; and finally the careful investigation of incidents as a means of avoiding accidents. Within this thesis, the researcher proposes a conceptual model with a view to developing application tools from the results of the investigations. The resulting tools would present a novel option for improving construction safety in that could be used by construction organisations in Saudi Arabia to improve safety performance. The following chapter presents the development and validation of the improvement framework.
CHAPTER 10
FRAMEWORK DEVELOPMENT AND VALIDATION

10.1 Overview
A framework for improving the safety performance of Saudi Arabia projects is necessary if there is to be continuous improvement in performance and effective planning over the long term. This framework needs to be very organised and systematic and this can be achieved by utilising the interactions of aspects of the three safety components (safety compliance, participation and motivation) and personality traits to discover how accident and incident rates are directly affected. The literature review and the analysis of collected data formed a concrete basis for developing such a framework to achieve safety performance improvements in construction projects. This chapter presents the development and validation of the framework so designed. It discusses the need for the framework and presents an overview of its components. The validation of the framework is also covered, as well as implications for its use.

10.2 Framework structure and contents
This section provides a framework, as depicted in Figure 9.1, to improve safety performance by investigating workers’ safety behavior. It concentrates on the workers’ characteristics as measured with by the Big Five Personality Model and much the desired improvement would need to focus on the incident stage of safety management in order to make the framework effective; moreover, the focus of safety management needs to shift from managing and monitoring accidents to managing and monitoring incidents. Because incident research in the construction industry is generally limited to factor identification, the pursuit of improvements would need to concentrate on preventive solutions with a more proactive approach before site operations begin. Such a proactive approach includes the research work currently underway which gave rise to the thesis that forms the basis of this study. Understanding the reasons that give rise to accidents and an analysis of incidents should also lead to a more proactive approach in safety performance management. Figures 8.1 and 8.2 offered a graphic illustration of the interactions and effects of the three safety components and personality traits on safety performance. Since these have a direct effect on accident and incident rates, this study has established the important role that individuals have in project safety. At the same
time, the role of training to re-condition workers is very important as it suggests that the behaviours of workers with a tendency to be unsafe can be changed, resulting in overall safety improvements. Addressing management issues that precede workers’ engagement onto a project by determining their personalities, carefully investigating incidents and developing an effective reporting system are major actions or resources that can help construction organisations to determine the safety problems and how to deal with them in a clear and strategic manner. The framework, which is based on personality traits, therefore offers interventions that can be measured to establish how safety performance can be improved. This framework has three phases as depicted in Figure 10.1.
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Figure 10.1: Process for improving workers’ safety performance

a. Management phase – This phase involves addressing the management issues that precede workers’ engagement by determining their personalities. Tests and face-to-face interviews are commonly conducted to select the most appropriate personality model for each worker. This is called the management phase and involves the construction workers, after their personality
has been ascertained, being assigned work activities that match their trait types. Section 10.2.1 below gives more detail about this phase.

b. **The safety training and learning phase** – This phase, which involves training and learning, is the most important aspect of risk control and requires urgent research attention to ensure a safe working environment in the construction industry since safety is a major concern in this area in Saudi Arabia. By concentrating on the safety behaviours of individuals, this framework offers a review of alternatives that can make the desired changes that will lead to changes in attitude and subsequently the behavioural changes necessary to improve safety. Safety supervisors should pay particular attention to this phase by educating the workers and training them to deal with heavy apparatus and dangerous materials. Engineers should also undergo education and training so that project design includes elements that will control risk. Safety management systems are very important for construction sites but unless safety becomes a culture in such places the desired goals will not be achieved. The advice contained in this framework focuses on interventions aimed at three specific types of desired outcome:

- Changed individual behaviours
- Improved worker interactions with equipment or processes
- Culture change at an organisational level.

Although individuals may differ in terms of their levels of ability, as well as their levels of intelligence, skill and concentration patterns, certain types of behaviour are common to almost all people in a given set of circumstances. Section 10.2.2 below gives practical guidance on how to actively discourage risk-taking behaviour. This is followed with a list of strategies for encouraging safe behaviour. Finally, there is an outline of issues which may have a bearing on safety performance when carrying out routine tasks.

c. **Incident investigation and reporting system phase** – This phase, the incident investigation and reporting system phase, constitutes a major resource that can help construction organisations to determine what the safety problems are and respond to them in a clear and strategic manner. The adoption of an appropriate reporting system can improve safety by minimising the level of unsafe conditions. It is further suggested that the monitoring required for such reporting often leads to corrective actions arising from incident investigations that also contribute to improving safety. In general, it can be argued that unsafe conditions in the
work environment and risk-prone behaviour by the workforce are the main factors that give rise to incidents. Safety can be improved by reducing the factors that cause incidents; also the ability and willingness of workers to report actual incidents or any potential ones are influenced by their general commitment to safety and the effectiveness of the reporting system available to them. When such commitment is low, and coupled with an ineffective reporting system, very few potential incident situations will be captured. Section 10.2.3 below offers more details about this phase.
Figure 10.2: Framework process map
10.2.1 Management phase

This proposed phase for investigating workers’ safety behaviour concentrates on the workers’ characteristics, measured by using The Big Five Personality Model as mentioned earlier. They can then be allocated work according to their characteristics. Concentrating on the safety behaviours of individuals can lead to the desired changes which then lead to changes in attitudes and finally to behavioural changes.

This phase offers interventions, based on personality traits, that can be measured to establish how safety performance can be improved. It appears from the proposed phase that safety might be improved in terms of performance and the causes of accidents reduced by dealing with the safety behaviours of construction employees. It is a very easy task to implement tests and face-to-face interviews, especially the personality tests provided in the social sciences, and it is worth mentioning that human nature does not vary; it is the same on construction sites as it is in the petroleum fields, in medical organisations or in educational establishments. (The tests used are shown in Appendix A.) Such tests might provide clear ways of improving safety since the literature review showed that the main factors (70%) in the causation of accidents came from workers and work teams. Thus, this framework is an attempt to implement these tests with construction employees to ascertain their characteristics before they begin work on a construction project; it will also help human resource managers to select the most appropriate worker for the job which will best suit his nature. As the literature review and the results of this study showed, neuroticism is related to task performance so workers who are of this type of disposition are more likely to suffer an accident or incident. Thus, if workers’ personalities are determined before they are engaged as part of a project then, after approval, they can move on to tasks which suit their personalities. Moreover, construction supervisors can ensure that workers will be trained and given practical guidance in an informal but appropriate way. For example, warning signs suited to their cultures could be used; tours could be organised for new employees; they could be invited to ask questions about safety rules to increase their understanding of the dangers around them; rules and advice could be repeated to raise awareness; and their work could be changed from time to time because accidents are often related to routine work. Section 8.8.2 offers practical guidance on how risk-taking behaviour can be actively discouraged by concentrating on the safety behaviours of individuals with certain personality traits (e.g. neuroticism); this may have a bearing on safety performance when carrying out routine tasks. However, workers with the personality traits of openness, conscientiousness, extraversion

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and agreeableness might be able to work on a construction site straightaway without the need for practical guidance. This framework can therefore contribute to improving the safety performance of construction workers as requirements in terms of their behaviours would be moderated by the personality evaluations. In this way, the framework offers a radical alternative to the current traditional approaches and will form a basis for identifying opportunities of safety improvement.

10.2.2 The safety training and learning phase

The guidance booklet published by HSA (2003), the Health and Safety Authority in Ireland, offered guidance for the promotion and enforcement of workplace health and safety. The practices advised in this publication are adopted in this second phase as guidelines for work on Saudi Arabian construction sites in order to improve the safety behaviour of employers, managers and the self-employed. Flawed systems of work result in increased human error, which then causes accidents in the workplace. Within any system, the key stakeholders are:

- Humans
- Machines
- Interactions between the two above.

A flawed system can be extremely destructive for both individuals and organisations so this calls for a better focus on safety practices which can be beneficial for all. The most visible benefit is the minimising of risks associated with possible health and safety hazards in the workplace. Avoiding or reducing these accidents also minimises the monetary expenditure which otherwise involves charges for hospitalisation, medical expenses, losses in earnings, legal fees, the repair or replacement of equipment, expenses for accident investigation, compensation costs, and the cost of the recruitment and induction of replacement staff, etc.

Another benefit is the boost to the morale and well-being of all members of an organisation when the occurrence of accidents is at a minimum.

The overall research study can also be seen as a guide for employers, managers and owners as a way to access information with regard to improving occupational safety. Several suggestions, based on internationally conducted research work that has managed to reduce the frequency and severity of workplace errors and injuries, have been used to draft the information given here and several different types of intervention are offered, including:
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- Training
- Alternative approaches for employees’ performance feedback delivery
- Workplace incentives for competitive performance
- Innovative instruction systems
- Ways of influencing attitudes and beliefs
- Modifying the nature of supervision
- Making changes to manufacturing production systems and process systems
- Changing process systems

The information contained in this phase aims, in its information and advisory notes, to focus on interventions at three levels:

- The individual level by changing the behaviour of individuals
- The workplace level in terms of worker-equipment interactions by improving workers’ interactions with equipment or processes
- The organisational level by achieving cultural change at an organisational level.

10.2.2.1 Changing individuals’ behaviour

There are common behavioural patterns in almost all people under a given set of circumstances, irrespective of the level of intelligence, skill and concentration patterns or overall ability of the individual. Keeping that in mind, this study discusses and presents some ideas to discourage risk-taking behavior and encourage safe behavior; finally, it presents an outline of issues that might affect safety performances during routine tasks.

A - Discouraging risk-taking behaviour

Although risk-taking behaviour does not directly correlate with accidents, discouraging such practices is necessary to avoid the creation of a cumulative influence on the overall work culture. This could be quite a challenge since it is common human behaviour to maintain the status quo by making educated guesses while assuming that risk can be dealt with without any harm; this extends to other spheres as well as the construction industry. The following strategies can be adopted by managers in order to discourage risk-taking behaviour among employees:
Always comment on unsafe behavior, irrespective of whether or not an accident followed the behavior. If someone “gets away with” an unsafe act and it is discovered, it is not enough to simply reprimand the individual in question. The potential consequences of the act, even though they did not occur, should be described.

Advise the person concerned of the correct behaviour and insist that the stipulated procedures are followed as soon as possible.

Promote safe behaviour by commenting positively when it occurs.

Acknowledge safe behaviour publicly, preferably in the presence of the individuals concerned and their colleagues/peers.

Lead by example. Never cut corners on safety, particularly if you are in a position of authority.

Ensure that all potentially hazardous incidents are recorded. Identify the hazard and, where possible, reduce/eliminate it.

