HUMAN FACTORS AND SAFETY BEHAVIOUR IN HIGH-RISK INDUSTRIES

by

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DECLARATION

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ABSTRACT

This study advocates for the importance of safety for organisations in high risk industries and the financial and person related impact that a lack of safety and in particular safety behaviour can have on organisations and the employees in those organisations. This highlights the need to explore the factors that influence safety behaviour of employees within high risk industries, specifically the construction industry in South Africa. The research objective of this study is therefore to determine why there is variance in safety behaviour amongst employees in the construction industry in South Africa and to propose a safety behaviour structural model that attempts to explain this variance. To construct this safety behaviour structural model literature is consulted to identify, define, and analyse the factors that influence safety behaviour, and the relationships between these factors are hypothesized. As a result a safety behaviour structural model is proposed.

The resultant structural model proved to be very comprehensive and a number of obstacles arose that prevents first generation testing of the complete model. Due to research constraints the safety behaviour model is abridged to allow for empirical testing. To test the proposed hypotheses and structural model an ex post facto correlation design with Structural Equation Modelling (SEM) is used. A sample of 217 construction workers from various construction sites in the Cape Winelands area participated in the study. The results of empirical testing are unpacked, following this managerial implications and recommendations for future research are discussed.

ACKNOWLEDGEMENTS

To my wife and family, thank you for the endless support and belief in me.

To my supervisor, Tendai, thank you for your endless patience with me during what seemed like a journey without end.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION AND BACKGROUND OF THE STUDY

1.1. INTRODUCTION

Organisations primarily exist to serve society. They do this through providing products and services to a market, jobs to those that are involved in the production of those goods and services, and a business interest to shareholders and owners of the organisation. In order for this to occur in a sustainable manner it needs to be done profitably, thus there is a need for the effective and efficient use of resources that organisations have access to. In essence, these resources are the people and machines or equipment that the organisation employs; and profitability is in part a function of having the right amount and quality of resources (both human and machines), and a good interaction or fit between them (Theron, 2015).

People bring knowledge, skills, and abilities to the fore and in turn need motivation to turn their knowledge, skills, and abilities into productive economic output. A poor alignment between humans and machines bring about unnecessary risk which could, among other issues, lead to poor safety outcomes which threatens the efficient and effective use of both of these resources, as well as financial resources which has a serious implication for the profitability of an organisation and therefore its sustainability (Theron, 2015). The costs of poor safety outcomes are both monetary and social. Some of the monetary costs involved in accidents include labour lawsuits, sick leave, loss of key personnel, training of new personnel, compensation costs, but to name a few.

There are several opinions in terms of what explains these undesirable safety outcomes in the workplace. Some have argued for person related theories (Brown, 1984; Feldman, 1981) others emphasised system reasons (Deming, 1986, Bell, Wicklund, Manko, & Larkin, 1976) and still others, more understandably so, have advocated for and possible solutions to be found in the system-person sequence theories. The person theory posits that nearly every accident in the workplace can be traced back to an employee’s unsafe act (Brown, 1984). As the name suggests, the systems view puts forward that accidents are caused almost entirely by a faulty system (Deming, 1986). Alternatively, the system-person sequence theory suggests that most accidents are caused by an interacting system of social and technical forces; and that the employee just finds themselves at the end of a series of interrelated events (Brown, Willis, & Prussia, 2000). The later view encompasses a holistic view of the possible causes to accidents in the workplace, and it is more likely closer to providing a more judicious explanation of safety poor outcomes, but that is as far as it explains – the nature and complexity of human-machine interaction remains an unsolved puzzle.

There needs to be a good relationship or fit between humans and machines, otherwise there is a chance for high risk. From this preposition, it can be concluded that both of these factors can be the cause of an accident. A case in point is one of the BP Gulf of Mexico oil spill (2010) where mechanical faults were the cause of an accident.

In what remains the largest and worst accidental oil spill in history, an explosion and sinking of the deep-water horizon oil rigger operated by BP happened in 2010, off the coast of the Gulf of Mexico. The explosion and sinking of the rig claimed eleven lives and caused incalculable damage to the environment (The Telegraph, 2014). A sea flow oil gusher flowed for 87 days, during which an estimated 4.9 million barrels of oil was spilled of which a mere 800000 were recaptured during containment efforts (The Telegraph, 2014). The incident happened due to a wellhead blowout which allowed high pressure methane gas to rise up into the rigger, subsequently igniting, causing the explosion. This has been very costly for BP, with 42.4 billion US dollars being paid out in fines and settlements (Fontevecchia, 2013). The incident has also led BP tainting their brand, losing a large amount of shareholder value, and losing future business. This makes a case for further research into the causes of mechanical failures that cause safety incidents but is not the focus of this research.

The Ken Woodward incident (1990) illustrates how human and system factors can lead to accidents, not only regarding the person involved in the accident, but also those that can prevent, or minimize the consequences of accidents. Ken Woodward was a team leader at one of Coke-Schweppes' factories in Kent, UK. When changing from the manufacture of one drink to another a CIP clean process was used to clean and sterilize the lines. Having run out of the premixed cleaning product that was usually used, the factory decided rather to order the necessary chemicals and mix it themselves. Furthermore, the mixing machine broke, and so the mixing of the products happened in open containers on a regular basis. On that day Ken, who was neither trained nor experienced in the process, was asked to do the CIP cleaning. Ken tried to find the appropriate safety gear, which was in an unusable condition due to age, but it was not available. When he mixed the two chemicals together there was an instantaneous explosion, seriously injuring him, causing the loss of his eyesight, taste, and smell. Additionally, many employees who witnessed the accident needed counselling afterwards. Mere hours earlier, an email was sent containing results from a lab test regarding the CIP cleaning process, which if circulated internally would have prevented the accident from ever happening. The financial implications to the company added up to ₤2.6Mn in fines and compensation (www.kenwoodward.co.uk). This is just but one of a million related and/or similar safety cases around the world, making it worthwhile to invest more in research aimed at providing empirical explanations to these poor safety outcomes and more specifically to the lack of safety behaviour displayed by employees.

In the South African context safety incidents have also resulted in the loss of life. An example of this is when a temporary bridge over a busy highway slip road in Grayston collapsed killing 2 people and injuring a further 21 (Kubheka, 2015). The exact cause of the collapse of the bridge was not confirmed, but authorities generally believe that there were several missing bolts in the scaffolding that made up the temporary structure (Nokwe, 2015).

Detail around the reasons why bolts were missing is again unclear but illustrates the severity of the consequences when this safety behaviour is not displayed by employees in the construction industry in South Africa.

With regards to safety across industries there are differences in terms of the number of safety incidents, the type of incidents, and the cost involved. According to The Health and Safety Executive (HSE) in the UK, heavy industries such as construction, mining, petrochemical, and shipping are the main suspects when it comes to high levels of accidents in the workplace. Injuries in the construction industry alone in the UK amounted to Billions of Pounds per year in lost revenue and settlement fees (HSE, 2013).

Although there are acute and discernible differences across industries, evidence also portray differences even within the same industries (HSE, 2013). Industry and the nature of work cannot be the only factors that are taken into consideration, as safety outcomes across organisations within the same industry differ drastically as well – which might indicate that some organisations have certain safety related factors (person, organisation, or some other) which other organisations may be lacking or might be having at different levels, which then explain the variance. A debunking of such differentiating factors, including the possible interaction among them becomes imperative in explaining such a variation.

In South Africa safety incidents in the construction industry are extremely high with 1.5 to 2.5 fatalities per week (Shields, 2020). Amongst other factors, the lack of safety behaviour is cited as one of the leading causes of safety incidents (Shields, 2020). The construction industry employs about 1.5 million workers in South Africa, making up around 4% of South Africa's gross domestic product (NIOH, 2020). Apart from being one of the biggest contributors to the GDP of South Africa, the construction industry is also one of the biggest contributors to safety incidents in South Africa (NIOH, 2020). Although South Africa lacks up to date occupational health and safety statistics in the construction industry, the International Labour Organisation estimates that 60,000 fatalities occur at construction sites annually which equates to one death every ten minutes worldwide (NIOH, 2020). If this statistic is applied to the South African context it implies very high fatality rate.

Even within the same organisation, variance in safety behaviour abounds. Accordingly, even when all or most organisational factors that promote safety behaviour are in place in an organisation there are still a large number of workplace accidents and injuries based on various individual level dimensions. This begs the question – what explains such variations, that is, why and how would individuals differ on their level of safety behaviour? This question makes permissible research into a specific direction to discover what such explanatory factors to safety behaviour are. Only by delving into this area can one begin to answer the question of why certain individuals engage in behaviours that promote safety in the workplace and why others act in ways that militates against safety. Once such explanatory factors are unearthed their potentially complex relationships ascertained and their individual and/or combined effect on safety behaviour have been determined can one look into how these antecedents can be manipulated in such a way as to improve safety behaviour in a workforce with the goal of maximising safety performance to improve the profitability and sustainability of an organisation.

1.2. PROBLEM STATEMENT

When safety in the high risk industries is researched the ultimate goal is to reduce the number of safety incidents that occur and thus decrease the number of fatalities and injuries as well as reducing the financial implications associated with the incidents. There are a number of different factors that could lead to undesirable outcomes, but this study intends to research one specific factor, namely safety behaviour of employees. Safety behaviour in employees is influenced by a complex network of factors that include human factors and decision-making processes. The field of research into these human factors that influence employee safety behaviour is limited. Thus the main research problem is to understand why there is variance in safety behaviour of employees working in the construction industry in South Africa.

1.3. RESEARCH INITIATING QUESTION

The research initiating question guiding this study is: *“Why is there variance in the safety behaviour of employees working in the construction industry in South Africa?”*

1.4. RESEARCH OBJECTIVES

The literature and empirical research objectives states what this study intends on achieving.

1.3.1. Literature Objectives

1.3.1.1. To review the meaning of safety behaviour.

1.3.1.2. To determine the antecedents and the meaning of the antecedents of safety behaviour.

1.3.1.3. To develop a structural model that explains the influence of human factors on safety behaviour OR that explains the relationship between human factors and safety behaviour.

1.3.2. Empirical Objectives

1.3.2.1. To investigate the relationship between the antecedents to safety behaviour and safety behaviour in the high-risk industries in South Africa, specifically the construction industry.

1.3.2.2. To test the safety behaviour structural model.

1.5. CONCLUSION

Chapter 1 made the argument that safety is a prevalent issue in high risk industries, specifically the construction industry in South Africa from a person and financial perspective. Several international and local examples of safety incidents and the resulting consequences were explored to provide substance to the argument that safety should be a primary concern for organisations. Safety behaviour was identified as a contributing factor towards safety, and as such the importance of exploring literature dealing with the human factors that influence safety behaviour was highlighted. Chapter 2 defines safety behaviour and examines safety literature to provide a credible base from which to hypothesize about the relationships between antecedents to safety behaviour.

CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

Chapter 1 highlighted that safety in high risk industries, specifically the construction industry in South Africa is an issue. The high levels of fatalities within the construction industry reveals the importance of decreasing incidents to curb the loss of life, disfigurement, and the financial implications of such events. The focus of this study however is to explore the human factors that influence safety behaviour. This chapter explores the body of research on safety and safety behaviour in particular in a manner that ultimately provides a credible basis from which to theorise about a structural model that adequately explains the antecedents to safety behaviour.

Safety behaviour in individuals a choice that has to be made, therefore it is appropriate to analyse the antecedents to safety behaviour within the confines of a decision making theory that aptly explains the process which occurs in the human mind when making the decision to act in a way that is conducive or contrary to safety. The Theory of Planned Behaviour (TPB) is one that can be applied to safety behaviour in the workplace. The TPB was adapted by Azjen from the theory of reasoned action put forth by Fishbein (1975) and Azjen (1980). The theory has been successful in predicting a number of different observed behaviours including but not limited to smoking, drinking, health services utilisation, breastfeeding, and substance abuse (Azjen, 2013).

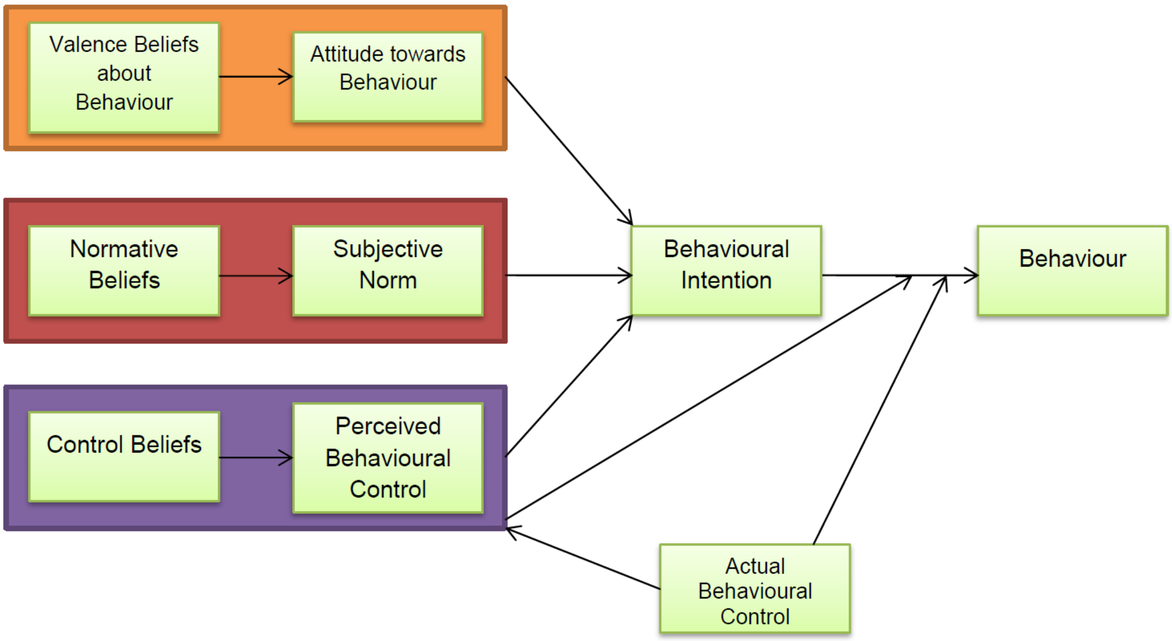
Following a brief analysis of the TPB and the factors therein, several other factors are explored. Safety Behaviour as a phenomenon is also unpacked. Throughout Chapter 2 the relationships between the factors that are explored are hypothesized and a result a safety behaviour structural model emerges.

2.2. THE THEORY OF PLANNED BEHAVIOUR (TPB)

The Theory of Planned Behaviour (TPB) evolved from the theory of reasoned action developed by Martin Fishbein (1975) and Icek Ajzen (1980). The TRA aims to predict an individual's intentions to behave in a certain manner at a specific time and place (Azjen, 2013), and stated that behavioural intentions are influenced by attitudes and subjective norms about a specific behaviour. The theory was later revised to include a third factor – perceived behavioural control, and renamed the theory of planned behaviour (TPB). Furthermore, the theory claims that if a person intends to behave in a certain manner and if they have the actual behavioural control necessary to perform that behaviour they will do so (Ajzen, 1991). A diagrammatic representation of the TPB can be seen in figure 2.1.

Figure 2.1

The Theory of Planned Behaviour (Azjen, 2006)



Note: The Theory of Planned Behaviour is a decision-making theory that attempts to explain the factors that influence an individuals behavioural decisions with regards to a specific behaviour.

Attitudes: Attitude toward behaviour is the degree to which performance of the behaviour is positively or negatively valued (Ajzen, 1991). It also includes the evaluation of the outcomes of performing the behaviour of interest.

Subjective norm: Subjective norm is the perceived social pressure to engage or not to engage in behaviour (Ajzen, 1991). Subjective norms are to a large extent influenced by normative beliefs or what can be referred to as the opinions of referent others.

Perceived behavioural control: Perceived behavioural control refers to the individual's perception of the ease or difficulty with which they can perform a behaviour (The Theory of Planned Behaviour, 2013), or in other words their ability to perform a certain task (Ajzen, 1991).

Actual behavioural control: This refers to the extent to which an individual has the skills, resources, and other relevant prerequisites to perform the behaviour of interest (Ajzen, 1991). The successful performing of a behaviour does not depend solely on the intentions to do so, but also on a sufficient level of behavioural control.

Intention: Intention is an indication of a person's readiness to perform a given behaviour, and it is considered to be the immediate antecedent of behaviour. The intention is based on attitude toward the behaviour and subjective norm with each predictor weighted for its importance in relation to the behaviour and population of interest (Ajzen, 1991).

Behaviour: Behaviour is the manifest, observable response in a given situation with respect to a given target. Single behavioural observations can be aggregated across contexts and times to produce a more broadly representative measure of behaviour (Azjen, 2006).

The theory of planned behaviour can be expressed as a mathematical function, which in its simplest form takes the shape of:

$$BI = (W_1)AB[(b) + (e)] + (W_2)SN[(n) + (m)] + (W_3)PBC[(c) + (p)]$$

where:

BI: Behavioral intention

AB: Attitude toward behavior

(*b*): the strength of each belief

(*e*): the evaluation of the outcome or attribute

SN: Subjective norms

(*n*): the strength of each normative belief

(*m*): the motivation to comply with the referent

PBC: Perceived Behavioral Control

(*c*): the strength of each control belief

(*p*): the perceived power of the control factor

W' : empirically derived weight/coefficient

The Theory of Planned Behaviour has certain limitations in that it does not consider all the variables that have an effect on behavioural intention. It also fails to consider the time frame between behavioural intention and the actual observed behaviour as well as the factors that may moderate that relationship.

This study applies the TPB to understand the influence the influence of human factors on safety behaviour. The flowing sections provides…leading up to the development of a comprehensive model.

2.3. SAFETY BEHAVIOUR

According to the TPB (Azjen, 2006) behaviour is "the manifest, observable response in a given situation with respect to a given target. Single behavioural observations can be aggregated across contexts and times to produce a more broadly representative measure of behaviour." (p. 1).

Safety behaviour then can be seen as those manifest behaviours which promote safety outcomes or avoid safety incidents. This can be behaviours such as compliance with safety regulations or guidelines, the wearing of protective gear, or proactive behaviours such as ensuring not being fatigued at work or not participating in behaviours that could potentially lead to accidents or be hazardous.Griffin and Neal (2006) define safety behaviours as behaviours that constitute work performance for safety-oriented tasks (Zhang & Wu, 2014). They go on to divide this definition into an in-role-dimension and extra-role dimension. The in-role dimension is referred to as safety compliance and encompasses behaviours that relate to maintaining workplace safety; and the extra-role dimension, which is referred to as safety participation, encompasses behaviours that are in nature proactive but not directly linked to safety performance, but none-the-less help to improve organisational safety (Zhang & Wu, 2014). Based on this, Zhang and Wu (2014) propose a dual process perspective regarding safety behaviours. The afore mentioned theorise that an employee's safety behaviour is underpinned by two basic cognitive systems, system 1 is an unconscious, autonomous, and effortless processing system that functions at high speed and is driven by intuition, heuristics, past experiences, etc.; while system 2 is a conscious, controlled, effortful processing system that uses reasoning, fluid intelligence, but to name a few in a slow and serial manner (Zhang & Wu, 2014). A compromise in this dual processing system can undermine safety behaviour; the question the literature review aims to answer is what causes these compromises. The first system is in use when an employee does day to day tasks, in which the stimulus they encounter is familiar to them and for which they have developed an unconscious approach for dealing with said stimulus (Zhang & Wu, 2014). The second system comes into play when an individual encounters stimulus with which they are unfamiliar and for which they have not developed processes to deal with that stimuli. This can lead to an overloading of available cognitive resources and thus cause the individual to act in a way contrary to what is necessary in the situation causing an accident (Zhang & Wu). There are various factors that determine employees' safety behaviour.

2.4. BEHAVIOURAL INTENTIONS

According to the TPB behavioural intention refers to the motivational factors that influence a given behaviour where the stronger intention to perform the behaviour, the more likely the behaviour will be performed (Boston University School of Public Health, 2013). Azjen (2006) goes on to argue that if the behavioural intention is strong and the individual has the necessary actual behavioural control, the behaviour will be performed. In a safety context, based on the theory of planned behaviour, it is therefore hypothesised that:

Hypothesis 1: *Behavioural intention has an effect on safety behaviour.*

2.5. SUBJECTIVE NORM

Subjective norm is the perceived social pressure to engage or not to engage in behaviour (Ajzen, 1991). Subjective norms are to a large extent influenced by normative beliefs or what can be referred to as the opinions of referent others. The basic formula derived from the TPB (BI = A + SN + PBC) shows the effect that subjective norms (SN) has on behavioural intention (BI). It can therefore be concluded that subjective norms is a direct antecedent to intention to behave. The impact of opinions of referent others and the effect that safety culture and climate has thereon will be discussed in the following section. In a safety context, based on the theory of planned behaviour, it is therefore hypothesised that:

Hypothesis 2: *Subjective norms about safety behaviours have an effect on intention to behave.*

2.6. NORMATIVE BELIEFS

Azjen (2006) refers to normative beliefs as the opinions or perceived behavioural expectations of important or referent individuals as seen by an individual. These referent individuals can be anyone whose opinion caries weight with the individual and can include a husband or wife, family, friends, and even community leaders and those to whom the individual looks up to. Azjen (2006) makes the assumption that normative beliefs combined with an individual's motivation to comply with referent people in their lives determine the subjective norm. Specifically, the motivation to comply with each referent individual contributes to the subjective norm in direct proportion to the person's subjective probability that the referent individual thinks the person should perform the behaviour in question (Azjen, 2006). The theory of planned behaviour hypothesises that:

Hypothesis 3: Normative beliefs have an effect on subjective norm.

As will be discussed in the following section, safety climate is the product of the workforce as an entirety and their attitudes and perceptions towards safety behaviour; it therefore stands to reason that the subjective norms of individuals in a workplace has an impact on the safety climate of the organisation as a whole. It is therefore hypothesised that:

Hypothesis 4: *Normative beliefs has an effect on safety climate.*

2.7. ATTITUDE TOWARDS SAFETY BEHAVIOUR

Attitude toward behaviour is the degree to which performance of the behaviour is positively or negatively valued (Ajzen, 1991). It also includes the evaluation of the outcomes of performing the behaviour of interest. The formula derived from the TPB (BI = A + SN + PBC) shows the effect that the attitude towards safety behaviour (A) has on behavioural intention (BI). The theory of planned behaviour concludes that attitude toward safety behaviour is a direct antecedent to intention to behave. The impact of factors such as beliefs about the valence of safety behaviour, safety training, and personality will be discussed hereafter. In a safety context, based on the theory of planned behaviour, it is therefore hypothesised that:

Hypothesis 5: A*ttitude towards safety behaviour has an effect on behavioural intention.*

2.8. BELIEFS OF VALENCE OF SAFETY BEHAVIOUR

Behavioural beliefs are the expectations of the probability of a certain outcome when a certain behaviour is displayed. Azjen (2006) refers to this as the valence of a behaviour in reaching an outcome. A person may at any given time have many behavioural beliefs with regards to a specific behaviour, but only a small number of these beliefs are accessible to them at any given point in time. When behavioural beliefs about a specific behaviour interacts with subjective values of the expected outcome it determines the attitude of an individual towards certain behaviour.
Therefore, if an individual is of the belief that displaying certain safety behaviours will result in safety performance or will reduce the number of safety incidences in the workplace, that individual's attitude towards that specific safety behaviour will change. In a safety context, based on the theory of planned behaviour, it is therefore hypothesised that:

Hypothesis 6: *Beliefs about the valence of safety behaviour has an effect on attitude towards safety behaviour.*

There are a number of factors that can influence an individual's beliefs of the valence of specific safety behaviours. One such factor is safety training, which will be discussed in the following section.

2.9. PERCEIVED BEHAVIOURAL CONTROL

Perceived behavioural control refers to the perception an individual has of their ability to perform the behaviour of interest, which is determined by the total available set of control beliefs and perception of the resources the individual has access to that will either allow or impede them to perform the behaviour (Ajzen, 1991). The perceived behavioural control can influence behavioural intention, and along therewith be used to predict observed behaviours (Ajzen, 1991). The theory of planned behaviour therefore hypothesises that:

Hypothesis 7: Perceived behavioural control has an effect on behavioural intention.

Hypothesis 8: Perceived behavioural control moderates the relationship between behavioural intention and behaviour.

2.10. CONTROL BELIEFS

Control beliefs refer to the individual's perception of the availability of factors and resources that may support or impede them in performing certain behaviour. The strength of the control belief is determined by the relative perceived strength of each factor that may support or impede the behaviour (Ajzen, 1991). The theory of planned behaviour therefore hypothesises that:

Hypothesis 9: Control beliefs have an effect on perceived behavioural control.

2.11. ACTUAL BEHAVIOURAL CONTROL

Actual behavioural control refers to the actual resources and factors that an individual has access to that will support them in performing the behaviour. Turning an intention into a behaviour is not solely dependent on the strength of the intention, but also on the actual behavioural control and individual has (Ajzen, 1991). The theory of planned behaviour therefore hypothesises that:

Hypothesis 10: Actual behavioural control has an effect on perceived behavioural control.

Hypothesis 11: Actual behavioural control moderates the relationship between behavioural intention and safety behaviour.

2.12. SAFETY CULTURE

There are a number of definitions of safety culture found in literature; the UK Health and Safety Commission defines it as "The product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (HSC, 1993, p. 3). The International Atomic Energy Authority (IAEA,

1991) defined safety culture as, “that assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance” (Cooper, 2000, p. 114). A further definition by the British Confederation of Industries defines safety culture as “the ideas and beliefs that all members of organisation share about risk, accidents, and ill-health” (Cooper, 2000, p. 114).

In April of 1986 reactor 4 of the Chernobyl nuclear power plant exploded killing 30 operators and fireman over a period of 3 months as well as causing several more deaths later on. One person was killed instantaneously, and a second died as a result of injuries later that day in hospital (World Nuclear Association – WNA, 2014). The disaster happened during a routine test when a combination of a peculiarly designed reactor as well as undertrained crew caused an explosion to occur. The subsequent fires caused a vast amount of radioactive particles to be released into the atmosphere. The containment efforts lasted for 3 days, and a large number of the individuals involved became ill as a result of radioactivity (WNA, 2014). As a result of the explosion neighbouring areas are still uninhabitable to humans and will be for many more years to come (WNA, 2014).

The Chernobyl disaster brought about an interest in safety culture and drew attention to the impact of managerial and individual characteristics on safety performance (Flin, Mearns, O'Connor, & Bryden, 2000). The term first made an appearance in the 1987 OECD Nuclear Agency report (INSAG, 1988) on the 1986 Chernobyl disaster (Cooper, 2000), and its use has grown in popularity in the years since. Cooper (2000) points out that unless safety culture is a first priority, which in his opinion it should be in high risk industries, it is but a sub-component of organisational culture.

One thing that the literature reviewed for this study (WNA, 2014; Cooper, 2000; HSC, 1993; IAEA, 1991) has in common about safety culture is that it is a shared group ideology or idea. It can be argued that safety culture is that which holds everything together, and influences all the other antecedents to safety behaviour in varying degrees. All of the above definitions points to the thoughts and beliefs individuals have towards safety (Cooper, 2000). It is therefore hypothesised that:

Hypothesis 12: *Safety culture has an effect on normative beliefs.*

Schein (1990) states that safety culture is not something which can be easily built or constructed, but can only be achieved through the systematic manipulation of organisational and individual characteristics that have an impact on safety management practices. When analysing which variables to manipulate in order to achieve a culture of safety within an organisation consideration must be given to the interactive relationship between psychological, behavioural and organisational factors (Cooper, 2000). Therefore, rather than being solely concerned with shared perceptions, meanings, values and beliefs as many definitions propose, it can be argued that organisational culture is, "The product of multiple goal-directed interactions between people (psychological), jobs (behavioural) and the organisation (situational)" (Cooper, 2000). An example of such a goal directed interaction is the implementation of safety training programmes, and it stands to reason that an organisation with a very strong sense of safety culture will have a focus on safety training and ensuring that their employees are well equipped to deal with any situation involving safety procedures, guidelines, or equipment. This in turn improves the immediate safety climate in the organisation, as climate can be seen as a snapshot of culture at any given point in time. It is therefore hypothesised that:

Hypothesis 13: Safety culture has an effect on safety training.

Hypothesis 14: *Safety culture has an effect on safety climate.*

As safety culture is an encompassing phenomenon that an employee subscribes to or is a part of it can be theorised that it will influence their behaviours not only at work, but also in their private lives; for example an employee that believes safety is an absolute first priority to themselves and the organisation will very likely make an effort to ensure they are not fatigued at work as they know this has an impact on their level of safety behaviour. This argument is not limited to fatigue but can be extrapolated to a number of other antecedents to safety behaviour.

2.13. SAFETY CLIMATE

The term safety climate refers to perceptions of policies, procedures, and practices relating to safety in the workplace (Griffin & Neal, 2000). Organisational safety climate can be seen as a snapshot of selected aspects of organisational safety culture at a point in time (Mearns et al., 2003). This concept particularly refers to employees' attitudes and perception of safety (Clarke, 2006), and according to Griffin and Neal (2000) can largely be influenced by management values and is moderated by knowledge, skill and motivation level of workers (Hetherington et al., 2006). This influence of management can to some extent be explained when the three dimension of safety climate and their inter-relationships are examined. It is therefore hypothesised that:

Hypothesis 15: *Safety climate has an effect on normative beliefs.*

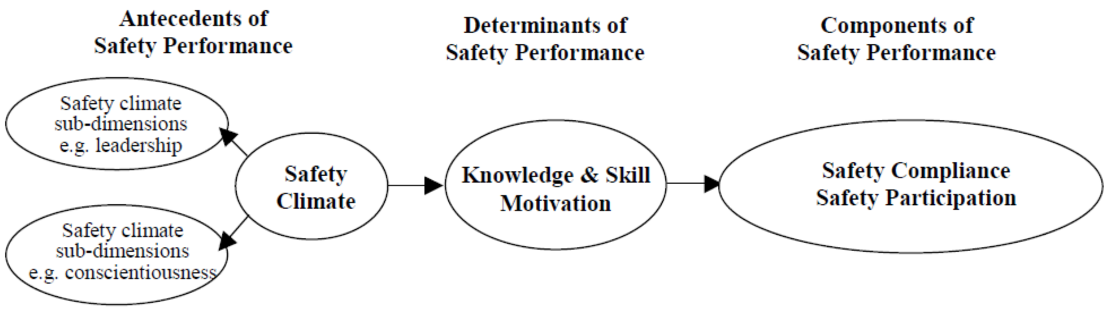
There are three dimensions of safety climate, namely management commitment to safety, priority of safety, and pressure of production (Bosak, Coetsee, & Cullinane, 2013). Bosak, Coetsee, and Cullinane (2013) conducted a study in which they tested the relationship between these three dimensions of safety climate as predictors for safety behaviour. Non-compliance and ignorance to safety policies and procedures has been a problem for organisations, and has been linked to workplace accidents (Griffin & Neal, 2000) as this non-compliance makes the entire system more vulnerable to risk (Reason, 1997). The results of this study revealed an inverse correlation between the priority of safety and risk behaviour as well as management commitment to safety and risk behaviour given there was high pressure for production. When priority to safety and management commitment to safety was low, risk behaviour was high; and as priority of safety and management commitment to safety increased risk behaviour decreased (Bosak et al., 2013). Furthermore there was a direct correlation between pressure for production and risk behaviour (Bosak et al., 2013). Bosak et al. (2013) also concluded, based on their results, that the more employees perceive that safety is a priority to an organisation and that senior management engages in communication and actions that support this priority, the less likely employees are to engage in risky behaviour. This validates the claim that safety climate is influenced by management and leadership values.

Safety climate has also been found to relate to procedures and patterns (Zohar, 2000). Consistent procedures were shown to represent patterns that reflect the importance and prioritisation of safety over competing goals (Hetherington et al., 2006). Bosak et al.'s (2013) agrees with this statement when they claim that when safety is a priority employees will be less likely to engage in risky behaviour.

Safety climate is moderated by the knowledge and skills of workers. This is explained by the fact that safety does not happen in a vacuum and that desired levels of safety performance cannot simply be achieved by a prioritisation of safety over other goals. There needs to be employees that act in a manner that is conducive to safety performance. This can be achieved when employees have the relevant knowledge of safety policies and procedures and the skill to be able to apply this knowledge in a manner that will increase safety performance. This relationship is illustrated in Figure 2.2.

Figure 2.2

Summary of relationship among antecedents, determinants and components of safety performance adapted from safety climate and safety behaviour (Griffin & Neal, 2002) Australian Journal of Management (27, p70)



The link between safety climate and the dimensions of safety performance, has been established (Griffin & Neal, 2000).

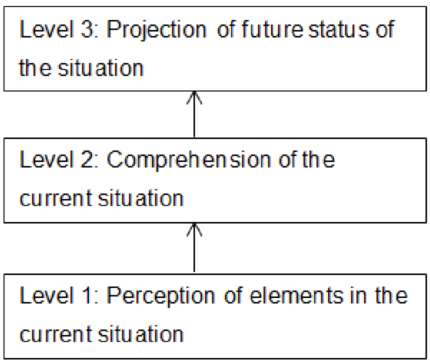
2.14. SITUATIONAL AWARENESS

Situational Awareness is defined as "the perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status in the near future" (Endsley, 1988). This stems from information processing theory which states that people perceive information via their senses, interpret this information and make decisions concerning its meaning and relevance based on their previous understanding and current interpretation (Wickens & Hollands, 2000). Endsley (1998) postulates three levels of situation awareness. Firstly, to form an accurate picture of their situation, individuals must have the correct perception of elements in the situation. The second level entails the combination, interpretation, storage, and retention of the relevant information to form a picture of the situation; whereby the significance of particular objects and events are understood. The final level is projection, and results from a combination of levels one and two. It can be argued that this is the most important stage of situation awareness as it is the ability of the individual to use the current information in such a way as to predict future outcomes of the situation, thereby allowing the individual to better deal with these future events by reducing the surprise element (Hetherington et al., 2006).

Alternatively, Bedny and Meister (1999) theorise that "Situational awareness is the conscious dynamic reflection of the situation by an individual. It provides dynamic orientation to the situation, the opportunity to reflect not only the past, present and future, but the potential features of the situation. The dynamic reflection contains logical-conceptual, imaginative, conscious and unconscious components which enables individuals to develop mental models of external events" (Stanton, N., Chambers, P., & Piggott, J., 2001).

Figure 2.3

The three-level model of situation awareness. Adapted from Situational awareness and safety (N.A. Stanton et al., 2001, Safety Science 39 p194)



The third definition of situational awareness found in literature takes the stance that situational awareness is "the invariant in the agent environment system that generates the momentary knowledge and behaviour required to attain the goals specified by an arbiter of performance in the environment (Smith & Hancock, 1995).

Stanton et al. (2001) integrates these somewhat contradictory definitions of situational awareness into a systems approach. They do this by identifying and representing the five main elements within the system: the person (comprising three subsystems: working memory, mental models, and reflection together with projection), and the world. Furthermore there is an interaction between the two main system elements – the person and the world (Stanton et al., 2001).

Situational awareness can also be categorised in terms of seven elements, according to the Human Factor Investigation Tool (HFIT) is divided into seven elements (Gordon, Flin, & Mearns, 2005). These seven elements include *attention* – distraction; lack of concentration; divided attention; focused attention; *detection/perception* – signal not detected; visual, verbal or tactile misperception; *memory* – forget or miss a step; failure to consider all factors; place losing error; *interpretation* – miscomprehension; *decision making* – apply incorrect/inappropriate/partial solution to situation; *assumption* – relating to task, equipment, parts, systems, or procedures; and *response execution* – stereotype take-over, motor variability.

It is hypothesised that:

Hypothesis 16: *Situational awareness has an effect on behavioural intention.*

Hypothesis 17: *Situational awareness has an effect on team situational awareness.*

2.15. TEAM SITUATIONAL AWARENESS

People inherently act differently in situation where they are expected to act as a team when compared to acting as an individual. This can be based on the skills, knowledge, and expertise required to complete the task, or based on the psychology of teamwork on the individual (Gordon et al., 2005). This elicits the question of whether teamwork can have an impact on safety behaviour in individuals in comparison to situations where low levels of teamwork or no teamwork is required.