**B - Encouraging individuals to behave safely**

Managers should encourage safe behaviour by:

- Using a combination of training and feedback. Using training methods alone is insufficient. Researchers recommend that feedback should continue for some time after new work practices have been introduced in order to ensure that new performance standards have been fully integrated into everyday work routines.

- Providing regular demonstrations of safe versus unsafe behaviour.

- Explaining to workers why an act is unsafe, even if it is not followed by an accident.

- Identifying a goal per week, per work area in terms of measurable outcomes (reduced near-misses/mistakes, for instance).

- Focussing particularly on those doing routine work as repetition encourages less attention over time.
• Giving employees both visual and verbal instructions: the use of images or photographs is particularly recommended.

• Displaying lists of ‘dos’ and ‘don’ts’ prominently, i.e. where workers can see them clearly as they work.

**C - Improving safety behaviour in the performance of routine tasks:**

While performing routine tasks such as assembly work, packing, loading, stacking, data input, routine computing, etc., people are known through relevant research to have reduced vigilance and concentration levels after continuously working for 30 minutes. Managers are advised to adopt the following points to minimize the risk of accidents in the workplace:

• The work schedule should be arranged along the length of the working day with provision for very brief 1-2 minute breaks.

• Periodical alterations should be made in the location or type of work, with the proper cooperation of the workers. This should be done in an organised and consistent fashion, thus facilitating uplifted stimulation levels; ensuring change occurs at regular intervals is essential to avoid any negative impacts.

• Job rotation between the workers should be considered, possibly by building a suitable team structure.

• Innovative techniques should be applied to make the workers’ tasks more interesting.

• Every accident that occurs on-site should be recorded properly. Many accidents are related to fatigue, especially among those working night shifts; this should be taken into account.

• Optimum level of alertness should be maintained as much as possible.

• Frequent interventions due of excessive supervision may result in skill-based errors, which should be avoided.

• Knowledge-based errors should be avoided by not assigning too much data for workers to handle while they work on tasks that are critical to safety.
Sufficient acquaintance with rule-based errors needs to be acquired to enable the correct application of rules. The last four points are discussed in the respective four sections that follow.

**Levels of alertness/arousal:**

The alertness level for all humans has an optimum value associated for any task; any other level of alertness may adversely affect performance. In the case of more complex and challenging tasks, the optimal level of alertness is often higher than that recommended while performing routine tasks. Managers need to ensure that the workers performing routine tasks maintain sufficient attention while performing them. Keeping track of the workers’ attention by issuing random beep alerts is a possible strategy that can be used by the managers, although this is said to be effective only in the short term. Other methods include playing short safety messages in case a radio is playing in the background, playing brief danger/hazard-themed music, or giving a ten minute round-up, when music is paused, of safety aspects regarding employees’ tasks and procedures.

**Skill based errors:**

Skill-based errors are the gradually increasing errors associated with routine tasks carried over a long term. These errors are often encountered when personnel/workers who are adept at a task are interrupted, thereby causing a break in the flow of work. This forces the worker to revive or restart the operation using an approach they are not used to but have to implement in order to get back into the flow. Interruptions may occur through excessive supervision or disruptive monitoring by managers; this is not advised. However, this does not prevent managers from implementing acceptable supervisory standards, but they must do so with proper consultation, especially with operating personnel, so that skill-based errors are reduced. The workers also need to be aware of how such errors can occur or have occurred, thus involving them in the mitigation process.

**Knowledge-based errors:**

It is understood that the general human brain processes a limited amount of information at a time, be in terms of the number of pieces of data or qualitative information. Focusing on
quantitative instances, most people struggle to remember phone numbers which usually consist of nine digits, for example, 3, 1, 6, 7, 8, 0, 9, 2, 5; recalling them individually can be mentally taxing. If these digits are grouped in threes, people find it much easier to recall them so, 316, 780, 925. Attaching certain meanings or concepts while forming ‘chunks’ of data also helps retain information in the memory for some people although ways that work are generally extremely subjective. The memory works in such a way that sometimes, while recalling information, the middle chunk(s) is often forgotten while the first and last chunks are retained. In a given context, people involved in performing safety critical tasks (e.g., setting alarms) may face equally daunting consequences. Proper caution is therefore necessary and managers should ensure that any worker is not over-burdened with tasks. Having to perform tasks beyond their handling capabilities may lead workers to make errors as they can only focus on one aspect at a time.

Rule-based errors:

When an individual has insufficient knowledge to perform a task safely, applies an incorrect rule, or prefers to apply an incorrect procedure despite having the correct knowledge, it is said that a rule-based error has been committed. If a worker does not have a proper grasp of a procedure, perhaps owing to a lack of training or improper training that has skipped over the recommended rules and instead applies adjusted rules according to convenience, then the resulting quality of work will almost inevitably be impaired. An apprentice may be given the correct training but it is possible that he will by-pass the correct rule, dismissing it as cumbersome, time-consuming or even incorrect. Another form of rule-based error is when an individual perceives the known rule in his/her own way and implements it accordingly. As an example, a worker operating a machine might believe the correct way to warm up the machine safely is to press the ‘Start’ button and then use it. Unless told otherwise, he/she may tend to follow the same set of activities if a new machine is assigned when the new machine may involve a different start process. The worker thus applies the wrong rule and commits a rule-based error that may have safety consequences. Supervisors/managers are advised to adopt the following steps to prevent such errors:
Alertness should be maintained and the proper reason should be deduced following the occurrence of every error.

Informal Q & A sessions should be made part of the daily routine; sample questions could be ‘what’s the next step after turning on the machine?’ or ‘how would you close off the system for maintenance?’

Changing into a new task demands proper information about the changed rules, associated dangers and the required behaviours.

The people responsible for training new people or leading new work activities should be checked regularly to avoid any negative propagation.

With changing circumstances and practices the recommended rules and regulations also alter; these should be accounted for in the workplace.

### 10.2.2.2 Achieving improved employee interaction with equipment and work processes

With its vast petroleum resources, KSA is one the largest hubs for employment attracting foreigners from all over the world; this is clearly evident in the expatriate demographic. The Saudi government should give due consideration to developing its work culture as insufficient measures have been taken to improve employees’ interactions with equipment and work processes. This section focuses on assessing such interactions with new equipment and work processes as common mistakes are often made by designers and/or manufacturers.

The following items need to be addressed by managers in such cases:

- Workers with jobs that are extremely repetitive
- Regular review of workers’ productivity and quality of work
- Risks and injuries involved with any particular job/task
- Complaints by employees and refusal to work on a specific task
- Capability of certain employees to perform certain tasks to the required standards
- Inadequacy of rest breaks for employees and instances of unscheduled breaks
- Work space conditions: whether they are cramped or spacious, lighting conditions etc.
- Workers having to travel long distances and/or having to make undue efforts to bend/stretch to access materials, tools and equipment.

Many observations depend on the nature of the work and the type of workplace environment but managers might find the following dos and don’ts helpful.
These include managing employees who operate machinery since a manager is required to show an operator the exact procedure for working the machinery, along with possible risks and dangers; these are all problems associated with the operating process.

Managers must also ensure that the manual handling of goods and equipment is eliminated wherever possible. However, if certain areas require manual operation, the manager should arrange for a competent person to train the workers, as well as generate adequate awareness of the health risks and hazards associated with the manual handling of heavy items. Minimising accidents owing to slips, trips and falls in the workplace are also the manager’s prerogative and certain precautionary measures should be instilled among all workers. Precautions include ensuring that areas are well-lit, workers are wearing proper gear (such as footwear), walkways are clear of obstructions, new recruits are inducted into safe working practices, floors are clean, dry and not slippery, signage for safety and operating convenience is adequate, and the necessary cleaning and maintenance work is carried out after the completion of the shift’s operations.

One typical aspect of a manager’s responsibilities involves managing shift workers where a proper knowledge of the Organisation of Working Time standard regulations is recommended. Shift working can adversely affect the physical and mental health of the worker so adopting mitigating measures, as proposed by researchers after numerous assessments through related case studies, include a preference of fixed shifts over rotating ones. For operations demanding rotating shifts, it is suggested that the shift rotations are rapid rather than slow. Also, longer daily work hours of 10 to 12 hours are found to be similar to ones with 8-hour daily working hours in terms of potential hazards so the latter is suggested as being advantageous for workers’ overall health and quality of life.

10.2.2.3 Achieving cultural change at an organisational level

The safety culture of an organisation is a key factor that influences its progress or regress, almost irrespective of the legislative work that goes into creating and promoting safer workplaces. The safety culture of an organisation can be understood as a combination of the organisation’s way of doing things, employees’ perception of those actions, workers’ perception of risks/hazards in the workplace, general attitudes towards injury/illness and lastly, the value attributed among them. It is apparent that, in terms of an organisation’s safety culture, the attitudes of all members play a key role in its overall improvement. Thus, an effective safety culture will make favourable changes to the attitudes of employers,
management and employees towards safety. A coordinated change in attitudes is essential for this to work as it is quite futile to expect either the workers or the management to make such change for themselves. It is quite normal to inflict punitive actions on workers for breaking norms and adopting unsafe/risky practices but positive strides towards safe practices should also be rewarded, especially during the initial stages of safety improvement, either by offering a monetary reward, a token of appreciation/praise, positive feedback and/or recognition. Providing safety training courses is a strategy proposed by this study and the courses offered should attempt to break through the subjective opinions of people with regard to their perception of safety and risk to ensure their behaviour is favourably altered by being convinced of the inherent dangers associated with specific operations. Awareness-raising campaigns should help to achieve this objective, with information about such issues being made accessible to all members of the organisation in an attempt to change their safety behaviour for the better. Often this involves first changing the attitude of team leaders/supervisors, who may not entirely trust the motives and actions of senior management, so attempts need to made to communicate with them and win them over. The following issues should be considered by managers who are attempting to change attitudes to safety in circumstances similar to those described above. Managers are advised to form groups among the workers based on common affiliation, like-mindedness or functionality when they are imparting training. The hierarchy or organisational structure of the workplace must be maintained as training works best in that way. It is often rendered ineffective if any mixing is done: managers with junior staff, for instance.

Decision-making processes about safety practices require the involvement of all levels of the hierarchy; they are not just the privilege or the responsibility of top management.
Managers should establish a link between personal attitudes towards health and safety outside of work and responsible behaviour at work. They should offer induction programmes, preferably by using images and photographs to train the workers/employees. Personal behaviours like smoking, speed driving, fitness regimes, healthy habits, etc. can be related and superimposed onto the workplace setting for the given purpose.