Teamwork includes shared situational awareness, that is, teams need to have the same expectations and common goals for the job (Gordon et al., 2005) – this refers to a shared set of safety goals and expected behaviour that is needed to achieve safety performance goals. Teamwork requires the buy-in from the individual as well as the entire group, as such problems can arise from individual or group deficiencies. It is therefore hypothesised that:

Hypothesis 18: *Team situational awareness has an effect on individual situational awareness.*

Glavin (2011) identified some of the individual and team deficiencies that may occur. *Individual deficiencies* may occur due to the individual simply not possessing the professional skills required to work in a team, not be a good team player because of personal characteristics, interpersonal conflicts, or the individual failing to recognise the importance of working as a team in order to reach safety performance goals (Glavin, 2011). *Team deficiencies* include issues such as unclear specification of responsibility, shared misconceptions, development of peer pressure, the formation of in groups and out groups, and communication styles mismatches (Glavin, 2011).

2.16. COMMUNICATION

In order to achieve high levels of safe production and performance in high-risk industries such as the petrochemical industry communication is critical (Hetherington et al., 2006). Communication can be defined as the exchange of information between individuals or groups that provides knowledge, builds relationships, establishes predictable behaviour patterns, maintains attention to the task, and can furthermore be used a s a management tool (Glavin, 2011). Glavin (2011) goes on to elaborate that communication can be one-way or two-way, the difference being that with two-way communication there is a feedback element.

The UK Civil Aviation Authority (CAA) identifies hazards that act as barriers to communication which could be relevant to other heavy industries. These barrier include failures during the transmitting process, difficulties due to the transmission medium – noise, failure during receiving, failures due to interference between the rational and emotional levels of communication, and physical problems in listening or speaking (UK Civil Aviation Authority, 2006).

In a study done by the Canadian Transportation and Safety Board (CTSB) analysing the communication errors between pilots, masters, and officers on watch in shipping, it was found that many times senior workers perceive that their communication is clear and understood by their subordinates while the subordinates perceive that this is not the case (Hetherington et al., 2006). This can be attributed to the subordinates being reluctant to question the senior workers instruction and can lead to misunderstandings or misperceptions that result in accidents. Effective communication can also contribute to team situational awareness as well as team working and effective decision making (Hetherington et al., 2006).

Another factor that may act as a barrier to effective communication is that of language proficiency. In the aforementioned study by the UK Civil Aviation Authority it was found that pilots who were not sufficiently proficient in the language of the captains aboard ships often experienced more communication errors. In a study done by the Seafarers International research Centre (SIRC) the question was raised if workers that are sufficiently proficient in a second language can communicate effectively in emergency situations in their second language when other cognitive demands are high (Kahveci & Sampson, 2011). The results showed that the results of miscommunication ranged from mild annoyance to the creation of potentially hazardous situations (Hetherington et al., 2006).

A study by Thorvaldsen and Sonvisen (2014) on the implications that multilingual crews have for safety on board Norwegian fishing vessels revealed some interesting findings. The crews on these Norwegian vessels are reported (Thorvaldsen & Sonvisen, 2014) to be increasingly multi-national and as a result multilingual, this has implications not only for day to day operational tasks, but also for communication in risky situations (Thorvaldsen and Sonvisen, 2014). Although the operating language is English, the majority of crew members from Norway and Russia are not completely fluent in the language and thus use a mixture of Russian, Norwegian, English and also a form of sign language to communicate.

The use of sign language has proved to be extremely effective not only in operational tasks but also in training of crew members, and in dangerous situations (Thorvaldsen and Sonvisen, 2014). This is proven by an event that occurred in November of 2008 when a fire started in the engine room of a fishing vessel whose crew was multilingual. The weather conditions and loss of propulsion and electricity made for a potentially catastrophic situation, but due to effective communication between crew members and safety equipment working as it should the situation was swiftly handled with no loss of life or injury (Thorvaldsen and Sonvisen, 2014). It is therefore hypothesised that:

Hypothesis 19: *Communication has an effect on team situational awareness.*

The above mentioned study by Thorvaldsen and Sonvisen (2014) illustrates that language does have an effect on effective communication between employees and that this may in fact have implications for safety behaviour of employees; but there are effective techniques that can be used to curb these barriers caused by language.

2.17. FATIGUE

Fatigue can be defined as “a state of tiredness that is associated with long hours of work, prolonged periods without sleep or requirements to work at times that are out of synch with the body’s biological or circadian rhythm.” (Flin, O'Connor, & Chrichton, 2008, p. 138). Mellor and Winsome (2012) identify a variety of definitions of fatigue in the existing literature, ranging from mental and physical impairment (Grandjean, 1979), to being characterised as task-related (Hancock & Verway, 2001), and as the inability to rest or recover (McQueen & Mander, 2003).

The National Sleep Foundation (2014) reports that although there is no magic number when it comes to sleep, the average adult needs between 7 and 8 hours of sleep to recover from a day’s activities which is corroborated by the Centre for Disease Control (2013). They report that there is an interaction with basal sleep needs and “sleep debt”, which comes about when a person does not get their basal sleep requirements in. This sleep debt can accumulate over time and lead to a person being drowsy or sleepy during the day, which may heavily affect decision making processes and function (The National Sleep Foundation, 2014). In today’s society, workers report that they get less sleep than what is needed on a daily basis (Glavin, 2011); and a loss of sleep of as little as 2 hours can lead to lower performance and alertness levels. A shortage in sleep can an also result in longer reaction times, reduced vigilance, cognitive slowing, memory problems, time on task decrements and optimum response decrements (Glavin, 2011).

Fatigue has been shown to be a major contributing factor in workplace accidents (Swaen, 2003). Mellor and St. John (2011) determined that fatigue was a major contributor to the Chernobyl nuclear disaster (1986). In support of this, Hetherington et al. suggests that fatigue may have been a contributing factor to the grounding of the Exxon Valdez in 1989 owing to the fact that the watch keeper had as little as 5-6 hours of sleep in the 24 hours prior to the incident. The consequences of the grounding of the Exxon Valdez was environmentally catastrophic and illustrates why it is so important to reduce levels of fatigue in workers. Gawron et al. (2001) stress the importance that recovery from fatigue has to take into account the rest needed to sufficiently address the nature, length, and intensity of effort expended during work (Mellor & St. John, 2011). As seen in Table 2.1, there are many adverse consequences that arise from a fatigued worker, all of which can potentially adversely affect safety behaviour in individuals.

In a study by Mellor and St. John (2011) on fatigue and work safety behaviour in men during early fatherhood it was established that there is an inverse correlation between fatigue and safety compliance and safety participation, as well as an inverse correlation between sleep hours and safety behaviour (Mellor & St. John, 2011).

Table 2.1.

Summary of the key effects of fatigue. Adapted from Human performance limitations (communication, stress, prospective memory and fatigue), by R.J. Glavin (2011). Best Practice & Research Clinical Research Anaesthesiology 25 p204.

Summary of the key effects of fatigue.
(A) Cognitive
Adverse effect on innovative thinking and flexible decision making
Reduced ability to cope with unforeseen rapid changes
Less able to adjust plans when new information becomes available
Tendency to adopt more rigid thinking and to adopt previous solutions
Lower standards of performance become acceptable
(A) Motor skills
Less co-ordination
Poor timing
(A) Communication
Difficulty in finding and delivering the correct word
Speech is less expressive
(A) Social

Become withdrawn
More acceptance of own errors
Less tolerant of others
Neglect smaller tasks
Less likely to converse
Increasingly irritable
Increasingly distracted by discomfort

Shift work contributes to fatigue and as a result causes poorer health and safety performance (IskaGolec, Folkard, & Noworol, 1996).
Based on the preceding argument on effects of fatigue situational awareness, as also illustrated in Table 2.1, it is hypothesised that:

Hypothesis 20: *Fatigue has a negative effect on individual situational awareness.*

2.18. PERCEIVED STRESS

Stress can be characterised as the resulting experience an individual gets when the demands placed on them outweigh the resources available to them to meet those demands (Glavin, 2011). This is supported by the UK Health and Safety Executive (2011) in its definition of stress as, "the adverse reaction people have to excessive pressure or other demands placed on them." (HSE, Health and Safety Executive Stress, 2011) Furthermore, the UK HSE divides workplace stress into 6 categories: (1) *Job demands:* factors include too much or too little time to complete tasks, too little training, and the work environment. (2) *Lack of Control:* High workload, hours, pace of work, and nature of activities. (3) *Relationships:* Bullying, harassment, among other issues. (4) *Change:* Uncertainty about what is happening, fears about job security, and restructuring. (5) *Role:* Staff feeling that the job requires them to behave in conflicting ways. (6) *Supervision of managers:* Lack of support from managers or unrealistic goals.
Glavin (2011) reports that those working in high-risk settings are subjected to acute stressors which can be brought on by high workload, emergencies, or high cost of

failure. It is important to examine the nature of these acute stressors as categorised by Flin et al. (2008):

- *Environmental:* Fatigue and physical environment
- *Novelty and uncertainty:* Unknown condition, critical information missing, etc.
- *Task related:* Performance anxiety (due to safety consequences, high workload, time pressure, personal danger, fear of failure.

Cooper, Dewe, and O'Driscoll's (2001) research has shown that stress is a factor that adds to the productivity and health costs of an organisation as well as to personal health and wellbeing (Cooper, Dewe, & O'Driscoll, 2001). It also commonly known that stress has an impact on attention (Ellenbogen et al., 2002), working memory (Ashcraft & Kirk, 2001), and perceptual-motor performance (van Gallen & van Huygevoort, 2000). This has implications for safety behaviour as acting in a safe manner and following protocols and other policies depend largely on a choice an individual makes and the working memory they have of specific policies and protocols; and if these functions are impaired this could very well decrease safety behaviour.

A study by Ge et al., (2014) analysing the effects of stress and personality on dangerous driving behaviours among Chinese drivers gives some insight into the effects of stress on a human's working memory and psychomotor processes. The study revealed that global stress was a good predictor of dangerous driving behaviour (Ge et al., 2014). Baddeley's (2001) working memory model states that general cognitive processing capacity resources are limited. Because stressful situations activate worrying (Eysenck, 1993), worrisome thoughts dominate working memory processing and overload the temporary storage capacity of working memory. Therefore, a person's limited attentional resources are not as available for concurrent task processing (Eysenck et al., 2007). This shortage of resources with regards to task processing leads to stressed individuals placing themselves in more dangerous situations in comparison to when their minds are free of stress and other distractions (Ge et al., 2014). Ge et al.'s (2014) study also revealed that specific external stressors such as a person being involved in a divorce are more prone to being involved in motor vehicle accidents as a result of placing themselves in more dangerous situations than they normally would (Ge et al., 2014). Furthermore, the study proves that anger is a moderating variable with stress regarding dangerous driving behaviours (Ge et al., 2014).

The results of the Ge et al. (2014) study is not limited to driving behaviour, and it can be hypothesised that it can be extrapolated to everyday activities that require working memory and attentional resources. These task processing resources are critical for workers in heavy industries as they have to be aware of their surroundings, remember policies and procedures regarding their work, and not put themselves in unnecessarily dangerous situations. It is therefore hypothesised that:

Hypothesis 21: S*tress has a negative effect on situational awareness.*

2.19. MINDFULNESS

Zhang and Whu (2014) suggest that mindfulness can improve safety behaviours through improving the dual system of safety behaviour. Mindfulness can be defined as the quality or state of being conscious or aware of something at the present moment in time. Mindfulness can moderate the dual system in a positive way manner (Brown & Ryan, 2003), through an improved attention on the present moment (Brown et al, 2007). Increased mindfulness he individual to better process information received from internal and external stimulus (Zhang & Whu, 2014).

As discussed earlier, system 1 of the dual system of safety behaviour is the unconscious part that is driven by intuition and heuristics. Mindfulness is thought to reduce the harm of this system, and improve the benefits of it by making the employee more aware of their unattended inner experiences and intuitions. (Brown & Ryan, 2003). Endsley (1995) postulates that mindfulness training can also improve levels of situational awareness, it is therefore hypothesised that:

Hypothesis 22: *Mindfulness has a positive effect on situational awareness.*

2.20. SAFETY TRAINING

Safety training is of critical importance if positive safety behaviour is to be expected. Workers cannot only know what is expected of them, but must also know how safety performance goals are to be achieved; both as individuals and as a group. An example of safety training that illustrates the aforementioned idea is Crew Resource Management. Crew Resource Management (CRM) is a technique used in the maritime industry in which crews are trained in the basic skills needed to cope with emergency situations and meet safety performance expectations (Hetherington et al., 2006). A similar approach tailored to specific industry or organisational needs can be used in order to reduce safety incidences. This allows for employees to acquire the knowledge of what is deemed as being safe behaviour and the skills to put that knowledge into action. The fact that employees know what safe behaviour is and what the outcomes of performing or not performing specific safety behaviours are, translates to the knowledge of the valence of specific behaviours. Thus safety training has an effect on the beliefs of the valence of safety behaviours on safety outcomes. Knowledge of the personal and organisational outcomes of abiding by safety regulations and policies will have an effect on the attitude towards safety behaviour. It is therefore hypothesised that:

Hypothesis 23: *Safety training has a positive effect on the beliefs about the valence of safety behaviour.*

Hypothesis 24: *Safety training positively effects attitude towards safety behaviour.*

Hypothesis 25: Safety training has a positive effect on safety climate.

Safety training is an opportunity for management and leadership to illustrate that safety is a first priority in the organisation, and that safety cannot be compromised on in order for operational requirement to be met. The link between management commitment to safety and safety behaviours have been proven by Bosak et al. (2013). Safety training is the tool that is used to equip employees with the necessary knowledge, skills, and expertise, as well as motivation to behave in a manner that is conducive to meeting safety outcomes, turning intentions to behave safely into observed behaviour. It is therefore hypothesised that:

Hypothesis 26: *Safety training moderates the relationship between behavioural intention and safety behaviour.*

2.21. FATALISM

According to Havold, Nesert and Strand (2011) fatalism can be defined as the perception that individuals have that they have little or no control over outside events such as accidents, and may be a reflection of underlying cultural values.

Due to the apartheid regime of the 1900s, South Africa is a country in which an unfair political system and racial segregation caused many people to receive a sub-standard education or none at all. This has resulted in large groups of people not being qualified or very poorly qualified. High risk industries make use of these groups of people for their workforce (Cronje, Reyneke, & van Wyk, 2013) as they are a source of low-cost labour. Since a large percentage of the employees in the high risk industries come from this social class the effects thereof must be analysed. Cronje, Reyneke, and van Wyk (2013) refer to the residential areas from which this workforce comes from as labour sending areas (LSA). The residential areas from which these individuals come and the social factors they experience within this area have certain effects on their psychological processes and how they think about certain things such as fatalism (Cronje et al., 2013). One such Fatalism was identified as a factor that has particular bearing on safety and safety behaviour within the high-risk industry.

Forcier, B.H., Walters, A.E., Brasher, E.E., & Jones, J.W. (2001), identify the similarity between fatalism and an external locus of control for safety. An individual with an external locus of control for safety will believe that accidents or dangerous situations are not within their control which will likely lead to that individual not acting in ways that are aligned to preventing or avoiding dangerous situations. In the high risk industries such belief could potentially lead to an employee not complying with safety regulations or guidelines and in turn translate to a poor interaction between the human and machine and as such create safety lapses or incidents. As mentioned by Havold et al., (2011), beliefs of fatalism could be a reflection of underlying cultural values, which are passed down from generation to generation and enforced by those referent others the individual finds themselves around. It therefore stands to reason that beliefs of fatalism of the workforce and society could shape the perceived control over behaviour of an individual. It is therefore hypothesised that:

Hypothesis 27: *Fatalism has an effect on perceived behavioural control.*

2.22. TOWARDS A STRUCTURAL MODEL OF SAFETY BEHAVIOUR

Table 2.2.

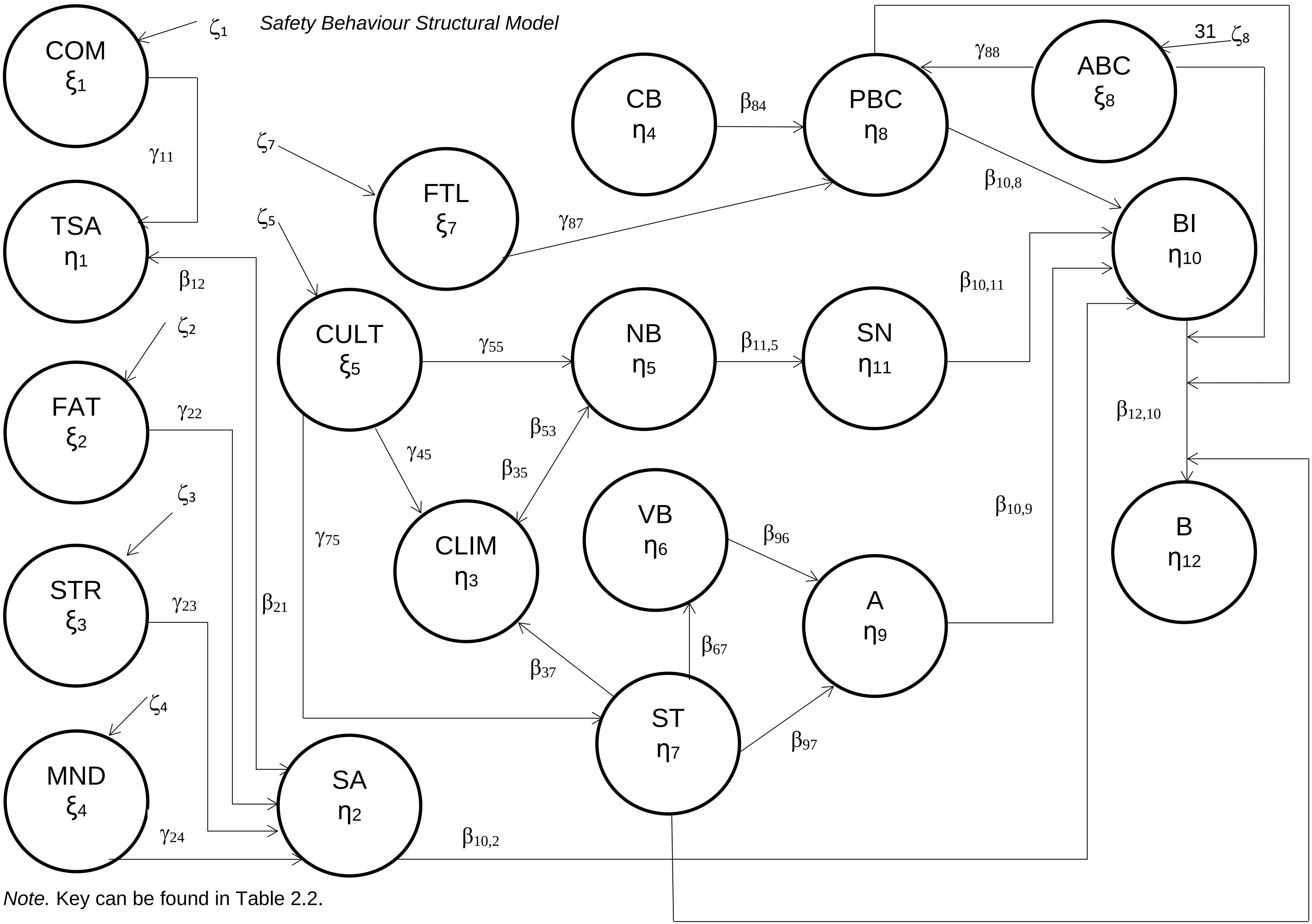
Safety Behaviour Structural Model Key

ξ1 = Communication and Language (COM)	η1 = Team Situational Awareness (TSA)
ξ2 = Fatigue (FAT)	η2 = Individual Situational Awareness (SA)
ξ3 = Stress (STR)	η3 = Safety Climate (CLIM)
ξ4 = Mindfulness (MND)	η4 = Control Beliefs (CB)
ξ5 = Safety Culture (CULT)	η5 = Normative Beliefs (NB)
ξ7 = Fatalism (FTL)	η6 = Valence Beliefs (VB)
ξ8 = Actual Behavioural Control (ABC)	η7 = Safety Training (ST)
	η8 = Perceived Behavioural Control (PBC)
	η9 = Attitude towards Safety Behaviour (A)
	η10 = Behavioural Intention (BI)
	η11 = Subjective Norm (SN)
	η12 = Behaviour (B)

Note. To be read with figure 2.4

Figure 2.4

Safety Behaviour Structural Model



Note. Key can be found in Table 2.2.