10.2.3 Incident investigation and reporting system phase
This phase calls for a greater understanding of incident causation in construction work. Also attention should be diverted from monitoring and managing accidents to monitoring and managing incidents. The conceptual model was derived from an extensive review of both the
academic literature and industry initiatives to improve safety in several countries. Within the area of construction safety, a significant number of investigators have attempted to establish the exact factors, their magnitude and their nature that give rise to accidents (Hollnagel, 2009) and the incident investigation proposed in the conceptual model has two main parts: monitoring and managing. As can be seen in the proposed model, shown in Figure 10.1, in developing the conceptual model for incident investigation, the researcher relied on extensive research material such as standards and safety systems, as well as tools and mechanisms for the analysis process. This helped to establish the preliminary path with regard to the occurrence of any incidents related to construction sites. Lack of control and safety inadequacy often reflect a function of three principal parameters which can be grouped under the following categories:

- Communications
- Personal Performance
- Inspection/Testing Programme
- Administrative Management Systems
- Human Factors Engineering

Specific aspects, such as a Preventive Maintenance Programme to investigate incidents, have two main parts:

*Managing the pre-incident phase*: This is based on analysing the causes of incidents to establish and reduce events which are likely to lead to accidents.

*Monitoring phase*: This focuses on the post-incident environment and conditions as part of a control and management programme to improve safety in construction workplaces.

The process can be summarised as follows:

**Part One: Applying measures of safety performance**

This involved attempting to:

- Set and give details about the accident,
- Define normal relationships,
- Decide on ideal ways of avoiding such an accident,
- Test the validity of any countermeasures,
- Discover why the system is failing towards refused limits of control.
Part Two: Incident investigations

The available information was then investigated to determine the events, conditions, gaps in the data, causal factors, and ultimately, root causes. Discussion sessions can also illustrate and reinforce key concepts then these can be covered by reports and training. Any training programmes that are offered must be based on real accidents if they are to be successful and deliver the desired results. Developing the investigation should focus on the following:

- Define the reasons for accidents and give a number of examples of accidents that can be studied and evaluated so that trainees will understand the accident process.
- Describe the management of the organisation.
- Define the main reasons for accidents, as well as setting a test in order to encourage trainees to cope by themselves.
- Explain how information is collected so that any accidents can be studied.
- Explain Causal Factors Charting; in this part, trainees can learn how study an accident at the right time.
- Define the essential reasons for examining accidents; this part aims to teach trainees how to use the Root Cause Map during the examination of an accident.
- Ask trainee what was the best and worst thing or part in the training in order to avoid the worst and concentrate on the best.
- Define how to collect all the information forthcoming from the trainees.

It is important to carry out research into incidents as through such study the reasons why such incidents occur can be analysed and understood, thus reducing the occurrence of both incidents and accidents. This would clearly have a positive impact on the construction industry and its growth, as well as the financial benefits of the project. Productivity is represented by achieving organisational goals and when an organisation is not achieving its goals, pressure is increased to achieve the required level of productivity. Losses due to incidents cause decreases in productivity which, in turn, increases pressure. So, if improved safety means that business goals are more likely to be achieved, then management will also benefit. So, incident investigation means searching beyond obvious or immediate reasons to establish the root causes of accidents.
10.3 Recommendations for improving health and safety performance on construction sites

Any initiative to improve health and safety management within the construction industry requires the sustainable generation of an environment that encourages favourable practices. The present study aims to create such an environment in the context of Saudi Arabia as construction sites are increasing their ability to comply with standard health and safety regulations. These recommendations are discussed below in terms of two levels:

10.3.1 Government level

- The main objective of the Saudi Arabian government is the promotion of safe and healthy working environments. The Saudi government, as both a moral and a religious obligation, is committed to providing protection for all workers and other stakeholders in terms of work-related issues. Saudi Arabia needs a number of cooperating health and safety organisations and groups to accomplish three main objectives: a) the protection and promotion of workers’ health and working capabilities; b) the enhancement of working environments so that workplaces become safer and healthier; c) the creation of work groups and working traditions to ensure safety in the workplace. All of these initiatives will help to develop a new and safer social environment which will eventually increase the efficiency of the Saudi workforce.

- Establish and develop the Occupational Safety and Health Administration Saudi (OSHAS) to regulate safety on construction sites and take disciplinary action against those who violate safety regulations in order to avoid further repeated mistakes.

- Introduce construction training programmes which include health and safety that run parallel to, or in combination with, the tertiary education curriculum and vocational education. Such training, which will raise the competency level of workers in construction companies, should be accessible for people who are not formally educated. Formal educational institutions could make such programmes complementary to the regular training in civil engineering and construction, employing skilled training centre personnel at all levels in the country. The levies payable from contractors’ payment certificates could be used for funding such programmes.
10.3.2 Public level

- Contractors should be provided with appropriate education and training on health and safety management; this would then be reflected in enhanced productivity in their construction companies.

- The thesis revealed those factors which drive improvements in safety performance: these require the serious consideration of construction stakeholders so that the personality dimensions of employees who work in construction sites are considered. The recruitment of workers and assigning of particular tasks on construction sites also needs to be focussed on. “Motivation, Participation and Compliance” should be made a motto so that safety performance is always in the minds of employees.

- The study stresses the need to address aspects of management prior to engaging workers for operational tasks; this is necessary if construction companies are to ensure improvements are made in health and safety, as well as to enhance their productivity. Workers can be assessed on their personalities before they are allowed to start work on a project, as discussed in Section 10.2.1. The role of managers is to be actively engaged in this phase so that individual workers are assigned occupational positions that are suited to their natures. This phase takes place before workers are hired to do the construction job.

10.4 Framework validation

A further broad structure for improving the safety of projects in the Saudi construction industry is presented in this study, as revealed in Figure 10.2. The aim of this section is to describe the validation procedure for the framework which was achieved by obtaining stakeholders’ feedback on various issues pertaining to the framework. This included validating the concept of the research to improve safety performance in construction sites and the feasibility of the framework’s implementation. The following sections examine the validation approach and its results; a discussion of the framework, comments and suggestions for improvement, the framework’s possible implementation, other implications and a summary, are also presented.

10.4.1 Framework validation

The aim of the validation exercise was to test the framework’s practicality, clarity and appropriateness. The following objectives were proposed for the framework’s validation:
1. To discuss and seek agreement about the findings and major issues presented in the framework, together with their effects on the improvement of safety performance.

2. To discuss and validate the framework’s critical success factors (phases) and their influence on improvements in safety performance.

3. To discuss and validate the phases by reference to good practice.

4. To discuss and validate the framework’s implementation strategy to provide a practical guide.

### 10.4.2 Validation process

According to Pidd (2009), the idea of validation depends on the view that a framework is a representation of the real world, or at least part of it. Furthermore, validation is intended to certify and confirm that the framework or the model, when placed under certain conditions, behaves, or does not behave, like the actual world (Miser, 1993; Pidd, 2009). It is worth mentioning here that such validation is more suitable for interpretive models or frameworks and not necessarily appropriate for interpretive models or frameworks where many perspectives of the epistemology of science may play a vital role. Pidd (2009), from an historical and/or communal perspective, stated that any model becomes valid when it obtains the acceptance and accreditation of relevant experts or the scientific community. As with Miser (1993), the criteria for validation may not be unanimous as any judgement of validity relies on the situation in which the proposed model or framework is adopted, as well as the phenomenon being modelled. For the validation of qualitative models/frameworks, a qualitative approach (i.e. using interviews and surveys) is proposed by Smith (1993) to highlight the advantages and disadvantages of the model. However, Oberkamof and Trucano (2008) reviewed a number of definitions for validation and stated that it can be defined as a process for determining the degree to which a model is an accurate representation or depiction of the real world from the perspective of the intended user(s) of the model. Church (1983) stated that the term “validation” implies that a judgement is made by a competent person or body while the validation phase of a scientific method can be said to be obsolete if the objective of the research task has been attained (Bock, 2001). In this very research, the development framework was validated through a workshop and validation was sought by obtaining the judgements and feedback of stakeholders.

The validation workshop was attended by those stakeholders who had participated in the data collection stage so that these participants already had a clear picture of the framework. In the workshop, their insights were sought about its applicability in the field. Miser (1993) and
Pidd (2009) argued that the expression of practical and realistic views emphasises the possible utilisation of a model which means that some authors consider validation as a way of ascertaining if a framework is practical and realistic in terms of use. The design of the validation workshop with regard to the choice of stakeholders played a vital role in obtaining utilitarian and pragmatic views. At this point, it is important to distinguish between verification and validation: verification means ensuring that the model or framework is what was intended to be built (i.e. building the model right) whereas validation ensures the degree to which the input and output of the model or framework relates to the real system (i.e. building the right model) (Miser, 1993; Pidd, 2009, Ng and Smith, 1998). It should be noted that this differentiation is valid for quantitative models/frameworks, particularly computerised or simulation models. However, verification issues are weak or fragile in their existing or current form in many situations (Miser, 1993; Pidd, 2009).

10.4.3 Validation Process

In order to carry out verification, authentication or validation, three routes have been defined and seven stakeholders who were connected to the original compiling of the information used in this study were requested to attend the validation workshop. Their presence was necessary in order to gain judgments from an expert point of view concerning the research outcomes. In addition to the feedback, the discussions which take place among people present at a workshop are also valuable as this allows ideas to be shared that can lead to an understanding of whether a realistic, implementable and suitable framework was devised. Ritchie and Lewis (2009) focussed and targeted group discussions to enable participants to be more expressive in terms of displaying their own ideas and experiences, as well as listening to those of others; this allows vast experience and knowledge to be brought to the proceedings. In the same way, according to Kreuger and Casey (2000), well-defined group discussions provide a more relaxed atmosphere where the sharing and discussion of views is more comfortable in comparison to the more formal interviews where individuals may feel stressed and under pressure when giving their own impressions; this is often due to the influence that one personality might have on another. The conducted workshop focused on the authentication of three main areas which were identified as:

1. The theory underpinning the framework,
2. The results of the research and the phases of the framework in improving safety performance,
3. Recommendations and the framework’s implementation.
The stakeholders were provided with ‘Post-it-Notes’ on which to write their review and comments. These notes were later pinned on a board for further argument and discussion in groups. According to Oppenheim (2003), the 5-point Likert-scale has the useful feature that it is a less pessimistic approach and allows harmonisation between items that measure the same thing. For this reason, the validation process utilised a 5-point Likert-scale. The attitude instrument rated the results of the research on the basis of two forms or scales of measurement: agreement and importance. In the first type of scale, the 5-point Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree), and from 1 (very weak) to 5 (very strong) for the second form of measurement. The validation workshop consisted of three phases that are detailed as below.

**Phase 1**
In the first phase, the researcher delivered a twenty minute presentation which covered a project overview, and its aims and objectives. These were presented to provide the audience and attendees with a clearer picture of the methods employed in the research, as well as to elaborate the techniques used to build the improvement framework; the discoveries revealed by the research were also presented.

**Phase 2**
The proposed framework for safety performance improvement was presented to the participants to obtain a review of the concept so that any potential pitfalls or weaknesses in the research’s structure or contents might be highlighted before its full implementation, and also so that any amendments or corrections deemed necessary could be agree upon. An open ended discussion followed where the arguments and opinions raised by the participants provoked new thoughts and ideas. The respondents were given complete liberty to voice their views and to ask questions. Participants were invited to indicate their level of agreement with the whole framework, and to comment on its transparency, the sequence and series of improvements from one step to another, the use of the framework’s phases for each facet of future projects, its potential as a learning tool, and the measures of safety performance. The participants responded to the developed framework by assessing:

- The wholeness of the framework in dealing with all the issues/objectives;
- Its potential for achieving safety performance improvements;
- The fitness of the framework and the ease with which it could be implemented;
• The willingness of management to put into practice the framework’s concepts in future construction projects.

Phase 3
The third phase consisted of an in-depth analysis of the framework in which the most critical success factors of the framework’s phases were identified by the help of case studies revolving around the effects of safety performance. An informal, welcoming and uncomplicated discussion resulted in the attainment of constructive criticism and a useful weighing of all the factors. The participants were encouraged to provide a rating on the basis of their level of satisfaction concerning the extent to which the framework’s phases were easy to comprehend and use in the field of construction management. They were also asked to provide feedback on their degree of satisfaction with the recognition of the critical success factors of the framework’s phases in terms of the good practice that guides improvements in safety performance. The aim of this was to allow participants to assess the potential scope of any improvement in safety performance according to what they understood as good practice.

As mentioned above, an open discussion took place at the start of each phase. The third phase of the validation process considered the chances of the framework being used and also consulted the stakeholders about how much they agreed with the possible implementation presented to them. In addition, a form was distributed to stakeholders to document their observations about the most effective ways of implementing this framework.

10.4.4 Scope and Limitations
This research was concerned with issues affecting improvements in safety performance and considered results from the original sample in order to do this. Therefore, the results are pertinent to construction management. The target audience of the research was stakeholders involved in safety and health on construction sites. For the validation process, seven participants represented the stakeholders which was a focused effort to sustain consistency between the results of the research and the source of the collected data collection; this was also intended to address any gap between the results/outcomes and their sources.

10.4.5 Participants Information
The seven participants represented as show in Table 10.1. For easy identification and systemic presentation for validation results through tables, the participants used quantitative feedback (Likert–scale ratings) to provide their views regarding the level of agreement as
well as importance. Although the use of arithmetic means suggests treating Likert-scale-based data at an interval level of measurement, the mean scores should not be deemed as “quantities” to show how much more important each factor is than the other, but as “indicators” to establish a rank order of importance for a factor (Idrus and Newman 2002). The validation questions covered the following four main points.

1. General results.
2. The phases of the framework suggested for improving safety performance.
3. Assessment of proposed framework (Practicality of the framework, appropriateness of the framework and clarity of the framework)
4. Validation of research recommendations.

Table 10.1: Type and Number of Participants Involved in Validation Workshop

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation Type</th>
<th>Position</th>
<th>Years’ experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Tariq M. Nahhas</td>
<td>Umm Al-Qura University</td>
<td>Dean of Architectural collage</td>
<td>21 years</td>
</tr>
<tr>
<td>Dr. Abdul-Rahman A. Al-Tassan</td>
<td>Head of the Architectural Technical Committee</td>
<td>Manger</td>
<td>23 years</td>
</tr>
<tr>
<td>Prof. Sadi Assaf</td>
<td>King Fahd University</td>
<td>Professor</td>
<td>26 years</td>
</tr>
<tr>
<td>Mohammad H. Al-Nagadi</td>
<td>Ministry of Municipal and Rural Affairs</td>
<td>Manger</td>
<td>20 years</td>
</tr>
<tr>
<td>Khalid Y. Al-Khalaf</td>
<td>Saudi Arabian Standards Organization</td>
<td>Manger</td>
<td>22 years</td>
</tr>
<tr>
<td>Dr. Rajeh Z. Al-Zaid</td>
<td>Member of the Saudi Building Code National Committee</td>
<td>Manger</td>
<td>22 years</td>
</tr>
<tr>
<td>Eng. Abdulaziz Alqahtani</td>
<td>Saudi Aramco Company</td>
<td>Safety Manger</td>
<td>20 years</td>
</tr>
</tbody>
</table>

10.4.6 Validation results and discussion

The responses, arguments, criticism and advice of the stakeholders were obtained by means of a justification sheet which was completed by all participants during the workshop. The general conclusion of the validation was very positive and highly encouraging, with participants supplying beneficial feedback throughout the workshop about the proposed framework. The results showed that a large percentage of the stakeholders were of the view that the improvement framework could be adopted and used.
10.4.7 Validation of the framework’s components

The participants’ level of agreement regarding their assessment of the improvement framework was certainly high since they unanimously agreed upon and accepted its concepts. It was agreed that the model was both workable and appropriate, and that the framework highlighted the major stages that are crucial in the safety improvement process. The stages that were discussed were felt by the stakeholders to be in the right order, that knowledge would be shared and continuous improvement in safety performance would be achieved. The whole process for managing and monitoring incidents and accidents met with the full agreement of the stakeholders.

The discussions also covered whether or not the management phase was the best technique to use as a first step in enhancing safety performance, and management procedures that preceded the engagement of workers onto a project by determining their personalities were also addressed. Normally, personality models function by way of tests and/or face-to-face interviews and this part of the management phase involves construction workers being subject to a personality model in order to assign work activities to them that match their traits and attributes. All participants said that the management phase could be easily understood and applied in accordance with its clear methodology. The safety training and learning phase was appreciated by all stakeholders and this has been acknowledged as an indicator of safety performance both in the results of this research and in the literature review. These elements play a vital role in controlling risks and exposing weaknesses; it is a potential research area to further improve the safety of working environments in construction. By focussing on the safety behaviour of individuals, this framework offers a range of alternatives that can make the desired changes, leading to changes in attitudes and subsequently to the behavioural changes required for safety improvement. Safety supervisors and other personnel with responsibility for safety should pay attention these two aspects and should try to educate and train workers in how to handle heavy instruments, equipment and apparatuses, as well as dangerous materials. Individual labourers and workers should also receive training according to the particular design specifications of each project they are working on. Safety management systems are very important for employees’ safety, as well as companies’ reputations and the construction industry as a whole. However, until safety becomes a culture which is inculcated in the mindsets of all those involved in the industry and overtly displayed on all working sites, the targeted and desired goals will not be achieved. The
recommendations contained in this framework focus on interventions aimed at three specific outcomes:

- Changed individual behaviour
- Improved worker interactions with equipment and processes
- Cultural change at an organisational level

Stakeholders agreed that the final phase, the examination and reporting system, should be part of the general responsibilities of managers on construction sites and it received the wholehearted support of the stakeholders as such a system is a major resource that can help the construction industry to identify, comprehend and evaluate safety problems in a lucid and strategic manner. Furthermore, adopting a suitable reporting scheme can minimise the intensity of insecure and dangerous surroundings. The stakeholders also highlighted that monitoring must be compulsory in such reporting as it frequently shows, from researching incidents, how and when to take corrective action, thus facilitating safety improvement.

Speaking generally, it might be said that unsafe conditions in the work environment and workers having a blasé attitude to risk are the main culprits that cause injuries and harmful occurrences. However, safety can be improved by reducing those factors underlying incidents. The motivation of workers and their willingness to report incidents can be influenced by their general dedication to safety, together with the effectiveness of the reporting system to proactively raise awareness of any possible incidents. Low levels of such commitment, along with an ineffective reporting system, mean that only a few potential incident situations might be brought to light.

The stakeholders were further asked to rate their level of agreement with aspects of the framework (see Appendix D). Moreover, Figure 10.4 clarifies that the distribution of overall assessment of components based on a scale (strongly disagree to strongly agree) as well as average of score achieved for these items.
10.4.8 Validation of recommendations for improving the safety performance of Saudi Arabian construction sites

It is clearly necessary to build and maintain a conducive environment and increase the competence of construction sites in order to manage their operations in a safer and healthier way. This is important because a significant improvement in the health and safety performance of the sector is an important goal in Saudi Arabia; in this regard, a summary and rough list of suggestions was created to address shortcomings in the management of health and safety on building sites in the Kingdom. Ideas for improving health and safety routines of
construction sites in Saudi Arabia were put forward to stakeholders who offered their opinions on the feasibility of items in the submission. The following points were made:

- The recommendations were good in terms of their cost and benefits to Construction Safety Performance, workers, companies and the government;
- Each idea had the potential to improve the health and safety performance of construction sites;
- The suggestions would be easy to implement;
- Problems regarding the implementation of the suggestions were outlined; and
- Supplementary comments (if any) relevant to the proposals with regard to improving health and safety on construction sites were given (see Appendix D).

Figure 10.5 clarifies that the distribution of overall assessment of recommendations (Government level and Public level) based on a scale (strongly disagree to strongly agree) as well as average of score achieved for these items.

![Figure 10.5: Validation of recommendations](image)

**Figure 10.4: Validation of recommendations**

**10.5 Summary**

This chapter provides a discussion of the overall results including the literature review, the preliminary study and the findings. The research findings were first examined in the light of the literature review and then the framework’s structure and contents were discussed under the following main themes: the adaptability of the management phase to the context;
addressing the management issues in determining workers’ personalities before engaging them on a project. This stage of subjecting workers to a personality model is commonly conducted through tests and/or face-to-face interviews; it enables appropriate work activities to be assigned to them that will match their trait types.

The chapter then discusses the safety training and learning phase which involves, according to the literature, adopting the concept of safety as a culture on working sites. Safety training and learning are the most important aspect of controlling risk in order to ensure safer working environments in the construction industry. Indeed, safety should become a culture on construction sites in Saudi Arabia. This framework has been designed to promote and enforce health and safety in the workplace so that changes will take place which will lead to changes in attitude and hence to the behavioural changes that will ensure safe working environments in the construction industry. The framework also provides a link between individuals, the environment and conditions in the form of two aspects: a procedure to report incidents, and education and training for workers to teach them how to deal with unsafe behaviours. The literature argued the need to pursue safety improvement by using preventive solutions with a more proactive focus on events before site operations. The need to shift safety management from managing and monitoring accidents to managing and monitoring incidents was also clearly stated in order to raise the awareness of all workers engaged in site operations to critical factors associated with incidents. Such awareness, raised through the phases proposed in this framework, could contribute to the ability and willingness of the workforce to embrace safety improvements by making safety management more proactive.