2.22. CONCLUSION

This chapter discussed the literature pertaining to safety behaviour and the antecedents related thereto. A comprehensive analysis of safety literature provided a credible base from which to hypothesize about the relationships between the antecedents to safety behaviour, and as a result a comprehensive safety behaviour structural model was constructed. Chapter 3 will discuss the research methodology that was used to test the various proposed hypotheses on the relationship between human factors and safety behaviour.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. INTRODUCTION

A theoretical argument of the antecedents to safety behaviour and their inter-relationships was set forth in the literature study. This produced a thorough set of structural relations that attempts to reach the research objectives. The overarching substantive research hypothesis of this study is that the structural model that was set forth in the literature study (Fig 2.4.) could provide a credible explanation for variance in safety behaviour. This overarching substantive research hypothesis was divided into a further 16 hypotheses that attempts to explain the direct effect causal pathways of the antecedents to safety behaviour in individuals, or rather how variance in those antecedents influence an individual's safety behaviour. If this model perfectly explains the variance in safety behaviour the overarching research hypothesis can be seen as an exact fit null hypothesis; this case is extremely rare, and is not expected. The model is expected to reasonably explain variance in safety behaviour, and as such it is expected that the close fit null hypothesis will be accepted.

The proposed structural model can be considered valid or permissible when the model closely fits the empirical data that has been collected (Babbie & Mouton, 2001). In order to collect and analyse data in such a way that the epistemic ideal of research is satisfied the research methodology needs to be both objective and rational (Babbie & Mouton, 2001). Objectivity is the scientific method's focus on reduction of error, while rationality refers to the fact that the validity of findings must be evaluated by knowledgeable peers (Babbie and Mouton, 2001). In order to satisfy the above-mentioned requirements of scientific research a description of the methodological choices made will be given with regard to the substantive research hypotheses, the research design, statistical hypotheses, sampling, data analysis techniques, measurement instruments, and ethical considerations.

3.2. AN ABRIDGED SAFETY BEHAVIOUR STRUCTURAL MODEL

The model that emerged from the literature study is a very complex representation of the causes of variance in safety behaviour. Although the relationships are in reality complex, one needs to take into consideration the practical implications of testing such a model, especially at first generation testing level. The implications of testing the complete structural model would result in a questionnaire that may be too long for participants to complete and result in response bias or other errors. The sample size needed to complete such a study would also be extremely large and may prove impossible to complete within given time constraints. It was therefore suggested that the safety behaviour structural model be streamlined in order to have a testable structural model from which accurate inferences can be drawn.

When minimising the model it was proposed that all of the variables relating to the theory of planned behaviour remain in the model, as this is the “point of origin” for the model and provides an accurate representation of the decision making process that takes place in an individual’s mind when deciding if they will perform safety behaviours or the contrary. In the literature review situational awareness emerged as a very important factor in influencing behavioural intentions of individuals, and therefore the focus of this research will be on the expansion of the theory of planned behaviour by adding the situational awareness variable and those variables that impact upon situational awareness. The list of variables that was removed from the original proposed safety behaviour structural model are, *communication and language, team situational awareness, safety culture, safety climate, fatalism, safety training,* and *personality.* Once the proposed changes were made the structural model that emerges can be depicted by Figure 3.1.

Table 3.1.

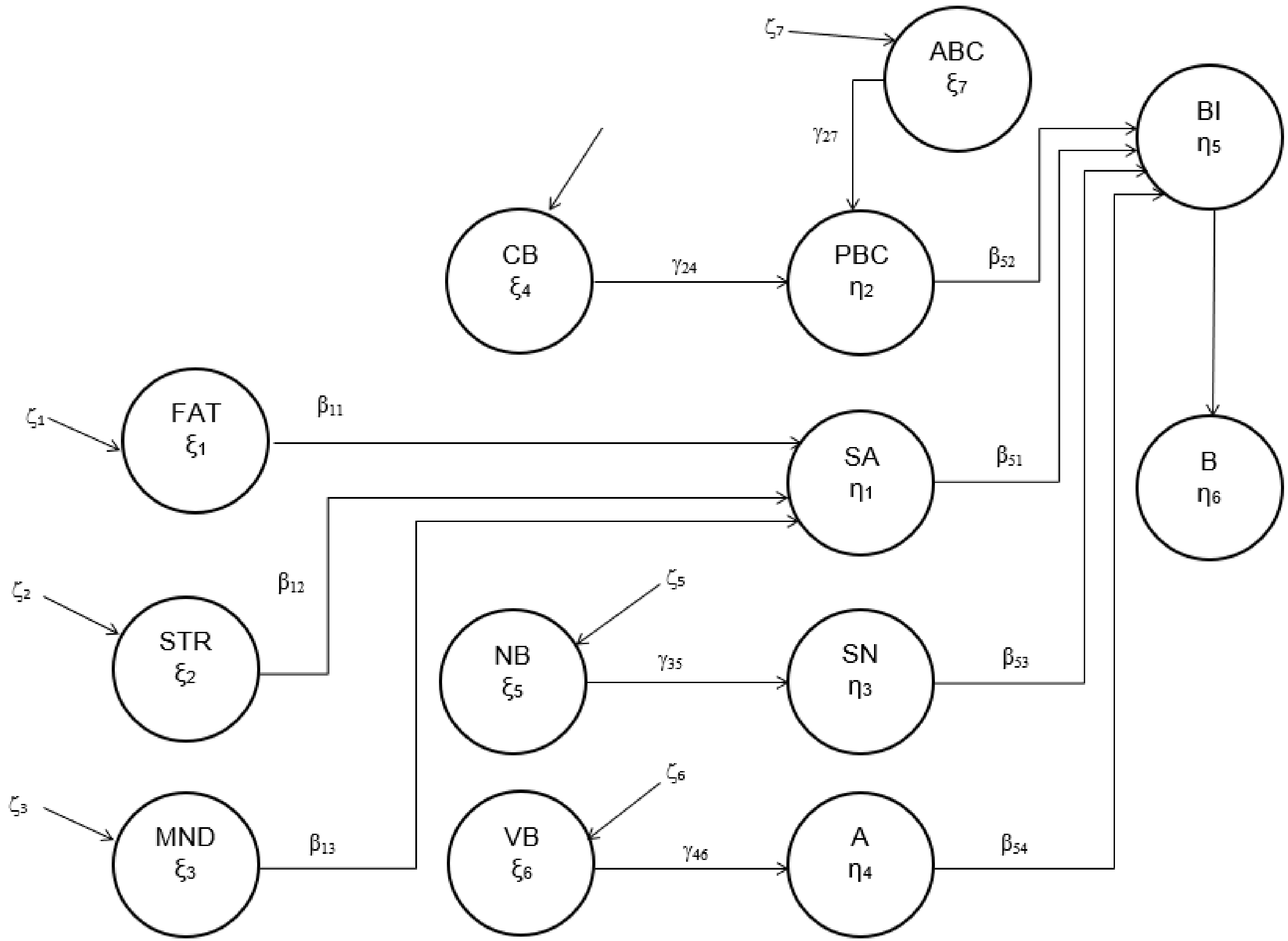
Abridged Safety Behaviour Structural Model Key

Independent Variables	**Dependent Variables**
ξ1 = Fatigue (FAT)	η1 = Individual Situational Awareness (SA)
ξ2 = Stress (STR)	η2 = Perceived Behavioural Control (PBC)
ξ3 = Mindfulness (MND)	η3 = Subjective Norm (SN)
ξ4 = Control Beliefs (CB)	η4 = Attitude towards Safety Behaviour (A)
ξ5 = Normative Beliefs (NB)	η5 = Behavioural Intention (BI)
ξ6 = Valence Beliefs (VB)	η6 = Behaviour (B)
ξ7 = Actual Behavioural Control (ABC)	

Note. To be read with Figure 3.1.

Figure 3.1

Abridged Safety Behaviour Structural Model



Note. Key can be found in table 3.1. The abridged safety behaviour structural model is a streamlined version of the model presented in figure 2.4. The focus of the abridged model is on individual factors so as to avoid a complicated multi-level study.

3.3. RESEARCH AIM, QUESTIONS, AND OBJECTIVES

The aim of this research study was to determine whether certain individual differences variables can be used to account for variance in safety behaviour amongst employees in high risk industries in South Africa. Subsequently, the research initiating question for this study was: *"Why is there variance in the safety behaviour of employees working in high risk industries in South Africa?"* This question was addressed through the attempt to achieve the following research objectives:

1. developing a structural model that depicts the dynamics of the variables that can possibly account for variance in safety behaviour, and
2. test the fit of the outer and inner model via Partial Least Squares modelling (PLS).

3.4. RESEARCH HYPOTHESES

The proposed safety behaviour structural model consists of several latent variables, and causal pathways are proposed between these variables.

Hypothesis 2: *Control beliefs (ξ_4) has an effect on perceived behavioural control (η_2).*

Hypothesis 3: *Perceived behavioural control (η_2) has an effect on behavioural intention (η_5).*

Hypothesis 4: *Actual behavioural control (ξ_7) has an effect on perceived behavioural control (η_2).*

Hypothesis 5: *Normative beliefs (ξ_5) has an effect on subjective norms (η_3).*

Hypothesis 6: *Subjective norms (η_3) has an effect on behavioural intention (η_5).*

Hypothesis 7: *Valence beliefs (ξ_6) has an effect on attitude towards safety behaviour (η_4).*

Hypothesis 8: *Attitude towards safety behaviour (η_4) has an effect on behavioural intention (η_5).*

Hypothesis 9: *Fatigue (ξ_1) has an effect on individual situational awareness (η_1).*

Hypothesis 10: *Stress (ξ_2) has an effect on individual situational awareness (η_1).*

Hypothesis 11: *Mindfulness (ξ_3) has an effect on individual situational awareness (η_1).*

Hypothesis 12: *Individual situational awareness (η_1) has an effect on behavioural intention (η_5).*

Hypothesis 13: *Behavioural intention (η_5) has an effect on behaviour (η_6).*

Statistical Hypotheses

If the overarching substantive research hypothesis is interpreted to mean that the proposed safety behaviour structural model provides a perfectly accurate description of the mechanisms that determine individual safety behaviour, the overarching substantive research hypothesis will translate into the following exact fit null hypothesis:

Exact fit null hypothesis:

H_{o1}: RMSEA = 0

H_{a1}: RMSEA > 0

If the overarching substantive research hypothesis is interpreted to mean that the proposed safety behaviour structural model provides only an approximate description of the mechanisms that determine individual safety behaviour, the overarching substantive research hypothesis will translate into the following close fit null hypothesis:

Close fit Hypothesis:

Ho2: RMSEA ≤ .0,05

Ha2: RMSEA > .0,05

Table 3.2 shows the statistical hypotheses that represent 26 path specific substantive research hypotheses into which the overarching substantive hypothesis was divided.

Table 3.2.

The path coefficient statistical hypotheses

Hypothesis 2	Hypothesis 7	Hypothesis 12
H02: $\gamma_{24}=0$	H08: $\gamma_{46}=0$	H015: $\beta_{51}=0$
Ha2: $\gamma_{24}>0$	Ha8: $\gamma_{46}>0$	Ha15: $\beta_{51}>0$
Hypothesis 3	Hypothesis 8	Hypothesis 13
H03: $\beta_{52}=0$	H09: $\beta_{54}=0$	H016: $\beta_{65}=0$
Ha3: $\beta_{52}>0$	Ha9: $\beta_{54}>0$	Ha16: $\beta_{65}>0$
Hypothesis 4	Hypothesis 9	
H04: $\gamma_{27}=0$	H012: $\gamma_{11}=0$	
Ha4: $\gamma_{27}>0$	Ha12: $\gamma_{11}>0$	
Hypothesis 5	Hypothesis 10	
H06: $\gamma_{35}=0$	H013: $\gamma_{12}=0$	
Ha6: $\gamma_{35}>0$	Ha13: $\gamma_{12}>0$	
Hypothesis 6	Hypothesis 11	
H07: $\beta_{53}=0$	H014: $\gamma_{13}=0$	
Ha7: $\beta_{53}>0$	Ha14: $\gamma_{13}>0$	

Note. Statistical hypotheses that represent 26 path specific substantive research hypotheses into which the overarching substantive hypothesis was divided.

3.5. RESEARCH DESIGN

According to Babbie and Mouton (2001) the research design is the plan with which the researcher intends to conduct their research to answer the research initiating question that has been identified at the outset. The research design outlines the procedure that will be followed to gather data that is required, how that data will be analysed, and ultimately how this will answer the initial research question or problem.

The design enables the researcher to test whether the hypothesised direct effect casual pathways between factors in the structural model validly explains variance, thus indicating whether or not the structural model as a whole is an accurate representation of the investigated factors. In order to achieve the above mentioned goals an ex-post-facto correlational design as depicted in Figure 3.1 was used.

Figure 3.2

Ex post facto correlational design

$[X_{11}]$	$[X_{12}]$	…	$[X_{1p}]$	Y_{11}	Y_{12}	…	Y_{1q}
$[X_{21}]$	$[X_{22}]$	…	$[X_{2p}]$	Y_{21}	Y_{22}	…	Y_{2q}
:	:			:	:		:
$[X_{i1}]$	$[X_{i2}]$	…	$[X_{ip}]$	Y_{i1}	Y_{i2}	…	Y_{iq}
:	:			:	:		:
$[X_{n1}]$	$[X_{n2}]$	…	$[X_{np}]$	Y_{n1}	Y_{n2}	…	Y_{nq}

Note. A figure illustrating an ex-post facto correlational design as described in the section following.

Ex-post facto design

The design requires measures on p exogenous indicator variables and the q endogenous indicator variables across n observations. The observed covariance matrix is subsequently calculated. Estimates for the freed parameters in the comprehensive LISREL model are obtained in an iterative fashion with the objective of reproducing the observed covariance matrix as closely as possible (Diamantopoulos & Siguaw, 2000). If the fitted model fails to accurately reproduce the observed covariance matrix the conclusion has to be drawn that the elaborated learning potential structural model does not provide an acceptable explanation for the observed covariance matrix (Diamantopoulos & Siguaw, 2000; Kelloway, 1998). As such the structural relationships hypothesized by the model do not provide an accurate representation of the antecedents to safety behaviour and their inter-relationships. The converse is not true. If the fitted covariance matrix derived from the parameter estimates obtained for the comprehensive LISREL model closely agrees with the observed covariance matrix it does not mean that the hypotheses portrayed in the structural model necessarily produce the observed covariance matrix. Therefore it cannot be concluded that the hypothesised direct effect causal pathways depicted in the structural model necessarily must be those that operate to determine variance in safety behaviour. This only means that it is permissible to interpret the statistical significance and magnitude of the estimated path coefficients and to regards that part of the structural model that receives support as one plausible account of the antecedents to safety behaviour and their inter-relationships. If the model fits closely it can be concluded that the statistically significant pathways in the model provide a valid account (Babbie & Mouton, 2001) of variance in safety behaviour.

In an ex post facto research design the researcher does not have control over independent variables or how they present because presentation has occurred already or they are not able to be manipulated. (Kerlinger, Floud, Meyer, & Babbie, 1973). Without any direct intervention, inferences about relations among variables are made. As can be concluded, the most important element of an ex post facto research design is the lack of control or manipulation that the researcher has. Although it is possible to draw subjects at random in a n ex post facto design, it is not possible to assign participants to groups at random or to subject groups to treatment at random. For this reason the researcher must be aware that participants can select themselves into groups based on factors that the researcher may not be interested in (Kerlinger et al., 1973).

According to Kerlinger, Floud, Meyer, and Babbie (1973), an ex post facto research design has the following limitations:

- Lack of ability to manipulate independent variables,
- The lack of ability to randomise, and
- The risk of incorrect interpretation

Although an ex post facto research design displays all of the limitations mentioned, the problems typically found in Industrial Psychology do not lend themselves to experimental inquiry because the variables considered are usually not manipulable. Taking the above-mentioned into consideration, measures must be taken to avoid incorrect interpretation of data.

3.6. SAMPLE AND SAMPLE DESIGN

The purpose of the research is to discover what the antecedents to safety behaviour in individuals working in high risk industries are. The focus therefore falls specifically on those individuals that work within the high risk industries such as mining and oil extraction and refinery. The target population is the population of employees that work within all of these high risk industries. Testing the proposed structural model of safety behaviour on the total population is not practically feasible, and as such a representative sample of employees needs to be selected from the target population. In order to achieve these goals the target population must therefore be operationalized as the sampling population, the sampling population will consist of those final sampling units (FSUs) in the target population that has a positive, non-zero probability of being selected to partake in the study. The ideal would be for the sampling population to be the same as the target population (Theron, 2007), but this is very rarely the scenario that is found in practice.