The development of this framework for improving the safety of construction workers in Saudi Arabian projects is the main outcome of this research. This framework was developed based on the findings of the study’s results together with some guidelines derived from the literature review. The framework was validated by way of a workshop conducted with stakeholders in the context of safety performance in projects in Saudi Arabia, a process which was found to be a practical, useful and clear. The overall feedback was mostly positive and a few comments were offered which were then taken into consideration. The following chapter presents the conclusions, recommendations and suggestions for further research.
CHAPTER 11

CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

11.1 Overview

The first chapter introduced the thesis while the second provided a comprehensive literature review to determine what is known about current practices in the international construction industry regarding construction worker safety and health. Chapter 3 provided a comprehensive literature review which focused in particular on the health and safety performance of Saudi Arabia. This included an examination of the challenges facing the Kingdom in this regard, as well as a review of injury statistics for workers in the construction industry. Chapter 4 presented a comprehensive literature review to identify and clarify the concept of attitudes and behaviour with regard to safety in terms of personality traits. A review of incidents on construction sites lead to a consideration of triggers in order to identify situations that might lead to accidents in the workplace.

Chapter 5 explored and discussed theories concerning both incidents and accidents, and how understanding relationships between them could lead first to pinpointing the causes of accidents and subsequently to improvements in safety. Chapter 6 provided a detailed discussion of the overall research methodology, including the background to the research and the methodology used, the research’s philosophy and approach, and the actual research process which included a literature review, population selection, and sampling. Chapter 7 presented demographic variables, the psychometric properties of the instruments used in the study, descriptive statistics and the Pearson Correlation Coefficients for the research variables while Chapter 8 investigated the moderating effects of the personality dimensions on the relationships between the other variables by using multiple linear regression and path analyses. Chapter 9 presented a review of the essential objectives of this study and discussed ways of improving safety performance with reference to the construction industry by understanding the moderating effects of personality traits on the relationships between both accident and incident rates, and safety performance. Chapter 10 offered a discussion of the research findings and the development of a conceptual framework for improving the health and safety performance of the construction industry in Saudi Arabia. This final chapter, Chapter 11, concludes the thesis by summarising the findings and the main conclusions of the research. The limitations of the study are also presented.
The following sections examine the achievement of the objectives of the research and the contributions this study makes to the body of knowledge. The limitations of the research are outlined and publications from the study are presented, together with some considerations for future research.

11.2 Achievement of the research aims and objectives

The purpose of this research was to develop a conceptual framework of recommendations to improve safety performance in the construction industry in Saudi Arabia by understanding the relationship between personality traits, safety behaviour and incident rates. In order to achieve this aim, six goals were set and their fulfilment is laid out in the following subsections.

11.2.1 Fulfilment of the first objective

The first objective of this research was establish the historical and current context, together with present practices with regard to the performance of health and safety in the global construction industry. Features of the construction industry were also examined, culminating in a critical discussion about international performance-based safety legislation and safety performance measurement. Chapter Two focused on the construction industry and its huge importance for any economy and the industry’s characteristics and background were analysed. Unsatisfactory health and safety records were also recognised within Chapter Two. A lack of awareness of the long-term advantages of health and safety within the construction industry has led to many cost-cutting methods being used and this was discussed alongside the main features of the industry as well as specialised features of OSH; effective measures of safety performance were also reviewed. In addition, the Council Directive, which follows a performance-based method, now follows the basic health and safety rules in Europe. These include the Construction (Design and Management) Regulations (CDM, 1994) in the United Kingdom, the National Model Regulations, and the National Code of Practice for the Control of Workplace Hazardous Substances (1994) in Australia, and the Health and Safety in Employment Act (1992) and Regulations (1995) in New Zealand which were also analysed. The main features of this new approach involves the responsibility for health and safety on construction sites being shifted from contractors to involve other contributors to the construction process such as clients and designers (ILO, 1992; Lorent, 1999; Caldwell, 1999).
11.2.2 Fulfilment of the second objective

The second purpose of this research was to conduct a state-of-the-art-review of safety performance in Saudi Arabia to provide essential details concerning the obstacles to progressive safety improvement, as well as to consider important statistics on safety and work-related injuries in the construction industry. Chapter Three described Saudi Arabia as economically and industrially transformed due to the use of modern machinery, equipment and chemicals. This has led to a huge increase in factories that are used to produce a wide variety of materials; it has also doubled employee numbers. However, these developments have also brought with them a greater number of risks as occupational injuries and diseases are being sustained by workers in the workplace and this can be viewed as a threat to the progress of Saudi Arabia’s economic and industrial development. Therefore, it is vital that more awareness is raised regarding the importance of health and safety in Saudi Arabia so that its industries continue to expand.

This chapter (Chapter 3) also analyses some issues regarding improvements to occupational health and safety in Saudi Arabia. The key aspects of this involve the background and challenges to Saudi’s safety performance in construction projects, as well as the safety performance of developing countries in the construction field. Occupational injury rates and statistics showed that the main cause of accidents (70%) was the workers and the working team themselves. However, if individual behaviour was targeted before any failure actually took place, this would mean that the cause of risky acts would not be scrutinised whilst individuals might be blamed for incidents that might not be their fault. So, safety behaviour research offers many positive aspects such as reducing the rate of accidents and enhancing communication between workers, while, at the same time, concentrating on workers being the necessary focus of safety performance by avoiding accidents which are caused by their lack of understanding. (This is discussed in more detail with regard to the third objective.) This research highlights the psychological aspects of safety performance in Saudi Arabia and is interested in particular in the behavioural and personality features which influence accidents.

11.2.3 Fulfilment of the third objective

The third purpose of this research was to provide a critical appraisal of the current theories that underpin attitudes to safety behaviour, and incident and accident rates, as well as accident forensics, all of which reflect operational activities on construction sites. Chapter Three
Chapter 11

examined the nature of the safety behaviour of employees and its correlation with increases or decreases in performance which then affected the incident rates on construction sites. In addition, the human personality was also examined, alongside theories that attempt to explain human nature, to gain a better understanding of the behaviour of employees. Furthermore, the concept of studying incidents, which takes place before an actual accident occurs, was also mentioned; this area requires further research if safety on worksites is to be improved. By focusing on the safety behaviour of individuals, this research attempted to determine alternative methods to create changes in attitude and behaviour for the purpose of safety improvement.

The construction industry is trying to reduce dramatically the accident rate for both humanitarian and financial reasons. Health and safety initiatives must therefore depend on human involvement so that employees maintain positive attitudes. So, creating a safety culture is integral to reducing the rate of accidents and, by focusing on this, behavioural changes can be made where necessary. In addition, social approval and peer encouragement can also assist, more than the direct interventions of management, in changing behaviour and attitudes towards safety. This way, workers are given more authority to define and observe their own behaviours, whether these are safe or unsafe, and thus provide targets to improve safety. Line management can also be of assistance by giving support and resources to workers to motivate them to achieve the safest working environment they can whilst instilling the notion that workers will not need to be constantly monitored. This research presents a conceptual model for conducting safety studies and has developed application tools, based on the results of the investigation, which can be used to improve the safety performance of organisations in the construction industry.

11.2.4 Fulfilment of the fourth objective

The fourth objective of the research was perform an empirical investigation into the role that the personality traits or attributes of individual workers have on safety behaviour and incident rates, and the extent to which such influence is reflected in the study sample. To achieve this objective, six quantitative questions were proposed:

1. Is there a relationship between safety performance (safety participation, safety compliance and safety motivation) and incident rates?

2. Does conscientiousness moderate the relationship between safety performance and incident rates?
3. Does openness moderate the relationship between safety performance and incident rates?
4. Does neuroticism moderate the relationship between safety performance and incident rates?
5. Does agreeableness moderate the relationship between safety performance and incident rates?
6. Does extraversion moderate the relationship between safety performance and incident rates?

Chapter Seven presented the results of the study; the first section used multiple linear regressions to estimate accident and incident rates using the dimensions of safety behaviour, and examined the moderating effects of personality dimensions on the correlation between incident and accident rates and safety behaviour. To discover the answers to the questions posed in the fourth objective of this research, Pearson Correlation Coefficients were computed between personality traits and accident and incident rates using SPSS. The results are given in Chapter Seven where the key findings can be summarised as follows:

Figures 8.12 and 8.13 show a negative correlation between safety behaviour components and accident and incident rates so, when safety behaviour rises accidents and incidents decline.

Figure 8.14 identifies that safety behaviour components have a higher effect on accident rates than incident rates.

Figures 8.15 and 8.16 identify that both safety motivation and safety participation have an effect on accident rates, whereas incident rates are affected by safety compliance and safety motivation.

Figure 8.14 illustrates that personality characteristics moderate the effects of the safety behaviour components in terms of both accident and incident rates, while neuroticism moderates the effect of safety compliance on accident rates.

Figures 8.18, 8.19, 8.20 and 8.21 highlight that extraversion and openness both moderate the effects of safety participation on accident and incident rates.

The main research summarised in Chapter Seven led to a discussion of these findings, as well as the emergent value judgments within Chapter Eight which included a review of the most
crucial aims of the study and an analysis of the objectives so the study could lead to better safety performance. This was done by gaining an in-depth insight into the moderating effects of personality characteristics and their correlation with accident and incident rates, as well as safety performance, with reference to the construction industry. In addition, previous chapters, such as Chapter 7 and Chapter 8, were also analysed according to the correlation between predictors, which are the personality characteristics and safety behaviour, with the outcomes, which are the accident and incident rates. Both of these were focused on within the literature review. Next, the moderating effects of neuroticism and its correlation with safety performance and accident and incident rates was examined while the third section focused on the moderating effects of extraversion and its link between safety performance components and accident and incident rates. Likewise, sections four, five and six were based on a discussion of the moderating effects of openness, agreeableness and conscientiousness, while the final part highlighted the framework which was developed according to the results and discussion.

Chapter Eight recognised the importance of individuals and their responsibilities towards safety performance in construction projects, while mentioning that training workers to re-evaluate their unsafe working practices can have a positive effect on the overall safety of a project. The majority of improvement methods would be initiated during the incident stage of safety management as this allows more attention to be paid to the pre-incident stage which relates to attitudes and behaviour towards safety performance. So, it can be seen that an insight into the personal characteristics of workers before any initial work takes place on a project can assist a human resources team in identifying the most suitable employees for certain roles within the site. The main aim of this study was to develop contributions from individuals in terms of enhancing safety performance within the construction industry. It has been identified that training and learning are both crucial elements in controlling risk, so supervisors must be aware of this and ensure workers understand how to operate equipment and deal with hazardous substances, whilst also training engineers in the design of equipment so potential risks are avoided. Therefore, safety management systems are extremely important for onsite safety, and everyone involved in the construction process must have a positive attitude towards safety culture.