To select a representative sample a brief analysis of the various methods of sampling available to the researcher has been done. These two methods are probability and non-probability sampling.

Sampling Methods

3.6.1. Probability Sampling Methods

According to Babbie and Mouton (2001) probability sampling enhances the likelihood of selecting a set of FSUs from a population in such a way that the statistical characteristics of specific attributes of those sampling units accurately portray the parameters of the total population. In this method of sampling the entire sampling population is known and has an equal, non-zero chance of being selected, and as such the sample can be seen as self-weighing (Graveter & Forzano, 2003). Examples of probability sampling methods include random sampling, stratified sampling, cluster sampling, and systematic sampling (Babbie & Mouton, 2001).

3.4.2. Non-probability Sampling Methods

According to Bless, Higson-Smith, and Kagee (2011) non-probability sampling methods refer to the case where the probability of including each element of the population in a sample is unknown. It is therefore not likely to determine the likelihood of the inclusion of all representative elements of the population into the sample, making it impossible to estimate how well the sample represents the population, and generalisations become questionable (Bless, et al., 2011).

Although probability samples are then of a much higher quality than non-probability samples, this is often the only option a researcher is left with if population lists are not available (Bless et al., 2011). Furthermore, non-probability samples almost always have the advantage of being more affordable, faster, and being adequate for homogenous populations (Bless et al., 2011). The representativeness of a non-probability sample can be increased by increasing the sample size. The types of non-probability sampling methods available to the researcher are accidental or convenience sampling, purposive or judgemental sampling, and quota sampling. This research made use of a non-probability sampling method, more specifically convenience sampling.

Convenience Sampling

This sampling method is the most rudimentary of all the sampling methods and involves taking on all the available cases until the sample reaches the desired size (Bless et al., 2011). The researcher chose a convenient place, in this case any construction sites in the Western Cape Winelands region that allowed access to their ground-level staff. The researcher requested that staff made available complete the safety behaviour questionnaire. For this research the ideal sample size was larger than 200 individuals.

3.7. DATA COLLECTION

The primary challenge during the data collection phase was to locate a substantially large enough sample of willing participants for the study. To locate the sample organisations within the Western Cape in the construction industry were approached. Access to construction workers was requested from the identified institution, which was suitably granted with the provision that the researcher would have to travel to various construction sites across the Western Cape and gain verbal permission from each site manager to gain access to the workers on that site.

Over 30 construction sites were approached by the researcher with access gained at 24 construction sites. Those sites that did not gain access to the researcher did so due to operational and time restraints.

The administration of questionnaires was done by the researcher. Ethical issues were taken into consideration. The issues will be discussed in the following section. The questionnaires were in a pen and paper format due to the lack of access to computers by construction workers. A lucky draw prize was used as incentive for construction workers to complete the questionnaire.

Due to the time consuming nature of the data collection process, a relatively small sample size of 217 construction workers completed the questionnaire.

3.8. ETHICAL CONSIDERATIONS DURING DATA COLLECTION

When performing a study and collecting empirical evidence a researcher must ensure that the dignity, rights, safety, and well-being of research participants is ensured. The purpose of reflection on the ethical risks of the study is to ensure that the above-mentioned is satisfied. The question that the researcher must ask is whether the possible damage or harm that may be caused to research participants is justifiable in terms of the results or outcomes of the study (Standard Operating Procedure, 2012).

The researcher must obtain informed consent all participants before engaging in the study. For this to occur the participants must have a clear understanding of the goals and objectives of the study and the possible risks that may be involved to them. The Standard Operating Procedure (2012) outlines that participants have to be informed on the following issues regarding the study:

- The objective and purpose of the research,
- what participation in the research will involve,
- how the research results will be disseminated and used,
- who the researchers are, what their affiliation is, where they can make further inquiries about the research if they wish to do so,
- what their rights as a participant are, and where they can obtain more information about their rights.

Maybe most importantly, the participants must know that they are free to choose if they want to partake in the study. This issue was dealt with by an informed consent form (Appendix B) that explained the above-mentioned to research participants and allowed them to accept or deny to participate in the study. A copy of this consent from can be found attached in Appendix B. The language used in the informed consent form is in a vernacular that all participants will be able to understand.

All data collected was anonymous as there is no reason to know the identity of participants. All data was treated as confidential and only the researcher and supervisor has access to said data.

An application for ethical clearance of the proposed research study has been submitted, and approved by the Research Ethics Committee Human Research

(Humanities) of the University of Stellenbosch. A copy of this Application is attached and can be found in Appendix A.

3.9. DATA ANALYSIS

3.9.1. Missing Values

Issues regarding missing values in the empirical data collected must be dealt with before data analysis can take place. The selection of the method used to deal with missing values is dependent on the nature of the data, especially concerning whether the data follows a multivariate normal distribution. Four options were explored in order to determine the correct method to use.

List-wise deletion involves the identification and deletion of all cases that have one or more items with missing values. The risk associated with this approach is that the deletion of too many cases will result in dramatically reduced sample size (Theron, 2015).

The full information maximum likelihood (FIML) estimation procedure is argued to be more efficient than list-wise deletion (Theron, 2015), but cannot be used in this study as no separate imputed data set is created which prevents item and dimensionality analysis as well as calculation of item parcels, both of which are needed in this study.

The multiple imputation method estimates missing values through derivation for all cases in the initial sample, thus the imputed data allows for dimensionality analysis and the formation of item parcels. The problem with this method is that the multiple imputation procedures available in LISREL assume that the data values are missing at random and that the observed variables are continuous and follow a multivariate normal distribution, and this may not be the case for the empirical data that will be collected (Theron, 2015).

Imputation by matching Is considered to be the safest, most conservative approach to accounting for missing values, and assumptions made tend to be less strict than that of multiple imputation methods. It involves substituting missing values with real values. The real values used to replace the missing values are derived from a single, or multiple cases that have a similar response pattern over a matching set of variables. The ideal is to use matching variables that will not be utilised in the confirmatory factor analysis; this is however usually not possible. The items least influenced by missing values are consequently typically identified to serve as matching variables. By default, cases with missing values after imputation are eliminated (Theron 2015).

Item analysis, exploratory factor analysis, confirmatory factor analysis and structural equation modelling (SEM) was used to analyse the questionnaire data and to test the proposed safety behaviour structural model.

3.9.2. Item Analysis

Once items that could accurately reflect employees standing on a particular latent variable were identified an item analysis was conducted. The items that are ultimately included in the measure of a latent variable should elicit responses from an employee that reflect an accurate portrayal of an employee's standing on that latent variable, this can be represented by a number of item statistics. To calculate these statistics the Statistical package for the social sciences (SPSS) was used. Firstly, the reliability and homogeneity of the item indicators earmarked to represent each latent variable was calculated using classic measurement theory item analysis. The reliability of a scale is a representation of the degree to which it is free of random error variance; this was measured by using internal consistency. The representation of this is given by Cronbach's Alpha – an indication of the average correlation amongst items that make up the scale.

The purpose of this exercise was to allow the researcher to identify those items that do not contribute to the internal consistency of a scale, and as such have a negative effect on the reliability of said scale. By removing these items the scale produces a more valid and reliable reflection of an employee's standing on the latent variable being measured.

3.9.3. Exploratory Factor Analysis

The logic underlying exploratory factor analysis is to investigate the uni-dimensionality of each scale or sub-scale in order to determine whether the design intention succeeded in measuring a single, indivisible latent variable, and to evaluate the success with which each item measures the specific latent variable it was designed to measure. According to Fabrigar, Wegener, MacCallum, and Strahan (1999) exploratory factor analysis is used to uncover the underlying structure of large sets of variables.

Fitting procedures should be done in such a way as to estimate factor loadings and test for any unique variance in the model. This study made use of a fitting method called the maximum likelihood method, which tests for correlations among factors, statistical significance of factor loadings and the fit of the model (Fabrigar et al., 1999). In this study, the exploratory factor analysis was done using SPSS software. The model comparison technique was used to determine the appropriate number of items to be included in the model. This technique not only identifies the correct number of items to be included, but also explains the data in a similar way to a more complex model with a larger number of factors (Fabrigar et al., 1999). To do this the root mean square error of approximation (RMSEA) was analysed to determine the degree of the fit of the model.

The RMSEA explains the variance between the model and data that has been collected via the degrees of freedom allowed for the model. The RMSEA can be interpreted in the following manner:

- values below 0.5 constitute a good fit;
- values between 0.5 and 0.8 constitute a reasonable fit;
- values between 0.8 and 1.0 constitute a marginal fit (MacCallum, Widaman, Zhang & Hong, 1999).

3.9.4. Confirmatory Factor Analysis

When analysing the fit of the structural model consideration must firstly be given to whether the variables used to operationalise the latent variables provide accurate reflections of the latent variables they were designed to represent (Theron, 2015). Thus the indicator variables must be analysed by testing the fit of the measurement model before fitting the structural model. This was done in LISREL.

To fit the measurement model, the covariance matrix produced by the LISREL software was analysed. Maximum likelihood estimation was used. Maximum likelihood estimation operates under the assumption that the indicator variables used to operationalize the latent variables follow a multivariate normal distribution.

Confirmatory factor analysis is concerned with the accuracy with which indicator variables represent latent variables in the structural model. As such, where the measurement model provides a perfectly accurate representation of the process that created the observed inter-item covariance matrix, the measurement model would translate to an exact fit null hypothesis:

$H_{o28:}$ RMSEA = 0

$H_{a28:}$ RMSEA > 0

Following from this the measurement model would translate to a close fit null hypothesis where an approximate representation of the process that created the observed inter-item covariance matrix is seen:

$H_{o29:}$ RMSEA ≤ 0.5

$H_{a29:}$ RMSEA > 0.5

3.9.5. Structural Equation Modelling (SEM)

Structural Equation Modelling (SEM) is used to analyse the relationship between multiple factors and the empirical testing of theoretical models (Hair, Black, Badin, and Anderson, 2010). SEM can be used in both exploratory and confirmatory factor analysis. In this study SEM was used to analyse the measurement model as well as the relationships between factors in the structural model.

Hair et al., (2010) state that Structural Equation Modeling (SEM) allows for the relationships between multiple items to be analysed in the empirical testing of theoretical models. SEM can be used for confirmatory and exploratory analyses. As well as analysing the measurement model, it was used to analyse the relationships between constructs in the structural model.

There are two approaches within SEM, namely the covariance approach, and the partial least squared approach (PLS). The different approaches reflect fundamentally different philosophies and estimation ideas (Hair, Ringle & Starstedt, 2012).

The covariance-based approach

This approach is a statistical approach that attempts to confirm relationships between variables in a theorized structural model (Hair et al., 2012). The covariance-based approach aims to minimise the difference between the covariance matrix that has been implied by the model and the sample covariance model.

Conversely, the PLS-SEM approach has a predictive objective that aims to increase the explained variance of target endogenous constructs that exist within the model (Hair et al., 2012). Robins (2014), states that in the cases where theory does not provide unlimited explanations for dependent phenomena and the primary goal of the study is prediction; the PLS approach offers noticeable advantages as a statistical analysis approach for models. For these reason, PLS-SEM was used for this study.

Partial Least Square (PLS)

Haenlein and Kaplan (2004) states that PLS-SEM aims to maximize the variance of dependent variables as reflected by the independent ones. This approach gives the following information:

1. An inner model (a structural part) that shows the linkages between the proposed latent variables, and
2. An outer model (a measurement part) that shows the linkages between the latent variables and their observed variables (Henseler, Ringle, & Sinkovics, 2009).

The outer model was assessed by analysing the reliability and validity of the reflective constructs. The validity of the formative constructs was also analysed. Thereafter the analysis moved from the outer model (the measurement model) to the inner model (the structural model), where the variance of reflective constructs was examined; as well as their effect sizes and predictive relevance (Henseler et al., 2009).

Overall model fit was analysed by evaluating the measurement model (outer) and then the structural model (inner).

3.9.5.1. Evaluating the measurement model (outer)

The measurement model's fit is assessed by evaluating the individual item reliability, convergent and discriminant validity (Aibinu and Al-Lawati, 2010; Urbach and Ahlemann, 2010).

Individual item reliability

The first criterion that is considered when evaluating the measurement model is the internal consistency reliability. This is done examining the Cronbach's alpha criterion which provides an estimate of reliability based on indicator intercorrelations (Cronbach, 1951). PLS, also supports this with a composite calculation which reflects the extent to which variance in an item is attributed to the construct it intends to measure. This criterion admits that indicators have different loadings and makes the assumption that all indicators are equivalently reliable. The composite reliability criterion requires a value of at least 0.70, while values below 0.60 are considered dissatisfactory (Nunnally & Bernstein, 1994).

Convergent validity

Construct validity was assessed through Convergent validity of the instrument. When items of a construct links to items of another construct it is said that convergent validity occurs (Ahlemann & Urbach, 2010). PLS uses AVE (average Variance Extracted) to assess convergent validity. A value of 0.50 is generally required to indicate good convergent validity (Ahlemann & Urbach, 2010).

Discriminant validity

Discriminant validity is a process of determining whether the items of an instrument are distinct and thus do not indicate other variables (Straub, Boudreau & Gefen, 2004). The value of the square root of each construct's AVE should be bigger than the correlations with other constructs. Discriminant validity was also assessed through analyzing the cross-loadings of specific items. In other words, it needs to be determined that the item's loading with its specific construct should not be lower than its loading with another construct.

3.9.5.2. Evaluating the structural model (inner model)

The coefficient of determination and path coefficients were analysed to evaluate the theorised relationships in the structural model.

The Coefficient of Determination, also known as the R^2, determines how much variation of each endogenous variable is accounted for by the whole model. Values of 0.67 are deemed significant; while values of 0.33 and 0.19 are considered moderate and weak respectively (Chin, 1998).

The Path coefficient

The path relationships reflected in the structural model obtains estimated values. These estimated values were assessed in terms of their sign, magnitude, and significance.

3.10. MEASUREMENT INSTRUMENTS

Measurement were used to obtain individual respondents' standing on latent variables in the safety behaviour structural model. The measurement instruments used were combined and together formed a comprehensive safety behaviour questionnaire that respondents completed in pencil and paper format. To gather meaningful and accurate data, multi-indicator measures were used. To ensure that the LISREL model is over-identified two or more indicator variables per latent variable was required. To avoid the requirement of an excessively large sample size two or more composite indicators variables was calculated for each latent variable by calculating the mean of each set. The success with which the indicator variables represent the latent variables in the safety behaviour model were empirically evaluated by using data analysis techniques like item analysis, exploratory factor analysis and confirmatory factor analysis. The number of latent variable item indicators included in each scale and sub-scale were intentionally made more in order to determine those item indicators that best describe a respondent's standing on the latent variable in question, and therefore also to make up for those item indicator variables that do not successfully describe the latent variable of interest.

3.10.1. Variables within the TPB Model

The variables found within Fishbein and Azjen's TPB model were measured by means of constructing a Theory of Reasoned Action questionnaire as outlined by Azjen (2006). This questionnaire is set up in such a way as to elicit responses that give the standing of an individual on the latent variable of interest. The questionnaire was developed in such a way that the questions pertain specifically to safety behaviour of individuals within the high risk industries. Two items were formulated to assess each of the theory's major constructs, and seven point bi-polar adjective scales were employed to elicit standings on the latent variables.

The variables that were measured using this questionnaire are:

- Beliefs of valence of safety behaviour (VB)
- Attitude towards safety behaviour (A)
- Normative Beliefs (NB)
- Subjective norms about safety behaviour (SN)
- Control Beliefs (CB)

- Perceived behavioural Control (PBC)
- Behavioural intention (BI)
- Actual behavioural control (ABC)

3.10.2. Fatigue

The fatigue questionnaire was used to assess the severity of fatigue in employees. The questionnaire consists of seven items related to the physical symptoms of fatigue, and four items related to the mental signs of fatigue. Responses are elicited via a four point Likert scale with weights assigned to each response option. The questionnaire achieved a Cronbach's alpha (α) of 0.89 for the 11 item scale. The subscale of physical fatigue showed an α of 0.85, and the subscale for mental fatigue had an α of 0.82 (Neuberger, 2003).

3.10.3. Stress

The Perceived Stress Scale (PSS) was used to determine the levels of stress that employees experience. It is a subjective measure of stress and is measured by a fourteen item scale that elicits responses via a four point Likert scale. The questions are very general in nature and easy to understand, as such can be used for a wide variety of populations. The questions are also free of any sub-group specific content. Over a period of three studies conducted by Cohen, Kamarck, and Mermelstein (1983) the PSS achieved coefficient alpha for reliability of 0.84, 0.85, and 0.86.

3.10.4. Mindfulness

The Mindfulness Attention Awareness Scale (MAAS) was used to determine employees standing on the mindfulness variable. The MAAS uses 15 items that a participant rates on a scale from one ("almost always") to six ("almost never"). Scoring involves calculating mean performance across the 15 items, with higher scores indicating greater mindfulness (MacKillop & Anderson, 2007). The Conbrach's alpha (α) of 0.89 indicates good reliability.

3.10.5. Situational Awareness

The Situational Awareness Global Assessment technique (SAGAT) was used to measure an individual's standing on situational awareness. The SAGAT is a global tool developed to assess situational awareness across all of its elements based on a comprehensive assessment of the employee's requirements (SAGAT, 2012). The technique used to formulate a situational awareness assessment is available in the public domain, and this was used to develop items to measure participants' situational awareness.

3.10.6. Safety Behaviour

Safety behaviour was measured in the same way that Pousete, Larsson, and Torner (2007) measured it in a cross-validation study. The researchers measured safety behaviour as the average of three safety behaviour measures. The first two scales were developed from the work of Cheyne, Cox, Oliver, and Manuel (1998). Two distinct dimensions were revealed as a result of factor analysis of the safety behaviour measure reported by Cheyne et al. (1998). The first dimension is measured by 5 items and is concerned with participation in organised safety activities (Pousete, Larrson, & Torner, 2007), it is labelled *structural safety behaviour.* The second dimension refers to safety activities in daily work in interaction with co-workers and management, it is also measured by 5 items, and labelled *interactional safety behaviour* (Pousette et al., 2007). The final safety behaviour scale was developed in the study by Pousete et al. (2007) with the goal of measuring behaviour promotional of personal protection and was labelled *personal safety behaviour.*

The reliability of the three scales measured by Cronbach's alpha (α) was 0.88, 0.79, and 0.86 calculated from the empirical data in the study by Pousete et al. (2007).