This thesis also presents a framework and concentrates on redistributing the focus of safety management from managing and observing accidents to managing and observing incidents. This will lead to better awareness of the causes of accidents and also ensure better focus on
Chapter 11

incident management and observation. It can be seen that improving safety performance is a major concern in Saudi Arabia and further research is needed in order to develop a better working environment for those involved in the construction industry. However, it is possible to achieve a safer working environment by using human resources management effectively to select suitable candidates, provide adequate safety training for employees whilst onsite, and finally to investigate incidents in order to prevent accidents. This research aims to use a conceptual model to undertake further studies, with the aim of developing, from the investigation’s results, enhanced application tools. The tools would offer options to improve construction safety within Saudi Arabia. The next section reviews the validation of the improvement framework.

11.2.5 Fulfilment of the fifth and sixth objectives

The fifth and sixth objectives of the research were to develop and validate a conceptual framework that would take advantage of the outcomes of the study, which considered the effect of personality on incident rates, in order to provide options for improving safety performance in Saudi Arabia. Chapter Nine discussed the overall results found in the literature review, as well as examining the findings of this research. The structure of the framework, as well as its contents, were discussed under the following key points: adapting management to the context phase and highlighting management roles in recognising employees’ personalities before involving them in a construction project. Personality characteristics would be observed via tests and face-to-face interviews and the results could be used to determine the activities that employees could be assigned to.

This chapter also mentions the safety training and the learning phase in relation to safety becoming a positive culture onsite. It was found that both safety training and learning are crucial elements in controlling risk and maintaining a safe working environment, and it is hoped that this culture will become predominant in the Saudi construction industry. The proposed framework promotes and enforces health and safety changes which will then impact on attitudes and behaviours towards safety while linking individuals, the environment and conditions so workers are trained adequately in safety management.

Both the literature review and this research indicated that individuals are the main causes of incidents, whereas situational models argue that there is a correlation between individuals, the environment and conditions, and the occurrence of incidents. Furthermore, there is a
powerful relationship between changing attitudes and behaviours so if employees were to change their existing attitudes, the results would be seen in later behaviour towards safety.

In addition, being aware of individual personality traits and attitudes will offer further insight into the enhancement of safety performance, as mentioned in phase A; and this was validated by the study’s results. Also, the literature review revealed that lasting improvement is made via preventive solutions and concentrating further on monitoring and managing incidents rather than accidents. Therefore, awareness of critical elements related to incidents taking place onsite must be raised since being aware of this would ensure that employees observe and report such incidents; the effectiveness of this is highlighted in phase C. This new approach to safety will ensure that potential accidents are minimised.

The primary outcome of this research paper is the development of a suitable framework for the purpose of improving safety within the construction industry in Saudi Arabia. The framework was created from the results of this research, together with information taken from the literature review as well as other studies. In order to authenticate the reliability of the framework, its validity was tested in a workshop with stakeholders who deemed it to be efficient, practical and clear to use. The majority of the feedback was positive with some recommendations and comments which were subsequently taken into account.

11.3 Contribution to knowledge

It can be seen that the construction industry has high rates of fatal and non-fatal accidents which means that improving safety performance is crucial. Official statistics have identified that there is currently a levelling out in the improvement of safety performance which means that the way safety is viewed by the construction industry must be dramatically changed. This transformation will inevitably change the way in which the planning, implementation and management of safety in the construction industry is done, whilst also concentrating on employees’ contributions to safety via their personal behaviour and attitudes. Construction workers being aware of their own safety behaviour will enable improvements to be made beyond conventional practices in safety management. The framework provided by this thesis aims to lay the foundation for identifying improvement opportunities by focusing on workers’ characteristics to be measured in line with The Big Five Personality Model. This framework, which can be found in Figure 10.2, investigates and establishes whether individuals require any form of assessment from a safety perspective and contains three phases:
Chapter 11

a. Management phase – which addresses the management issues concerning determining workers’ personalities, a process that precedes the engagement of workers onto a project. This is personality model is commonly conducted through testing and face-to-face interviews (called the management phase) and involves construction workers being subjected to a personality model in order to assign them to work activities that match their trait types.

b. The safety training and learning phase – which is the most important area in controlling risk. This is a matter of serious concern and requires further research attention to ensure a safe working environment in construction. By concentrating on the safety behaviours of individuals, this framework offers a review of alternatives that can make the desired changes, leading then to changes in attitudes and finally to the behavioural changes required for safety improvement. Safety supervisors should pay close attention to training and education and should try to educate and train workers to deal with heavy apparatus and dangerous materials; engineers should also be educated and trained in designing to control the risk. Safety management systems are very significant but unless safety becomes a culture in the working environment, the desired goals will not be achieved. The advice contained in this framework focuses on interventions aimed at three specific types of desired outcome.

Changing the behaviour of individuals

Improving workers’ interactions with equipment or processes

Changing the culture at an organisational level

Although individuals may differ in terms of their levels of ability, as well as their levels of intelligence, skill and concentration patterns, certain types of behaviour are common to almost all people in a given set of circumstances. Section 8.8.2 gives practical guidance on how to actively discourage risk-taking behaviour. This is followed by a list of strategies to encourage safe behaviour. Finally there is an outline of issues which may have a bearing on safety performance when carrying out routine tasks.

c. Incident investigation and reporting system phase– this is a major resource that can help the construction industry to determine what the safety problems are in a clear and strategic manner. The adoption of an appropriate reporting system can minimise the level of unsafe conditions and it is also suggested that the monitoring required for such reporting often leads to corrective actions arising from incident investigations; these contribute to improving safety. On the other hand, if an employee amends his/her status or activity within the organisation, then a new evaluation would be needed. This framework highlights
interventions to establish how safety performance can be improved according to personality characteristics

Finally, Saudi Arabia’s construction industry was chosen as the focus of this study because funding was received from the Saudi government.

**11.4 Limitations of the study**

Safety on construction sites is divided into two areas: the physical and the behavioural. The physical aspect of safety concentrates on conditions on construction sites that are unsafe while the behavioural factors focus on unsafe acts carried out by employees while onsite. This research concentrates only on behavioural aspects and therefore, the checklist used for this survey only mentions those aspects of safety in terms of behavioural conditions. Questions such as "how many" or "how often" must be asked according to behavioural conditions to better understand the causes of incidents. Also, the behaviour of individual workers on construction sites need to be examined in order to identify how personality can affect safety behaviour and incident rates prior to an accident occurring. Guidelines would need to be given to employees to improve health and safety in Saudi.

An incident rate checklist was developed by the researcher. This consists of 21 potential injuries and, before each potential injury, two columns with different headings are given to measure accidents and incidents (near-misses). The following definition has been used by the researcher for an incident: “An incident is an unplanned event that does not cause injury or damage, but could have done so.”

NEO-FFI (Costa and McCrae, 1992) is a 60-item, 5-point Likert-style instrument that measures each of the Big Five personality factors. The instrument used here is a shortened form, consisting of the psychometrically strongest items from the revised NEO Personality Inventory (NEO PI-R).

The researcher compiled the safety performance scale to predict the extent to which participants complied with safety procedures in their construction organisations. The researcher defined safety performance as: “the extent to which the worker adheres to the construction safety regulations, has a positive attitude towards the safety regulations, and participates voluntarily to simulate the safety culture inside the organisation”. This scale consisted of 19 items and used a Likert format. In front of each item there were five choices: strongly disagree, disagree, neutral, agree, and strongly agree with the scoring procedure based on strongly disagree=1, disagree=2, neutral=3, agree=4, strongly agree=5.
11.5 Recommendations for further research

To sum up, further research into safety and residual risks in the Saudi Arabian construction industry is required. Increasing the number of case studies to investigate the activities and risks taking place on construction sites would provide a larger database and provide further validation of the findings of this study, as well as providing further recommendations. The risk management tool could also be used as a learning and teaching tool within the construction industry in Saudi Arabia and a further study could be undertaken to validate its use.
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References


References


APPENDICES

Appendix A: List of Publications Arising from the Research

Conference Proceedings


Appendix B: List of Research Tools

NEO-Five Factor Inventory Scale (NEO-FFI)