3.11. CONCLUSION

This chapter presented he proposed hypotheses based on the literature review discussed in Chapter 2. The research design, sampling and data collection, as well statistical analysis techniques were explored. Lastly the measurement instruments used were discussed and their psychometric properties presented. The research results will be presented in the next chapter.

CHAPTER 4: RESEARCH RESULTS

4.1. INTRODUCTION

The aim of this research study was to determine whether certain individual differences in variables can be used to account for variance in safety behaviour amongst employees in high risk industries in South Africa. In previous chapters a comprehensive literature review was conducted from which a structural model emerged. It was proposed that an abridged version of the structural model be tested in this study due to time, and sample constraints. Following this the research methodology used to test whether the structural model is a good representation of the theoretical model that was tested was clarified. This chapter reports on, and discusses the research results.

4.2. THE ABRIDGED SAFETY BEHAVIOUR STRUCTURAL MODEL

Figure 4.1 depicts the abridged safety behaviour structural model that was tested.

Table 4.1.

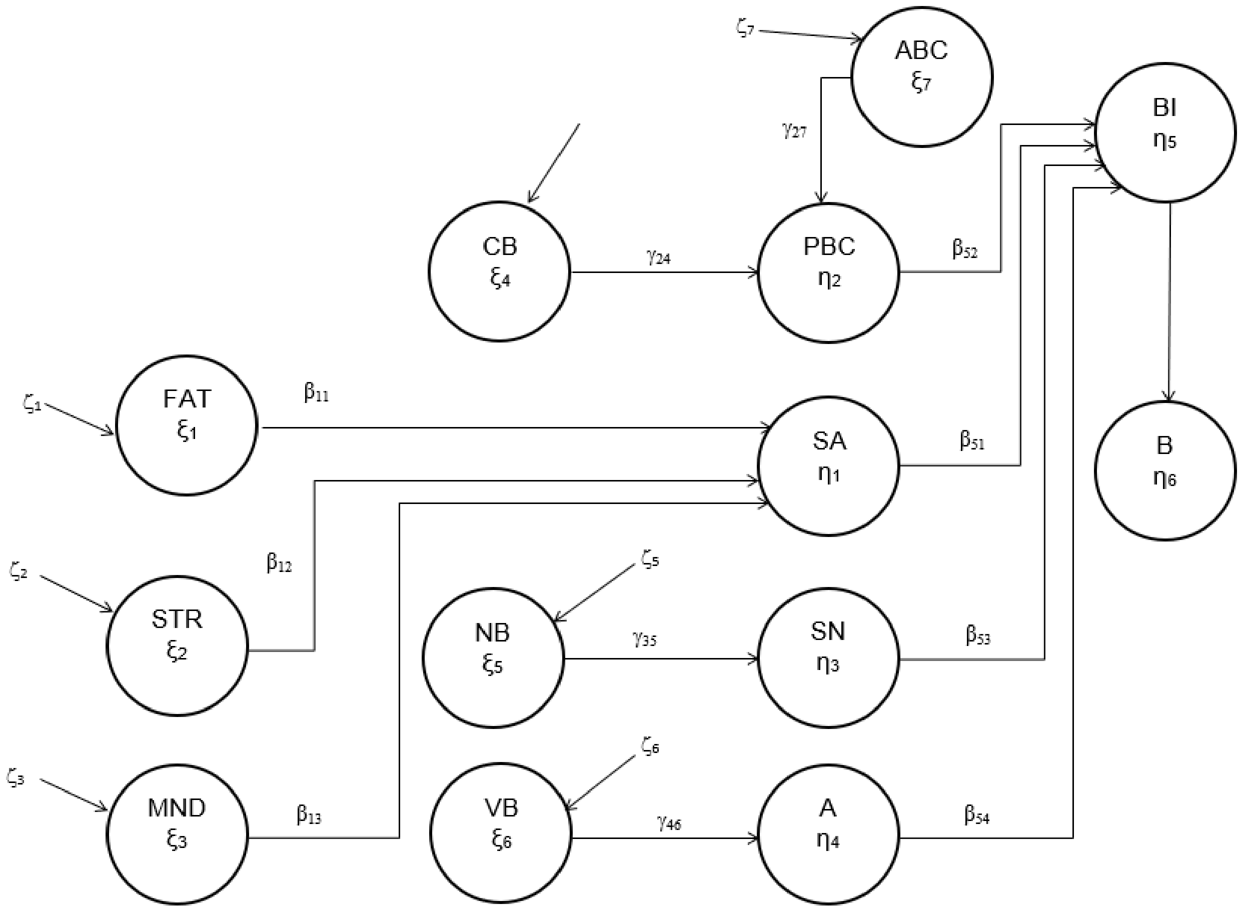
Abridged Safety Behaviour Structural Model Key

Independent Variables	Dependent Variables
ξ1 = Fatigue (FAT)	η1 = Individual Situational Awareness (SA)
ξ2 = Stress (STR)	η2 = Perceived Behavioural Control (PBC)
ξ3 = Mindfulness (MND)	η3 = Subjective Norm (SN)
ξ4 = Control Beliefs (CB)	η4 = Attitude towards Safety Behaviour (A)
ξ5 = Normative Beliefs (NB)	η5 = Behavioural Intention (BI)
ξ6 = Valence Beliefs (VB)	η6 = Behaviour (B)
ξ7 = Actual Behavioural Control (ABC)	

Note. To be read with Figure 4.1.

Figure 4.1

Abridged Safety Behaviour Structural Model



Note. Key can be found in table 3.1. The abridged safety behaviour structural model is a streamlined version of the model presented in figure 2.4. The focus of the abridged model is on individual factors so as to avoid a complicated multi-level study.

4.3. ITEM ANALYSIS

For each of the subscales in the Safety Behaviour model item statistics were calculated. The results were then evaluated and based on this the decision was made whether poor items were deleted before calculating item parcels and fitting the measurement model. The analysis is summarised in the table below.

Table 4.1

Item Statistics for Safety Behaviour subscales

Subscale	Sample Size	Mean	Number of items	Variance	Standard Deviation	Cronbach Alpha
Stress	217	29.600	10	53.686	7.327	.799
Mindfulness	217	58.070	14	97.291	9.864	.764
Fatigue	217	22.060	10	23.043	4.800	.684
Attitude	217	11.820	2	5.225	2.286	.891
Subjective Norm	217	11.920	2	7.030	2.651	.901
Normative Beliefs	217	12.060	2	6.200	2.490	.877
Perceived Behavioural Control	217	10.070	2	15.000	3.873	.952
Control Beliefs	217	10.674	2	10.674	3.267	.926
Behavioural Intention	217	9.980	2	13.333	3.651	.935
Actual Behavioural Control	217	11.550	2	7.499	2.738	.891
Valence Beliefs	217	12.360	2	3.815	1.953	.798
Situational Awareness	217	27.690	6	70.309	8.385	.829
Safety Behaviour	217	67.620	12	155.052	12.452	.896

The results of the item analysis for each subscale are presented individually below.

Subscale 1 (Stress)

Once the results were analysed it was evident that no extreme low or high means were observed in the Stress subscale. Further, item deviations from standard distribution were not markedly different from distributions generally observed for other items. This leads to the conclusion that all items were adequately sensitive.

When the inter-item correlation matrix is scrutinised, it reveals that STR7 does not correlate sufficiently (r_{ij}<.30) with other items in the subscale. Subsequently the effect on scale variance when removing STR7 must be investigated.

Table 4.2

Inter-item correlation matrix for Stress subscale

	STRESS7
STRESS 1	-0.160
STRESS 2	-0.225
STRESS 3	-0.190
STRESS 4	-0.179
STRESS 5	-0.181
STRESS 6	-0.364
STRESS 7	1.00
STRESS 8	-0.205
STRESS 9	-0.081
STRESS 10	-0.364

When STR7 is removed from the scale, scale variance is significantly reduced. This is presented in table 4.3. Additionally, the lower inter-item correlation and squared multiple correlation results are indicative that STR7 is a problematic item.

Table 4.3

Item total statistics for Stress subscales

Subscale	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Correlated Item-Total Correlation	Squared Multiple Correlation	Cronach's Alpha if Item Deleted
STRESS1	26.44	40.932	0.684	0.625	0.754
STRESS2	26.40	40.814	0.641	0.627	0.759
STRESS3	26.23	41.678	0.646	0.543	0.760
STRESS4	26.79	42.140	0.633	0.456	0.762
STRESS5	26.87	42.579	0.631	0.511	0.763
STRESS6	26.73	43.384	0.526	0.464	0.774
STRESS7	26.41	57.891	-0.316	0.214	0.857
STRESS8	27.14	44.277	0.548	0.475	0.773
STRESS9	26.32	44.181	0.466	0.242	0.782
STRESS10	27.08	46.711	0.338	0.375	0.796

The current Cronbach alpha of .799 for the subscale falls below the cut-off value of 0.80 for this study. In order to sufficiently raise this statistic, the Cronbach alpha if item deleted statistic was analysed. Consequently, if STR7 is removed from the subscale the Cronbach alpha result increases substantially to 0.857, confirming that STR7 is a problematic item. As such, the decision was made to remove STR7 from the Stress subscale.

Subscale 2 (Mindfulness)

Once the results were analysed it was evident that no extreme low or high means were observed in the Stress subscale. Further, item deviations from standard distribution were not markedly different from distributions generally observed for other items. This leads to the conclusion that all items were adequately sensitive.

When the inter-item correlation matrix is scrutinised, it reveals that MND4, MND12, and MND13 do not correlate sufficiently (r_{ij}<.30) with other items in the subscale. Subsequently the effect on scale variance when removing MND4, MND12, and MND13 must be investigated.

Table 4.4

Inter-item correlation matrix for Mindfulness subscales

	MND4	**MND12**	**MND13**
MND1	0.035	-0.078	-0.018
MND2	0.553	-0.034	-0.029
MND3	0.215	0.022	-0.084
MND4	1.000	0.196	-0.071
MND5	0.034	-0.172	-0.012
MND6	0.007	-0.004	-0.035
MND7	-0.060	-0.011	0.066
MND8	-0.101	-0.034	-0.033
MND9	-0.149	-0.107	-0.015
MND10	-0.199	0.003	0.098
MND11	-0.135	-0.001	0.119
MND12	0.196	1.000	-0.118
MND13	-0.071	-0.118	1.000
MND14	-0.141	-0.044	-0.50

Note. MND is Mindfulness

When MND4, MND12, and MND13 are removed from the scale, scale variance is significantly reduced. This is presented in table 4.5. Additionally, the lower inter-item correlation and squared multiple correlation results are indicative that MND4, MND12, and MND13 are problematic items.

Table 4.5

Item total statistics for Mindfulness subscales

Subscale	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Correlated Item-Total Correlation	Squared Multiple Correlation	Cronach's Alpha if Item Deleted
MND1	54.20	84.024	0.384	0.476	0.749
MND2	53.48	85.381	0.340	0.482	0.754
MND3	53.59	83.705	0.405	0.317	0.747
MND4	54.25	94.699	0.025	0.454	0.782
MND5	54.73	86.504	0.327	0.563	0.755
MND6	54.74	85.852	0.258	0.481	0.752
MND7	53.73	77.021	0.631	0.489	0.721
MND8	53.77	78.521	0.658	0.711	0.721
MND9	54.39	80.164	0.549	0.579	0.732
MND10	54.12	81.260	0.548	0.661	0.733
MND11	53.93	84.611	0.388	0.393	0.749
MND12	53.10	97.440	-0.054	0.144	0.778
MND13	53.31	96.552	-0.020	0.099	0.779
MND14	53.61	81.072	0.588	0.567	0.730

Note. MND is Mindfulness

The current Cronbach alpha of .764 for the subscale falls below the cut-off value of 0.80 for this study. In order to sufficiently raise this statistic, the Cronbach alpha if item deleted statistic was analysed. Consequently, if MND4, MND12, and MND13 are removed from the subscale the Cronbach alpha result increases substantially to 0.782, 0.778, and 0.779 respectively, confirming that these are problematic items. As such, the decision was made to remove these items from the Mindfulness subscale.

When analysis was repeated without these items a Cornbrach's alpha value of 0.815 was returned.

Subscale 3 (Fatigue)

Once the results were analysed it was evident that no extreme low or high means were observed in the Stress subscale. Further, item deviations from standard distribution were not markedly different from distributions generally observed for other items. This leads to the conclusion that all items were adequately sensitive.

When the inter-item correlation matrix is scrutinised, it reveals that FAT2, and FAT4 do not correlate sufficiently (r_{ij}<.30) with other items in the subscale. Subsequently the effect on scale variance when removing FAT2, and FAT4 must be investigated.

Table 4.6

Inter-item correlation matrix for Fatigue subscales

	FAT2	**FAT4**
FAT1	0.261	-0.010
FAT2	1.000	-0.111
FAT3	0.156	-0.155
FAT4	-0.111	1.000
FAT5	0.087	-0.061
FAT6	0.021	0.016
FAT7	0.099	-0.018
FAT8	0.080	-0.067
FAT9	0.088	-0.073
FAT10	0.123	0.048

Note. FAT is Fatigue

When FAT2, and FAT4 are removed from the scale, scale variance is significantly reduced. This is presented in table 4.7. Additionally, the lower inter-item correlation and squared multiple correlation results are indicative that FAT2, and FAT4 are problematic items.

Table 4.7

Item total statistics for Fatigue subscales

Subscale	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Correlated Item-Total Correlation	Squared Multiple Correlation	Cronach's Alpha if Item Deleted
FAT1	19.36	17.972	0.471	0.266	0.631
FAT2	19.21	20.369	0.187	0.102	0.688
FAT3	19.79	19.603	0.302	0.154	0.665
FAT4	20.80	23.218	-0.087	0.056	0.703
FAT5	19.56	18.275	0.456	0.361	0.635
FAT6	19.67	18.453	0.388	0.295	0.649
FAT7	19.86	17.666	0.482	0.322	0.628
FAT8	19.76	18.405	0.408	0.274	0.645
FAT9	20.34	19.318	0.387	0.310	0.650
FAT10	20.15	19.978	0.276	0.276	0.670

Note. FAT is Fatigue

The current Cronbach alpha of .684 for the subscale falls below the cut-off value of 0.80 for this study. In order to sufficiently raise this statistic, the Cronbach alpha if item deleted statistic was analysed. Consequently, if FAT2 and FAT4 are removed from the subscale the Cronbach alpha result increases substantially to 0.688 and 0.703 respectively, confirming that these are problematic items. As such, the decision was made to remove these items from the Fatigue subscale.

When analysis was repeated without these items a Cornbrach's alpha value of 0.711 was returned.

Subscale 4 (Attitude)

None of the items in the Attitude subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately ($r_{ij}>.30$) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.891 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Attitude subscale were retained.

Subscale 5 (Subjective Norm)

None of the items in the Subjective Norm subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately (rij>.30) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.901 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Subjective Norm subscale were retained.

Subscale 6 (Normative Beliefs)

None of the items in the Normative Beliefs subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately (rij>.30) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.877 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Normative Beliefs subscale were retained.

Subscale 7 (Perceived Behavioural Control)

None of the items in the Perceived Behavioural Control subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately (rij>.30) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.952 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Perceived Behavioural Control subscale were retained.

Subscale 8 (Control Beliefs)

None of the items in the Control Beliefs subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately (rij>.30) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.926 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Control Beliefs subscale were retained.

Subscale 9 (Behavioural Intention)

None of the items in the Behavioural Intention subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately (rij>.30) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.935 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Behavioural Intention subscale were retained.

Subscale 10 (Actual Behavioural Control)

None of the items in the Actual Behavioural Control subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately ($r_{ij}>.30$) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.891 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Actual Behavioural Control subscale were retained.

Subscale 11 (Valence Beliefs)

None of the items in the Valence Beliefs subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately ($r_{ij}>.30$) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.798 for the current subscale is marginally below the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Valence Beliefs subscale were retained.

Subscale 12 (Situational Awareness)

None of the items in the Situational Awareness subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. The inter-item correlation matrix for the Situational Awareness subscale is shown in Table 4.8 Item SA5 shows itself as a questionable item in Table 4.8 in that it tends to correlate low (r_{ij}<.30) with the majority of the other items in the subscale.

Table 4.8

Inter-item correlation matrix for Situational Awareness subscale

	SA5
SA1	0.064
SA2	0.115
SA3	0.028
SA4	0.018
SA5	1.000
SA6	0.076

Note. SA is Situational Awareness.

The removal of item SA5 shows that scale variance reduces significantly. This supports the conclusion that SA5 is problematic. The item-total correlation and squared multiple correlation statistics support this conclusion as well.

Table 4.9

Item total statistics for Situational Awareness subscales

Subscale	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Correlated Item-Total Correlation	Squared Multiple Correlation	Cronach's Alpha if Item Deleted
SA1	23.22	47.238	0.656	0.853	0.789
SA2	23.31	46.270	0.726	0.695	0.772
SA3	23.30	46.470	0.763	0.851	0.765
SA4	23.25	46.919	0.713	0.804	0.776
SA5	21.97	67.281	0.075	0.032	0.874
SA6	23.39	48.812	0.611	0.844	0.799

Note. SA is Situational Awareness.

The current Cronbach alpha of .829 for the subscale falls above the cut-off value of 0.80 for this study. Because SA5 was a problem item, the Cronbach alpha if item removed statistic was consulted. This showed that removing SA5 would increase the Cronbach's alpha to 0.874 confirming that SA5 is a problem item. As such, the decision was made to remove this item from the Situational Awareness subscale.

Subscale 13 (Safety Behaviour)

None of the items in the Safety Behaviour subscale had extreme low or extreme high means. None of the items displayed small standard deviations that set them apart from the typical distributions observed for the majority of the items. It can therefore be concluded that all the items were sufficiently sensitive. No items in this subscale show themselves as questionable items in that they all tend to correlate moderately ($r_{ij}>.30$) with each other.

When scale variance is investigated it reveals that removing any individual item from the subscale reduces scale significantly, this confirms that there are not problematic items. Item-total correlation and squared multiple correlation statistics supports the aforementioned conclusion.

The Cronbach alpha of 0.896 for the current subscale is above the cut-off value of 0.80 set for this study. When each of the items are individually removed from the scale, this statistic decreases which shows that each item individually responds to changes in the latent variable. Consequently, removing any of these items will adversely affect the internal consistency of the subscale. Therefore, each of the items in the Safety Behaviour subscale were retained.