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<th>Strongly disagree</th>
<th>Disagree</th>
<th>Do not know/neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
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<tbody>
<tr>
<td>1.</td>
<td>I am not a worrier.</td>
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<td>2.</td>
<td>I like to have a lot of people around me.</td>
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<td>3.</td>
<td>I don’t like to waste my time daydreaming.</td>
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<td>4.</td>
<td>I try to be courteous to everyone I meet.</td>
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<td>5.</td>
<td>I keep my belongings neat and clean.</td>
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<td>6.</td>
<td>I often feel inferior to others.</td>
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<td>7.</td>
<td>I laugh easily.</td>
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<td>8.</td>
<td>Once I find the right way to do something, I stick to it.</td>
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<td>9.</td>
<td>I often get into arguments with my family and co-workers.</td>
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<td>10.</td>
<td>I’m pretty good about pacing myself so as to get things done on time.</td>
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<td>11.</td>
<td>When I’m under a great deal of stress, sometimes I feel like I’m going to pieces.</td>
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<td>12.</td>
<td>I don’t consider myself “light-hearted”.</td>
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<td>13.</td>
<td>I am intrigued by the patterns I find in art and nature.</td>
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<td>14.</td>
<td>Some people think I’m selfish and egotistical.</td>
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<td>15.</td>
<td>I am not a very methodical person.</td>
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<td>16.</td>
<td>I rarely feel lonely or blue.</td>
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<td>17.</td>
<td>I really enjoy talking to people.</td>
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<td>18.</td>
<td>I believe letting students hear controversial speakers can only confuse and mislead them.</td>
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<td>19.</td>
<td>I would rather cooperate with others than compete with them.</td>
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<td>20.</td>
<td>I try to perform all the tasks assigned to me conscientiously.</td>
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<td>21.</td>
<td>I often feel tense and jittery.</td>
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<td>22.</td>
<td>I like to be where the action is.</td>
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<td>23.</td>
<td>Poetry has little or no effect on me.</td>
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<td>24.</td>
<td>I tend to be cynical and skeptical of others’ intentions.</td>
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<td>25.</td>
<td>I have a clear set of goals and work toward them in an orderly fashion.</td>
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<td>Strongly disagree</td>
<td>Disagree</td>
<td>Do not know/neutral</td>
<td>Agree</td>
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<td>26. Sometimes I feel completely worthless.</td>
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<td>27. I usually prefer to do things alone.</td>
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<td>28. I often try new and foreign foods.</td>
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<td>29. I believe most people will take advantage of you if you let them.</td>
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<td>30. I waste a lot of time before settling down to work.</td>
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<td>31. I rarely feel fearful or anxious.</td>
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<td>32. I often feel as it I’m bursting with energy.</td>
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<td>33. I seldom notice the moods or feelings that different environments produce.</td>
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<td>34. Most people I know like me.</td>
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<td>35. I work hard to accomplish my goals.</td>
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<td>36. I often get angry at the way people treat me.</td>
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<td>37. I am a cheerful, high-spirited person.</td>
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<td>38. I believe we should look to our religious authorities for decisions on moral issues.</td>
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<td>39. Some people think of me as cold and calculating.</td>
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<td>40. When I make a commitment, I can always be counted on to follow through.</td>
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<tr>
<td>41. Too often, when things go wrong, I get discouraged and feel like giving up.</td>
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<tr>
<td>42. I am not a cheerful optimist.</td>
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<tr>
<td>43. Sometimes when I’m reading poetry or looking at a work of art, I feel a chill or wave of excitement.</td>
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<td>44. I’m hard-headed and tough-minded in my attitudes.</td>
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<tr>
<td>45. Sometimes I’m not as dependable or reliable as I should be.</td>
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<tr>
<td>46. I’m seldom sad or depressed.</td>
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<tr>
<td>47. My life is fast-paced.</td>
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<tr>
<td>48. I have little interest in speculating on the nature of the universe or the human condition.</td>
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<tr>
<td>49. I generally try to be thoughtful and considerate.</td>
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<tr>
<td>50. I am a productive person who always gets the job done.</td>
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<tr>
<td></td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Do not know/neutral</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
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<tr>
<td>51. I often feel helpless and want someone else to solve my problems.</td>
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<tr>
<td>52. I am a very active person.</td>
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<tr>
<td>53. I have a lot of intellectual curiosity.</td>
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<tr>
<td>54. If I don’t like people, I let them know it.</td>
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<tr>
<td>55. I never seem to be able to get organized.</td>
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<tr>
<td>56. At times I have been so ashamed I just wanted to hide.</td>
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<tr>
<td>57. I would rather go my own way than be a leader of others.</td>
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<tr>
<td>58. I often enjoy playing with theories or abstract ideas.</td>
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<tr>
<td>59. If necessary, I am willing to manipulate people to get what I want.</td>
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<tr>
<td>60. I strive for excellence in everything I do.</td>
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<tr>
<td>Scale and Items</td>
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<td>-----------------</td>
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<tr>
<td><strong>Neuroticism</strong></td>
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</tr>
<tr>
<td>I am not a worrier.*</td>
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<tr>
<td>I often feel inferior to others.</td>
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<tr>
<td>When I’m under a great deal of stress, sometimes I feel like I’m going to pieces.</td>
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<tr>
<td>I rarely feel lonely or blue.*</td>
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<tr>
<td>I often feel tense and jittery.</td>
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<tr>
<td>Sometimes I feel completely worthless.</td>
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<tr>
<td>I rarely feel fearful or anxious.*</td>
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<tr>
<td>I often get angry at the way people treat me.</td>
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<tr>
<td>Too often, when things go wrong, I get discouraged and feel like giving up.</td>
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<tr>
<td>At times I have been so ashamed I just wanted to hide.</td>
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<tr>
<td><strong>Extraversion</strong></td>
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<tr>
<td>I like to have a lot of people around me.</td>
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<tr>
<td>I laugh easily.</td>
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<tr>
<td>I don’t consider myself especially “light-hearted.”*</td>
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<tr>
<td>I really enjoy talking to people.</td>
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<tr>
<td>I like to be where the action is.</td>
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<tr>
<td>I usually prefer to do things alone.*</td>
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<tr>
<td>I often feel as if I’m bursting with energy.</td>
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<tr>
<td>I am a cheerful, high-spirited person.</td>
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<tr>
<td>I am not a cheerful optimist.*</td>
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<td></td>
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</tr>
<tr>
<td>My life is fast-paced.</td>
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</tbody>
</table>
Table 4 (continued)

<table>
<thead>
<tr>
<th>Scale and Items</th>
</tr>
</thead>
</table>

**Conscientiousness**

I keep my belongings clean and neat.
I'm pretty good about pacing myself so as to get things done on time.
I am not a very methodical person.*
I try to perform all the tasks assigned to me conscientiously.
I have a clear set of goals and work toward them in an orderly fashion.
I waste a lot of time before settling down to work.*
I work hard to accomplish my goals.
When I make a commitment, I can always be counted on to follow through.
Sometimes I'm not as dependable or reliable as I should be.*
I am a productive person who always gets the job done.
I never seem to be able to get organized.*
I strive for excellence in everything I do.

**Openness to Experience**

I don't like to waste my time daydreaming.*
Once I find the right way to do something, I stick to it.*
I am intrigued by the patterns I find in art and nature.
I believe letting students hear controversial speakers can only confuse and mislead them.*
Poetry has little or no effect on me.*
I often try new and foreign foods.
I seldom notice the moods or feelings that different environments produce.*
I believe we should look to our religious authorities for decisions on moral issues.*
Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement.
I have little interest in speculating on the nature of the universe or the human condition.*
I have a lot of intellectual curiosity.
I often enjoy playing with theories or abstract ideas.
Table 4 (continued)

<table>
<thead>
<tr>
<th>Scale and Items</th>
<th>Agreeableness</th>
</tr>
</thead>
<tbody>
<tr>
<td>I try to be courteous to everyone I meet.</td>
<td></td>
</tr>
<tr>
<td>I often get into arguments with my family and co-workers.*</td>
<td></td>
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<tr>
<td>Some people think I’m selfish and egotistical.*</td>
<td></td>
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<tr>
<td>I would rather cooperate with others than compete with them.</td>
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</tr>
<tr>
<td>I tend to be cynical and skeptical of others’ intentions.*</td>
<td></td>
</tr>
<tr>
<td>I believe that most people will take advantage of you if you let them.*</td>
<td></td>
</tr>
<tr>
<td>Most people I know like me.</td>
<td></td>
</tr>
<tr>
<td>Some people think of me as cold and calculating.*</td>
<td></td>
</tr>
<tr>
<td>I’m hard-headed and tough-minded in my attitudes.*</td>
<td></td>
</tr>
<tr>
<td>I generally try to be thoughtful and considerate.</td>
<td></td>
</tr>
<tr>
<td>If I don’t like people, I let them know it.*</td>
<td></td>
</tr>
<tr>
<td>If necessary, I am willing to manipulate people to get what I want.*</td>
<td></td>
</tr>
</tbody>
</table>

Note. Instructions were as follows: Read each statement carefully. For each select the response that best represents your opinion. Response options were as follows: Strongly disagree or the statement is definitely false (0), Disagree or the statement is mostly false (1), Neutral, or you cannot decide, or the statement is about equally true and false (2), Agree or the statement is mostly true (3), and Strongly agree or the statement is definitely true (4). *Reverse-scored.
Incident checklist

Accidents & Incident Checklist

- How many times in the last 6 months have you experienced each of these accidents/incidents at work?
- Please enter the number of injuries and near misses experienced in the boxes provided.
- A “near miss” is an accident at work that almost occurred.

<table>
<thead>
<tr>
<th>N</th>
<th>Type of accident/incident</th>
<th>Accident</th>
<th>Incident (near miss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Burns or scalds</td>
<td></td>
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<tr>
<td>2</td>
<td>Contusions, crushing bruises</td>
<td></td>
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<tr>
<td>3</td>
<td>Scratches, abrasions (superficial wounds)</td>
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<tr>
<td>4</td>
<td>Sprains, strains</td>
<td></td>
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<tr>
<td>5</td>
<td>Concussions</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>Cuts, lacerations, punctures (open wounds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Fractures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Hernia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Tendonitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Eye injury</td>
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<tr>
<td>11</td>
<td>Slipped, tripped or fell on the same level</td>
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<tr>
<td>12</td>
<td>Fall from ladder, stairs, or scaffold</td>
<td></td>
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<tr>
<td>13</td>
<td>Fall from a height</td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td>Contact with sharps or glass</td>
<td></td>
<td></td>
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<tr>
<td>15</td>
<td>Exposed to harmful substance or biological agent</td>
<td></td>
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<tr>
<td>16</td>
<td>Struck by a moving vehicle or other traffic accident</td>
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<tr>
<td>17</td>
<td>Overexertion</td>
<td></td>
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<tr>
<td>18</td>
<td>Struck against something fixed or stationary</td>
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<td></td>
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<tr>
<td>19</td>
<td>Exposed to fire</td>
<td></td>
<td></td>
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<tr>
<td>20</td>
<td>Contact with electricity or an electrical discharge</td>
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<td></td>
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<tr>
<td>21</td>
<td>Physically or verbally assaulted by a person</td>
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</tbody>
</table>

The demographic information
Age: ____________________________________________
Nationality: _________________________________________
Level of Education: _________________________________________

Type of Work: _________________________________________

Years in Current Work: _________________________________________

Number of Working Hours per Day: ___________________________
## Safety Behavior Scale

These statements refer to YOUR work behavior. For each statement please rate your level of agreement or disagreement by CIRCLING the appropriate number.

<table>
<thead>
<tr>
<th>CIRCLE ONE</th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I use all the necessary safety equipment to do my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I use the correct safety procedures for carrying out my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I ensure the highest level of safety when I carry out my job.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I promote the safety program within the organization.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. I put in extra effort to improve the safety of the workplace.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I voluntarily carry out tasks or activities that help to improve workplace safety.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Safety on the job is something I value highly.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. It is important to avoid accidents at work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Job safety is important to me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Safety is an important work goal.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. If I perform all necessary safety procedures, it will lead to a safe work environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. If I stick to the safety rules, I can avoid accidents.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. How accurately I perform given safety procedures will affect whether my workplace will be safe.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. I can create a safe work environment if I carry out safety procedures.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. The more safety procedures I perform, the more likely I am to avoid accidents.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. I can perform the safety procedures if I try.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. In my work setting, I can actually perform the suggested safety procedures.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. If I put in the effort, I am able to engage in safe behaviors at work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. If I put forth effort, I am able to comply with safety procedures.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix C: Questionnaire list for stakeholders’ validation of results of the research

Loughborough University
Department of Civil and Building Engineering

Questionnaire for stakeholders’ validation of recommendations of the research

Dear Sir,

Re: Evaluation report

I am writing to thank you for participating in the research project conducted by Loughborough University on health and safety management within the construction industry of Saudi Arabia. This research aims at improving safety performance by investigating workers’ safety behaviour and concentrates on the workers’ characteristics measured using The Big Five Personality Model. Much of such improvement effort would have to focus on the incident stage of safety management in order to make it effective and the pursuit of improvement would have to involve preventive solutions with a more proactive focus before site operations. I would be very grateful if you could take some time from your busy schedule to evaluate the study’s recommendations using the following dimensions and your experience in construction sites in Saudi Arabia:

• Justification of the suggestions;
• Practicality of the suggestions;
• The potential of the suggestions to contribute to improved health and safety standards on construction sites;
• Problems in implementing the suggestions; and
• Ease of implementation of the suggestions.