Summary of Item Analysis

The item analysis section of this chapter evaluates how successfully items reflected performance dimensions as measured by the Safety Behaviour Questionnaire. When developing the questionnaire, the intention was to construct a one-dimensional set of items that accurately represent variance in variables in the Safety behaviour model. Item analysis reveals if this was achieved.

Several item statistics including item-total correlations, squared multiple correlations, inter item correlations, and Cronbach alpha coefficients. To satisfy the status of achieved, the item-total correlations, squared multiple correlations, and inter-item correlations should moderately highly correlate, and the Cronbach’s alpha should be higher than 0.80.

As a result of this analysis, the majority of items satisfied the requirements. Further, seven items were identified as problematic enough to remove them from their respective subscales. The summary of these statistic after the removal of seven items can be found in Table 4.10 below.

Table 4.10

Summary Statistics for all subscales after the removal of problematic items

Subscale	Sample Size	New Mean	Number of items	Number of items removed	New Number of items	New Variance	New Standard Deviation	Cronbach Alpha Old	Cronbach Alpha New
Stress	217	26.41	10	1	9	57.891	7.609	.799	.857
Mindfulness	217	44.52	14	3	11	94.121	9.702	.764	.815
Fatigue	217	17.95	10	2	8	20.446	4.522	.684	.711
Attitude	217	11.82	2	0	2	5.225	2.286	.891	N/A
Subjective Norm	217	11.92	2	0	2	7.030	2.651	.901	N/A
Normative Beliefs	217	12.06	2	0	2	6.200	2.490	.877	N/A
Perceived Behavioural Control	217	10.07	2	0	2	15.000	3.873	.952	N/A
Control Beliefs	217	10.674	2	0	2	10.674	3.267	.926	N/A
Behavioural Intention	217	9.98	2	0	2	13.333	3.651	.935	N/A
Actual Behavioural Control	217	11.55	2	0	2	7.499	2.738	.891	N/A
Valence Beliefs	217	12.36	2	0	2	3.815	1.953	.798	N/A
Situational Awareness	217	21.97	6	1	5	67.281	8.203	.829	.874
Safety Behaviour	217	67.62	12	0	12	155.052	12.452	.896	N/A

4.4. Exploratory Factor Analysis

Exploratory factor analysis aims to explore the underlying theoretical structure between variables in a scale or subscale to reduce data to a smaller set of summary variables. Exploratory factor analysis condenses variables into highly correlated groups that measure a single underlying construct by first examining the pairwise relationship between different variables. In this study, exploratory factor analysis was performed using R-type factor analysis that involves calculating factors from a correlation matrix (Hair, Babin, & Anderson, 2018).

SPSS was used to perform a series of thirteen exploratory factor analyses on the items comprising the subscales of the Safety Behaviour questionnaire. Table 4.11 is a summary of the results of the factor analyses.

Table 4.11

Summary results for factor analysis of all scales

Subscale	Determinant	KMO	Bartlett X2	% Variance explained	No. of factors extracted
Stress	.023	.859	799.436	52.678	2
Mindfulness	.008	.821	1028.228	56.165	3
Fatigue	.222	.742	319.377	36.639	2
Attitude	.347	.500	226.766	80.721	1
Subjective Norm	.327	.500	239.771	81.979	1
Normative Beliefs	.389	.500	202.772	78.128	1
Perceived Behavioural Control	.173	.500	376.655	90.890	1
Control Beliefs	.255	.500	292.841	86.202	1
Behavioural Intention	.229	.500	316.172	87.722	1
Actual Behavioural Control	.355	.500	221.975	90.233	1
Valence Beliefs	.558	.500	125.313	66.430	1
Situational Awareness	.008	.710	1035.565	86.736	2
Safety Behaviour	.000	.878	1708.966	66.329	3

4.4.1. Factor Analyzability of the Inter-Item Correlation Matrix

In this study, the Kaiser-Meyer-Olkin measure as well as Bartlett's test was used to examine factor analyzability of the inter-item correlation matrices. Scores are expressed as a number between 0 and 1, values closer to 1 being considered better. Sricharoena and Buchenrieder (2005) states that higher scores will be achieved when items represent a single common underlying factor. The assumption can then be made that when this factor is controlled, the correlation between items will be close to 0.
In the case of the Safety Behaviour questionnaire KMO values ranges between .5 and .859. This indicates that all the correlation matrices are factor analysable.

To test the null hypothesis that the inter-item correlation matrix is an identity matrix in the parameter, the Bartlett test of sphericity was used. With the Safety Behaviour questionnaire, the stated null hypothesis could be rejected for all of the 13 subscales. This implies that the correlation matrices are all factor analysable.

Further, the inter-item correlation matrices showed that all thirteen subscales showed significant ($p<0.05$) correlations), which supports the conclusion that that subscale correlation matrices are factor analysable.

4.4.2. Factor Extraction Method

Principal axis factor analysis was used to factor analyse the thirteen subscales as it produced factor decomposition that was easily interpreted.

4.4.2.1. Decision on the Number of Factors to Extract

To determine the number of factors that would be extracted in this study, the eigenvalue-greater-than-one criterion and scree test was used. The eigenvalue represents that variance that a factor account for (Hardy & Bryman, 2004). To make the decision on the number of factors to extract, the eigenvalues are calculated in a correlation matrix. Factors with an eigenvalue of 1.00 or higher are retained, while factors with an eigenvalue of less than 1.00 would be rejected. The problem lies with the fact that factors with a value either just above or below the cut-off value may be falsely rejected or retained. Hardy and Bryman (2004) overcome this problem by extracting both more and fewer factors than suggested by the eigenvalue greater than one rule to assess whether factors are meaningful when rotated.

4.4.2.2. Rotation of Extracted Factors

Factors are re-oriented to make factors more easily interpretable through rotation (Powell & Peng, 1989). Although a number of options exist to choose from, the rotation of factors in this study was done using a varimax rotation method.

4.4.2.3. Differential Skewness

For this study, the majority of items showed a significantly ($p<0.05$) negatively skewed and leptokurtic distribution. It can therefore be assumed that the likelihood that differential item characteristics accounting for factor fission observed is low.

Stress

When designing the Stress subscale the intention was that each of the 9 items should represent a single underlying performance dimension. The EFA output evaluation reveals that two factors are required to sufficiently explain correlations between the items of the subscale. Two items have eigenvalues-greater-than-one, which is confirmed by analysis of the scree plot.

To analyse whether this represents meaningful fission of the Stress dimension the rotated factor matrix must be consulted. In this matrix, it is clear that items STR1-STR9 have larger loadings on the first factor (>.5) while item STR10 has a larger loading on factor two (>.5). STR6, STR7, and STR10 load on both factors.

When the wording of the item loadings was inspected it was found that each of the two factors elicit responses that represent different sub-dimensions of Stress.

When residuals between observed and reproduced correlations were calculated it was found that only 3 (8%) of the residuals were non-redundant with an absolute value greater than .05. It can therefore be concluded that the extracted two-factor solution accurately provides an explanation for the observed inter-item correlation matrix. This leads to the further conclusion that unidimensionality for the STR subscale is not corroborated as 32.011% of variance is accounted for by factor 1, and 20.667% of variance accounted for by factor 2.

SPSS was used to extract a single factor, and determine loadings of items on that factor, with the purpose of analysing how well items reflect a single underlying performance dimension.

STR10 proved to be the only problematic item, as it was the only item to have a loading of higher than 0.50 on the single factor. The residual correlation matrix reveals that 61% of residual correlations are large. From these results it can be concluded that a single factor solution sufficiently explains the observed correlation matrix, and that all items with the exception of STR10 sufficiently reflects a single second-order underlying factor.

Because item STR10 has a borderline loading of 0.408 it was decided to retain it in the subscale for this analysis, but to flag it as a borderline questionable item for future analysis of the Safety Behaviour Questionnaire.

Mindfulness

When designing the Mindfulness subscale the intention was that each of the 11 items should represent a single underlying performance dimension. The EFA output evaluation reveals that three factors are required to sufficiently explain correlations between the items of the subscale. Three items have eigenvalues-greater-than-one, which is confirmed by analysis of the scree plot.

To analyse whether this represents meaningful fission of the Mindfulness dimension the rotated factor matrix must be consulted. In this matrix, it is clear that items MND7, MND8, MND9, MND10, MND11, and MND14 have larger loadings on the first factor (>.5) while items MND1 and MND5 has a larger loading on factor two (>.5), and lastly MND2 and MND3 have a larger loading on factor 3 (>.5).

When the wording of the item loadings was inspected it was found that each of the three factors elicit responses that represent different sub-dimensions of Mindfulness.

When residuals between observed and reproduced correlations were calculated it was found that only 4 (7%) of the residuals were non-redundant with an absolute value greater than .05. It can therefore be concluded that the extracted three-factor solution accurately provides an explanation for the observed inter-item correlation matrix. This leads to the further conclusion that unidimensionality for the MND subscale is not corroborated as 30.005% of variance is accounted for by factor 1, 16.355% of variance accounted for by factor 2, and 9.80% of variance accounted for by factor 3 .

SPSS was used to extract a single factor, and determine loadings of items on that factor, with the purpose of analysing how well items reflect a single underlying performance dimension.

Items MND7, MND8, MND9, MND10, MND11, and MND14 (>.3) have loadings greater than .50 on the single factor, while the rest have lower loadings. In the residual correlation matrix 72% of the residual correlations are large suggesting that the single factor solution still manages to adequately explain the observed correlation matrix. This evidence shows that items MND7, MND8, MND9, MND10, MND11, and MND14 satisfactorily reflect a single second-order underlying factor. Item MND1, MND2, MND3, MND5, and MND6 have lower loading as shown in Table 4.39 Based on the evidence produced by factor analysis it was decided to flag these items as a borderline, questionable item for future analysis on the Safety Behaviour Questionnaire but to retain it in subscale MND for the current analysis.

Fatigue

When designing the Fatigue subscale the intention was that each of the 8 items should represent a single underlying performance dimension. The EFA output evaluation reveals that two factors are required to sufficiently explain correlations between the items of the subscale. Two items have eigenvalues-greater-than-one, which is confirmed by analysis of the scree plot.

To analyse whether this represents meaningful fission of the Fatigue dimension the rotated factor matrix must be consulted. In this matrix, it is clear that all items with the exception of FAT10 have larger loadings on the first factor (>.5) while item FAT10 has a larger loading on factor two (>.5).

When the wording of the item loadings was inspected it was found that each of the three factors elicit responses that represent different sub-dimensions of Fatigue.

When residuals between observed and reproduced correlations were calculated it was found that only 5 (17%) of the residuals were non-redundant with an absolute value greater than .05. It can therefore be concluded that the extracted two-factor solution accurately provides an explanation for the observed inter-item correlation matrix. This leads to the further conclusion that unidimensionality for the FAT subscale is not corroborated as 24.641% of variance is accounted for by factor 1, and 15.998% of variance accounted for by factor 2.

SPSS was used to extract a single factor, and determine loadings of items on that factor, with the purpose of analysing how well items reflect a single underlying performance dimension.

Items FAT1, FAT5, FAT6, and FAT7 (>.3) have loadings greater than .50 on the single factor. In the residual correlation matrix 71% of the residual correlations are large suggesting that the single factor solution still manages to adequately explain the observed correlation matrix. This evidence shows that all items except FAT3, FAT8, FAT9, and FAT10 satisfactorily reflect a single second-order underlying factor. These items have a lower loading. Based on the evidence produced by factor analysis it was decided to flag these items as a borderline, questionable items for future analysis on the Safety Behaviour Questionnaire but to retain it in subscale FAT for the current analysis.

Attitude

When the unidimensionality assumption for the Attitude subscale is tested it was found that items comprising the subscale all represent a single underlying performance factor. Both items load satisfactorily on the extracted factor (>0.50). Only one item has an eigenvalue greater than one, which is supported by the scree plot.

The unidimensionality assumption for subscale SN is therefore corroborated. 80.721% of the total subscale variance can be explained by the extracted factor.

Situational Awareness

When designing the Situational Awareness subscale the intention was that each of the 5 items should represent a single underlying performance dimension. The EFA output evaluation reveals that two factors are required to sufficiently explain correlations between the items of the subscale. Two items have eigenvalues-greater-than-one, which is confirmed by analysis of the scree plot.

To analyse whether this represents meaningful fission of the Situational Awareness dimension the rotated factor matrix must be consulted. In this matrix, it is clear that all items have larger loadings on the first factor (>.5) while items SA1 and SA6 loads on both factors, albeit more on the first factor.

When the wording of the item loadings was inspected it was found that each of the three factors elicit responses that represent different sub-dimensions of Situational Awareness.

When residuals between observed and reproduced correlations were calculated it was found that none of the residuals were non-redundant with an absolute value greater than .05. It can therefore be concluded that the extracted two-factor solution accurately provides an explanation for the observed inter-item correlation matrix. This leads to the further conclusion that unidimensionality for the SA subscale is not corroborated as 49.228% of variance is accounted for by factor 1, and 37.509% of variance accounted for by factor 2.

SPSS was used to extract a single factor, and determine loadings of items on that factor, with the purpose of analysing how well items reflect a single underlying performance dimension.

All items have loadings greater than .50 on the single factor. In the residual correlation matrix 100% of the residual correlations are large suggesting that the single factor solution still manages to adequately explain the observed correlation matrix.

Safety Behaviour

When designing the Safety Behaviour subscale the intention was that each of the 12 items should represent a single underlying performance dimension. The EFA output evaluation reveals that three factors are required to sufficiently explain correlations between the items of the subscale. Three items have eigenvalues-greater-than-one, which is confirmed by analysis of the scree plot.

To analyse whether this represents meaningful fission of the Safety Behaviour dimension the rotated factor matrix must be consulted. In this matrix, it is clear that items B1, B2, B3, B4, B5, B6, B7, B8 and B9 have larger loadings on the first factor (>.5) while items B11 and B12 have a larger loading on factor two (>.5), and lastly B10 a larger loading on factor 3 (>.5).

When the wording of the item loadings was inspected it was found that each of the three factors elicit responses that represent different sub-dimensions of Safety Behaviour.

When residuals between observed and reproduced correlations were calculated it was found that only 7 (10%) of the residuals were non-redundant with an absolute value greater than .05. It can therefore be concluded that the extracted three-factor solution accurately provides an explanation for the observed inter-item correlation matrix. This leads to the further conclusion that unidimensionality for the SB subscale is not corroborated as 37.935% of variance is accounted for by factor 1, 15.957% of variance accounted for by factor 2, and 12.437% of variance accounted for by factor 3 .

SPSS was used to extract a single factor, and determine loadings of items on that factor, with the purpose of analysing how well items reflect a single underlying performance dimension.

All items except for B4, B11, and B12 (>.3) have loadings greater than .50 on the single factor, while the rest have marginally lower loadings. In the residual correlation matrix 53% of the residual correlations are large suggesting that the single factor solution still manages to adequately explain the observed correlation matrix. This evidence shows that items B1, B2, B3, B5, B6, B7, B8, B9, and B10 satisfactorily reflect a single second-order underlying factor. Items B4, B11 and B12 have marginally lower loading as shown in Table 4.53. Based on the evidence produced by factor analysis it was decided to flag these items as a borderline, questionable item for future analysis on the Safety Behaviour Questionnaire but to retain it in subscale B for the current analysis.

Variables of the Theory of Planned Behaviour Model

Subjective Norm, Normative Beliefs, Perceived Behavioural Control, Control Beliefs, Behavioural Intention, Valence Beliefs, and Actual Behavioural Control were all assessed using two items each in the safety behaviour questionnaire. The use of exploratory factor analysis in this instance would therefore not be appropriate as the two items are already highly correlated. Exploratory factor analysis was therefore not done for the items that make up these variables, and all items used to assess these variables were kept for the purposes of this study.

4.5. Confirmatory Factor Analysis

When the fit of the structural model is analysed consideration has to be given to whether variables used to operationalize the latent variables provide an accurate representation of the latent variables they were designed to reflect. To do this, the indicator variables were analysed by testing the fit of the measurement model before fitting the structural model using LISREL.

By analysing the covariance matrix produced by LISREL the measurement model will be fitted. Maximum likelihood estimation will be used if the multivariate normality assumption is satisfied before or after normalisation. Maximum likelihood estimation operates under the assumption that the indicator variables used to operationalize the latent variables follow a multivariate normal distribution. In the case that normalization fails to achieve multivariate normality in the observed data robust maximum likelihood estimation is used.
Confirmatory factor analysis is concerned with the accuracy with which indicator variables represent latent variables in the structural model. As such, where the measurement model provides a perfectly accurate representation of the process that created the observed inter-item covariance matrix the measurement model would translate to an exact fit null hypothesis:

$H_{o28:}$ RMSEA = 0
$H_{a28:}$ RMSEA > 0

Following from this the measurement model would translate to a close fit null hypothesis where an approximate representation of the process that created the observed inter-item covariance matrix is seen:

$H_{o29:}$ RMSEA ≤ 0.5
$H_{a29:}$ RMSEA > 0.5

The overarching substantive research hypothesis (Hypothesis 1) is that the Safety Behaviour structural model provides a realistic account of the psychological processes that underpin Safety Behaviour. This overarching substantive research hypothesis can be divided into 12 more detailed substantive research hypotheses as follows:

- Hypothesis 2: *Control beliefs (ξ_4) has an effect on perceived behavioural control (η_2).*
- Hypothesis 3: *Perceived behavioural control (η_2) has an effect on behavioural intention (η_5).*

- Hypothesis 4: *Actual behavioural control (ξ_7) has an effect on perceived behavioural control (η_2).*
- Hypothesis 5: *Normative beliefs (ξ_5) has an effect on subjective norms (η_3).*
- Hypothesis 6: *Subjective norms (η_3) has an effect on behavioural intention (η_5).*
- Hypothesis 7: *Valence beliefs (ξ_6) has an effect on attitude towards safety behaviour (η_4).*
- Hypothesis 8: *Attitude towards safety behaviour (η_4) has an effect on behavioural intention (η_5).*
- Hypothesis 9: *Fatigue (ξ_1) has an effect on individual situational awareness (η_1).*
- Hypothesis 10: *Stress (ξ_2) has an effect on individual situational awareness (η_1).*
- Hypothesis 11: *Mindfulness (ξ_3) has an effect on individual situational awareness (η_1).*
- Hypothesis 12: *Individual situational awareness (η_1) has an effect on behavioural intention (η_5).*
- Hypothesis 13: *Behavioural intention (η_5) has an effect on behaviour (η_6).*

The overarching substantive research hypothesis states that the structural model provides an accurate and valid account of the psychological processes that drive safety behaviour. If the overarching substantive research hypothesis is interpreted to mean that the structural model provides an exact explanation for the psychological dynamics underlying safety behaviour, the substantive research hypothesis translates into the following exact fit null hypothesis:

H01a: RMSEA = 0
Ha1a: RMSEA > 0

The probability of achieving perfect fit is next to nothing, as such the close fit null hypothesis should be taken into account as it takes into account the error of approximation. If the overarching substantive research hypothesis is interpreted to mean that the structural model provides an approximate explanation of the psychological dynamics underlying employee engagement, the substantive research hypothesis translates into the following close fit null hypothesis:

H01b: RMSEA ≤ 0.05

Ha1b: RMSEA > 0.05

Should the test for reasonable fit be successful, the following path coefficient hypotheses will be tested:

Hypothesis 2

H02: $\gamma_{24}=0$

Ha2: $\gamma_{24}>0$

Hypothesis 3

H03: $\beta_{52}=0$

Ha3: $\beta_{52}>0$

Hypothesis 4

H04: $\gamma_{27}=0$

Ha4: $\gamma_{27}>0$

Hypothesis 6

H06: $\gamma_{35}=0$

Ha6: $\gamma_{35}>0$

Hypothesis 7

H07: $\beta_{53}=0$

Ha7: $\beta_{53}>0$

Hypothesis 8

H08: $\gamma_{46}=0$

Ha8: $\gamma_{46}>0$

Hypothesis 9

H09: $\beta_{54}=0$

Ha9: $\beta_{54}>0$

Hypothesis 10

H012: $\gamma_{11}=0$

Ha12: $\gamma_{11}>0$

Hypothesis 11

H013: $\gamma_{12}=0$

Ha13: $\gamma_{12}>0$

Hypothesis 12

H014: $\gamma_{13}=0$

Ha14: $\gamma_{13}>0$

Hypothesis 13

H015: $\beta_{51}=0$

Ha15: $\beta_{51}>0$

Hypothesis 14

H016: $\beta_{65}=0$

Ha16: $\beta_{65}>0$

Should the measurement model successfully reproduce the observed covariance matrix, and the measurement model shows that the large majority of variance in indicator variables can be accounted for in terms of the latent variables they load onto, the operationalization is successful.