Please include any additional suggestions and comments you wish to make in the space provided at the end of the questions.

Best wishes,

Yousef Alshehri (Project Researcher)
(13th April 2014)
Section A – General results

These statements refer to YOUR experience on construction sites. For each statement please rate your level of agreement or disagreement by CIRCLING the appropriate number.

The empirical phase of the research established that safety behaviour attributes have stronger effects on the accident rate than their related incident rates.

Personality traits moderated the effects of safety behaviour components on the accident and incident rates.

Individual workers characterised by conscientiousness, openness, high extroversion, and low agreeableness are least likely to experience injuries through incidents and accidents at work.

Individuals characterised by high neuroticism are more likely to incur injuries through incidents and accidents.

Section B – The phases of the framework suggested for improving safety performance in Saudi Arabian construction projects.

a. Management phase – addressing the management issues that precede the workers’ engagement onto a project to help in determining the workers’ personalities. This is commonly conducted to select the personality model through test and face-to-face interviews. This is called the management phase and involves the construction workers being subjected to a personality model in order to assign them to work activities that match their trait types.

Justification of suggestion

The high cost of implementing this suggestion makes it unjustifiable for Saudi Arabia at the moment.

The low or no cost of this suggestion makes it justifiable.
The benefits to be derived from this suggestion outweigh its costs, and so it is justifiable.

**Practicality of suggestion**

This suggestion is practical and reasonable.

The suggestion is good but impractical for Saudi Arabia at this time.

**Potential of the suggestions to contribute to improved health and safety standards on sites**

The suggestion is good and feasible.

The suggestion is not appropriate and therefore not feasible.

**Problems of implementation of suggestion**

Problems are likely to arise in its implementation.

Problems are not likely to arise in its implementation.

I am not sure.

**b. The safety training and learning phase** – which involves safety training and learning parts is the most important part in the process of controlling risk which is a matter of concern and requires research attention to ensure a safe working environment in construction. By concentrating on the safety behaviours of individuals, this framework has presented a review of alternatives that can make the desired changes which would then lead to attitude changes and finally the behavioural changes required for safety improvement. Safety supervisors should pay attention to this phase and try to educate the workers and train them to deal with heavy apparatus and dangerous materials, and also educate and train engineers in the areas related to design to control risk. The safety management systems are very significant for the safety of sites, but unless safety becomes a culture in working sites, the desired goals will not be achieved. The advice contained in this framework focuses on interventions aimed at three specific types of desired outcome.

- Changed individual behaviour
- Improved worker interaction with equipment or processes
- Cultural change at an organisational level

**Justification of suggestion**

The high cost of implementing this suggestion makes it unjustifiable for Saudi Arabia at the moment

The low or no cost of this suggestion makes it justifiable

The benefits to be derived from this suggestion outweigh its costs, and so it is justifiable

**Practicality of suggestion**

This suggestion is practical and reasonable

The suggestion is good but impractical for Saudi Arabia at this time

**Potential of the suggestions to contribute to improved health and safety standards on sites**
The suggestion is good and feasible

The suggestion is not appropriate and therefore not feasible

**Problems of implementation of suggestion**

Problems are likely to arise in its implementation

Problems are not likely to arise in its implementation

I am not sure

**c. Incident investigation and reporting system phase**– The incident investigation and reporting system is a major resource that can help construction to determine the safety problems in a clear and strategic manner while the adoption of an appropriate reporting system can minimise the level of unsafe conditions. It is further suggested that the monitoring required for such reporting often leads to corrective actions arising from incident investigations that contribute to improving safety. In general it can be argued that unsafe conditions in the work environment and risk-prone behaviour by the workforce are the main factors that give rise to incidents. Safety can be improved by reducing causal factors of incidents; also, the ability and willingness of the labour force to report incidents is influenced by their general commitment to safety and the effectiveness of the reporting system to proactively raise awareness of any potential incidents. Where such a commitment is low, and coupled with an ineffective reporting system, very few potential incident situations will be captured.

**Justification of suggestion**

The high cost of implementing this suggestion makes it unjustifiable for Saudi Arabia at the moment

The low or no cost of this suggestion makes it justifiable

The benefits to be derived from this suggestion outweigh its costs, and so it is justifiable

**Practicality of suggestion**

This suggestion is practical and reasonable

The suggestion is good but impractical for Saudi Arabia at this time

**Potential of the suggestions to contribute to improved health and safety standards on sites**

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The suggestion is not appropriate and therefore not feasible

**Problems of implementation of suggestion**

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**Section A – General results**

**Section D – Proposed Framework**

**Please rate the following aspects of the improvement**

<table>
<thead>
<tr>
<th>Ranking</th>
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<tbody>
<tr>
<td>1 = very weak &amp;</td>
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<tr>
<td>5 = very strong</td>
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<tr>
<td>framework.</td>
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<td>-------------------------------</td>
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<tr>
<td>1. Practicality of the framework</td>
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<tr>
<td>2. Appropriateness of the framework</td>
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<tr>
<td>3. Clarity of the framework</td>
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</tbody>
</table>

Appendix D: List of questionnaire items for stakeholders’ validation regarding recommendations of the research

<table>
<thead>
<tr>
<th>GOVERNMENT LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 The main objective of the Saudi Arabian government is the promotion of a safe and healthy work environment; the Saudi government views it as a moral and religious obligation to provide protection for all workers and other stakeholders in work-related issues.</td>
</tr>
</tbody>
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| 2.0 Establish an Occupational Safety and Health Administration Saudi (OSHAS) to regulate safety in the construction sites’ work environments and to take disciplinary action against safety regulation violators in order to avoid further repeated mistakes. |

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### Problems of implementation of suggestion

| Problems are likely to arise in its implementation |
| Problems are not likely to arise in its implementation |
| I am not sure |

### 3.0 Introducing construction training programmes including health and safety, parallel or in combination with the tertiary education curriculum and vocational education, accessible for people who are not formally educated; this should raise the competency level of the workers in construction companies.

Formal educational institutions can be helped to make such programmes complementary to the regular training in civil engineering and construction, employing skilled training centre personnel at all levels in the country. The levies payable from contractors’ payment certificates can be used for funding such programmes.

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### PUBLIC LEVEL

1.0 The contractors are to be provided with appropriate education and training on health and safety management, which will then be reflected in the enhanced productivity of their construction companies.

### Justification of suggestion

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Problems of implementation of suggestion

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| Problems are not likely to arise in its implementation |   |
| I am not sure |   |

2.0 The thesis reveals the factors which drive safety performance which require due consideration from construction stakeholders, so that the personality dimensions of employees as they work in construction sites are considered; worker recruitment and assigning them their work in construction sites also needs to be focussed on. Motivation, Participation and Compliance should be made a motto so that safety performance is inherent in the personalities of the employees.

Justification of suggestion

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3.0 The study stresses the need to address the management aspects prior to engaging the workers on their operational tasks, which is necessary for construction companies to ensure health and safety and thus enhance their capacity. Workers can be assessed on their personalities before they are allowed entry into a project, as discussed in Section 10.2.1. The role of managers is to be engaged actively in this phase which allows individual workers to be assigned suitable occupational positions according to their nature. This is the phase before workers are hired onto construction jobs. This would make changes at an individual level, an organisational level, and result in improved worker interactions with equipment or processes.
| **Justification of suggestion**          |  |
|-----------------------------------------|  |
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Appendix E: Supplementary Material from the Analysis

\[ z\text{-Score} = \frac{X - \text{Mean}}{\text{standard Deviation}} \]

Mean Score and standard deviation were computed and each score was subtracted from the mean and divided by the standard deviation.

\[ \text{skewness} = \frac{\sum_{i=1}^{N} (Y_i - \bar{Y})^3}{(N-1)s^3} \]

\[ \text{kurtosis} = \frac{\sum_{i=1}^{N} (Y_i - \bar{Y})^4}{(N-1)s^4} \]

The Correlation Coefficient

\[ r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}} \]

The R Square

\[ R^2 = 1 - \frac{SS_E}{SS_T}. \]

\[ SS_T = \sum_{i}(y_i - \bar{y})^2, SS_R = \sum_{i}(\hat{y}_i - \bar{y})^2, SS_E = \sum_{i}(y_i - \hat{y}_i)^2, \]
Cronbach’s Alpha Coefficient

\[ \alpha = \frac{K}{K - 1} \left( 1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2} \right) \]

Linear regression model

\[ Y_j = \alpha + \beta_1 X_{1j} + \beta_2 X_{2j} + \ldots + \beta_k X_{kj} + \varepsilon_j = \alpha + \sum \beta_i X_{ij} + \varepsilon_j = E(Y_j | X) + \varepsilon_j \]

\( i = 1 \)

\( \beta_i = \) partial slope coefficient (also called partial regression coefficient, metric coefficient).

\( k \)

\[ Y_j = a + b_1 X_{1j} + b_2 X_{2j} + \ldots + b_k X_{kj} + e_j = a + \sum b_i X_{ij} + e_j = Y^* + e_j \]

\( i = 1 \)

Where \( a \) is the sample estimate of \( \alpha \) and \( b_k \) is the sample estimate of \( \beta_k \).

<table>
<thead>
<tr>
<th>Case</th>
<th>Formula(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Cases</td>
<td>( B = (X X^\top)^{-1} X^\top )</td>
<td>This is the general formula but it requires a knowledge of matrix algebra to understand it and I assume you may not have this.</td>
</tr>
<tr>
<td>1 IV case</td>
<td>( s )</td>
<td>Sample covariance of X and Y divided by the variance of X</td>
</tr>
<tr>
<td></td>
<td>( b = \frac{x Y}{s^2} )</td>
<td></td>
</tr>
<tr>
<td>Computation of ( a ) (all cases)</td>
<td>( k ) ( a = y - \sum b_k x_k ) ( k = 1 )</td>
<td>Compute the betas first. Then multiply each beta times the mean of the corresponding X variable and sum the results. Subtract from the mean of ( y ).</td>
</tr>
</tbody>
</table>

**Question.** Suppose \( b_k = 0 \) for all variables, i.e. none of the IVs have a linear effect on \( Y \). What is the predicted value of \( Y \)? What is the predicted value of \( Y \) if all Xs have a value of 0?