Due to the small sample size of 217, three separate CFA models had to be fitted. None of the CFA models fitted returned acceptable goodness of fit statistics, so for the purposes of this study it was reluctantly decided not to include these results, and subsequently move on to Structural Equation Modelling (SEM) using Smart PLS making the assumption that the measurement instruments used are valid. This is permissible as the extensive literature review backs up this assumption.

4.6. Fitting the Comprehensive Structural Model Using PLS-SEM

This section reports on the measurement and structural model Partial Least Squares (PLS) results. The previous section discussed the validation results of the measurement instruments utilised in this study. Structural model results are used to discuss the hypotheses that the study sought to validate.

PLS Results: Validating the Outer (Measurement) Model

4.6.1. Alpha Coefficient, Composite Reliability, and AVE Values

The alpha coefficients, composite reliability and AVE results of the measurement instruments used in this study are shown below. From The results show that all of the measurement instruments displayed acceptable internal consistency (i.e. acceptable alpha scores, as well as composite reliability scores), and convergent validity (i.e. acceptable AVE values exceeding 0.50). The exception to the above is Mindfulness, Stress, and Fatigue, which all showed unsatisfactory AVE values of 0.30, 0.39, and 0.24 respectively; this falls below the threshold of 0.50.

Table 4.12

Composite Reliability and AVE

Latent Variable	**Alpha Coefficient (α)**	**Composite Reliability**	**AVE**
Stress	0.86	0.85	0.39
Mindfulness	0.82	0.80	0.30
Fatigue	0.71	0.71	0.24
Attitude Towards Safety Behaviour	0.89	0.91	0.84
Subjective Norm	0.90	0.91	0.84

Normative Beliefs	0.88	0.88	0.79
Perceived Behavioural Control	0.95	0.96	0.92
Control Beliefs	0.93	0.93	0.86
Behavioural Intention	0.94	0.94	0.88
Actual Behavioural Control	0.89	0.89	0.81
Valence Beliefs	0.80	0.81	0.69
Individual Situational Awareness	0.87	0.88	0.59
Safety Behaviour	0.90	0.90	0.43

4.6.2. Discriminant Validity

Discriminant validity confirms that hypothesised structural paths do exist. The Heterotrait-Monotrait ratio (HTMT) is calculated in this instance to assess discriminant validity. This method has been selected as it assesses discriminant validity on the basis that it more reliably detects the lack thereof in comparison to other methods (Voorhees et al., 2016). It does this by within-scale item correlations and comparing it to another scale's cross correlations. In order for discriminant validity to be achieved the cross-correlations should be lower than the within-scale correlations. The results showed that discriminant validity was achieved for all the measurement instruments.

A tabular representation of discriminant validity can be found in Appendix D: Results under heading *3.2.5) Discriminant Validity.*

4.6.3. Evaluating the Outer Loadings

To calculate the outer loadings of the model a complete item level model was fitted. PLS bootstrap analysis was used to determine if item or subscale loadings of the outer model were statistically significant. This translates to analysis on a 95% confidence interval. The factor loadings would be classified as being statistically insignificant if zero fell within this interval. However, the factor loadings would be considered statistically significant if zero were to not fall within the interval.

These results show that all subscales loaded significantly on the latent constructs they intend to measure. The only exception to this was item MND6 which did not load significantly on the Mindfulness (MND) construct. It was decided however, not to flag item MND6 as a poor item as the effect of one poor item on the model at this stage could be argued to be negligible.

4.6.4. Validating the Inner (Structural) Model

The R^2 values of the endogenous variables in the model are shown in the table below. Values range from 0 (Attitude towards safety behaviour) to 0.30 (Safety Behaviour). The results were somewhat surprising in that items such as Attitude towards safety behaviour (A) and Perceived Behavioural Control (PBC) returned very low values of 0 and 0.02 respectively. The fact that Safety Behaviour (B), Behavioural Intention (BI), Situational Awareness (SA) returned high values of 0.3, 0.2, and 0.12 respectively is encouraging. This means that the account for 30%, 20%, and 12% of reported variance in the model respectively.

The Hypothesised paths were tested via PLS analysis, and the results thereof can be seen in the table 4.13 below.

Table 4.13

PLS-SEM Outer Loadings for Causal Pathways between Latent Variables

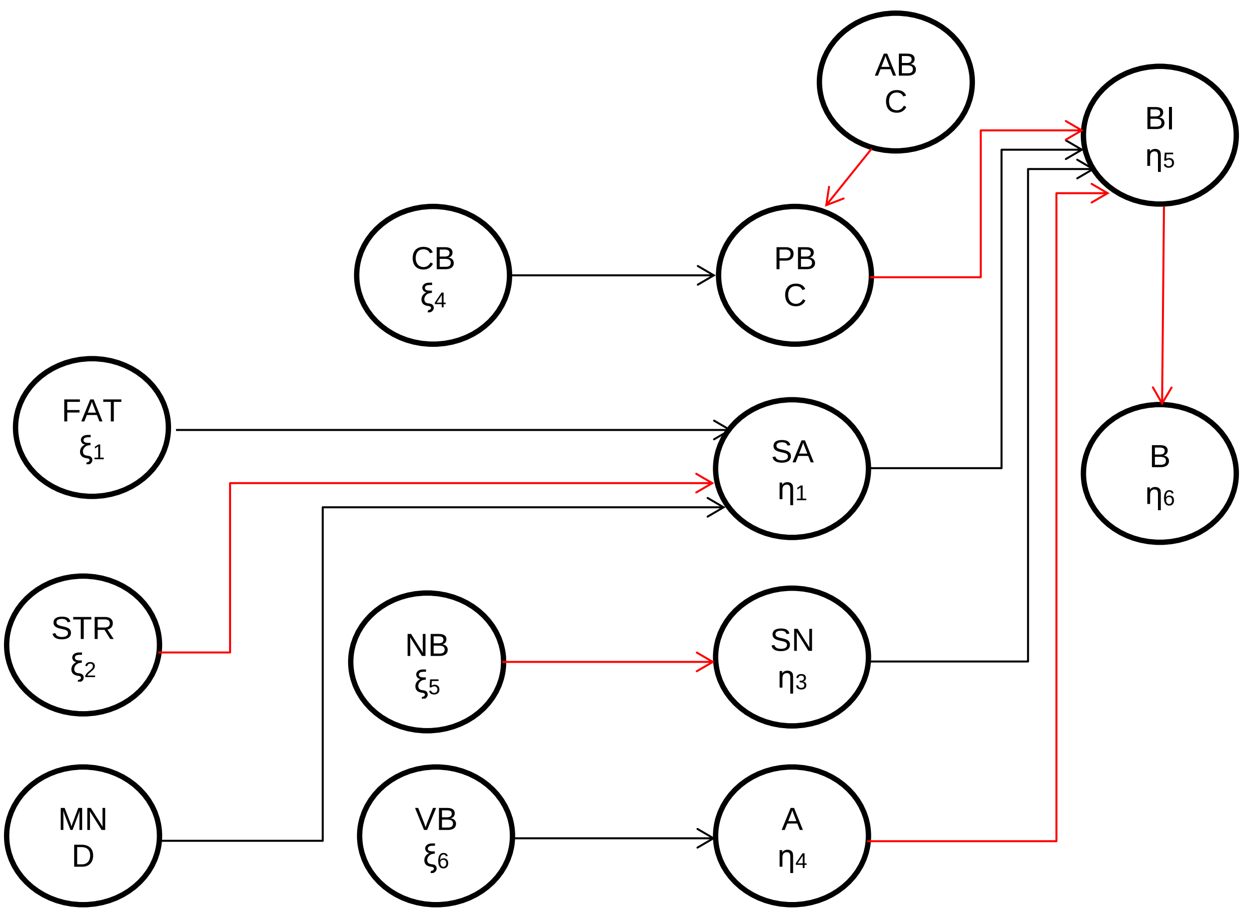
from	to	Path coefficient	95% lower	95% upper	Significant from CI	p-value from T-test
A	BI	0.19	0.06	0,34	yes	0.01
ABC	PBC	0.14	0.03	0,27	yes	0.02
BI	B	0.55	0.43	0,66	yes	0.00
CB	PBC	0.07	-0.07	0,22	no	0.34
FAT	SA	0.01	-0.27	0,29	no	0.97
MND	SA	-0.14	-0.34	0,05	no	0.20

NB	SN	0.22	0.09	0,38	yes	0.00
PBC	BI	0.32	0.19	0,46	yes	0.00
SA	BI	-0.1	-0.25	0,06	no	0.19
SN	BI	0.07	-0.05	0,19	no	0.23
STR	SA	0.24	0.01	0,48	yes	0.05
VB	A	0.02	-0.13	0,16	no	0.82

Of the 12 hypothesised paths, 6 were statistically significant, these paths are shown in red in the figure 4.2 below.

Figure 4.2

Abridged Safety Behaviour Structural Model with Significant Causal Pathways



Note. Statistically significant pathways are shown in red, while statistically insignificant pathways are shown in black.

4.7.5. Interpreting the results of the tested hypotheses

Hypothesis 1: *Control beliefs (ξ_4) has an effect on perceived behavioural control (η_2).*
The results showed that hypothesis 1 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Control Beliefs (CB) about safety behaviour effects Perceived Behavioural Control (PBC).

Hypothesis 2: *Perceived behavioural control (η_2) has an effect on behavioural intention (η_5).*

The results showed that hypothesis 2 achieved a statistically significant path coefficient of 0.32. It can therefore be concluded that this study did yield evidence to support the hypothesis that Perceived Behavioural Control (PBC) has a positive effect on Behavioural Intention (BI).

Hypothesis 3: *Actual behavioural control (ξ_7) has an effect on perceived behavioural control (η_2).*

The results showed that hypothesis 3 achieved a statistically significant path coefficient of 0.14. It can therefore be concluded that this study did yield evidence to support the hypothesis that Actual Behavioural Control (ABC) has a positive effect on Perceived Behavioural Control (PBC).

Hypothesis 4: *Normative beliefs (ξ_5) has an effect on subjective norms (η_3).*

The results showed that hypothesis 4 achieved a statistically significant path coefficient of 0.22. It can therefore be concluded that this study did yield evidence to support the hypothesis that Normative Beliefs (NB) has a positive effect on Subjective Norm (SN).

Hypothesis 5: *Subjective norms (η_3) has an effect on behavioural intention (η_5).*

The results showed that hypothesis 5 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Subjective Norms (SN) effects Behavioural Intention (BI).

Hypothesis 6: *Valence beliefs (ξ_6) has an effect on attitude towards safety behaviour (η_4).*

The results showed that hypothesis 6 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Valence Beliefs (VB) effects Attitude towards Safety Behaviour (A).

Hypothesis 7: *Attitude towards safety behaviour (η_4) has an effect on behavioural intention (η_5).*

The results showed that hypothesis 7 achieved a statistically significant path coefficient of 0.19. It can therefore be concluded that this study did yield evidence to support the hypothesis that Attitude towards safety behaviour (A) has a positive effect on Behavioural Intention (BI).

Hypothesis 8: *Fatigue (ξ_1) has an effect on individual situational awareness (η_1).*

The results showed that hypothesis 8 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Fatigue (FAT) effects Individual Situational Awareness (SA).

Hypothesis 9: *Stress (ξ_2) has an effect on individual situational awareness (η_1).*

The results showed that hypothesis 9 achieved a statistically significant path coefficient of 0.24. It can therefore be concluded that this study did yield evidence to support the hypothesis that Stress (STR) has an effect on Individual Situational Awareness (SA).

Hypothesis 10: *Mindfulness (ξ_3) has an effect on individual situational awareness (η_1).*

The results showed that hypothesis 10 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Mindfulness (MND) effects Individual Situational Awareness (SA).

Hypothesis 11: *Individual situational awareness (η_1) has an effect on behavioural intention (η_5).*

The results showed that hypothesis 11 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Individual Situational Awareness (SA) effects Behavioural Intention (BI).

Hypothesis 12: *Behavioural intention (η_5) has an effect on behaviour (η_6).*

The results showed that hypothesis 12 achieved a statistically significant path coefficient of 0.55. It can therefore be concluded that this study did yield evidence to support the hypothesis that Behavioural Intention (BI) has an effect on Safety Behaviour (B).

4.7. CONCLUSION

The aim of this chapter was to present and discuss the research results. Firstly, item analysis exploratory factor analysis, dimensionality analysis, and confirmatory factor analysis was discussed. Following this, validation of the outer model encompassed a discussion regarding alpha coefficients, composite reliabilities and AVE values of the variables contained in the structural model. Furthermore, the discriminant validity and outer-loadings of the scales were interpreted. Thereafter, the results of the proposed hypotheses contained within the structural model, were discussed. The following chapter will focus on the interpretation of the research results, identify the limitations of this research study, provide recommendations for future research, and discuss the practical implications of this research.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

5.1. INTRODUCTION

This study explored a vast amount of literature and a structural model of the antecedents to safety behaviour was derived. It was decided that for the purposes of this study the full derived model could not practically be tested, and so an abridged safety behaviour structural model was formed. This abridged model looked at the 12 hypothesised paths that were deemed to be of interest for this study.

Various measurement instruments that were available in the public domain were explored. These instruments were then altered in such a way that the variables in question could be measured. The result of this was the Safety Behaviour Questionnaire which consisted of 6 sections and 68 items.

A number of construction organisations were approached to take part in the study, but due to a number of constraints it was decided that the best course of action for data collection would be to approach the foremen of construction sites in and around the Cape Town area to ask for permission for workers to take part in the study. A number of lucky draw prizes was used as incentive for workers to take part. Participants completed the questionnaires using a pen and paper format. Upon completion of data collection a usable sample size of 217 participants was achieved.

The data was then captured electronically and analysed using a combination of SPSS, LISREL, and PLS-SEM techniques. The results were analysed in Chapter 4. During assessment of the results problematic items were flagged and removed from the questionnaire. It was also concluded the CFA models could not be fitted successfully, and regrettably this part of the analysis could not be completed. Using the PLS-SEM technique it was shown that 6 of the 12 hypothesised pathways were statistically significant. This study was however too small to conclusively say that the remaining 6 hypotheses can be discounted as there is a multitude of research to back these arguments up. It is therefore recommended that further research be initiated to investigate these hypotheses.

Improved understanding of safety behaviour is of critical importance in the high-risk industries in South Africa where accidents, injuries, and workplace deaths occur on a regular basis, and a complete understanding of the complex phenomenon will lead to a basis from which to develop instruments to identify those individuals which are predicted to behave in a way conducive to safety performance and employ them rather than those who act in ways that lead to workplace accidents. An understanding of safety behaviour also acts as a base from which to develop interventions for those already in the workplace, to not only equip them, but also change their understanding, and attitudes and beliefs toward safety behaviour, with the aim of decreasing workplace accidents. The advantages of decreasing workplace accidents speak for themselves and include lower financial costs to organisations, and maybe more importantly less physical harm and loss of life to employees.

The remainder of this chapter will aim to discuss the results presented in Chapter 4, draw main conclusions of the study from the discussions, make recommendations for future research, discuss the limitations of the study, and lastly discuss the managerial implications of this research.

5.2. DISCUSSION OF RESULTS

The results will be discussed under two sections, firstly those pathways in the safety behaviour structural model that proved to be significant, and those that proved not to be significant.

Significant Pathways

5.2.1. Perceived behavioural control has an effect on behavioural intention.

The results showed that hypothesis 2 achieved a statistically significant path coefficient of 0.32. It can therefore be concluded that this study did yield evidence to support the hypothesis that Perceived Behavioural Control (PBC) has a positive effect on Behavioural Intention (BI).

As expected, the results show that this hypotheses proved to be a good representation of the theoretical model that was tested, and as such perceived behavioural control can be used to predict some level of behavioural intention, and ultimately safety behaviour.

5.2.2. Actual behavioural control has an effect on perceived behavioural control.

The results showed that hypothesis 3 achieved a statistically significant path coefficient of 0.14. It can therefore be concluded that this study did yield evidence to support the hypothesis that Actual Behavioural Control (ABC) has a positive effect on Perceived Behavioural Control (PBC).

Again, as expected the results show that this hypothesis proved to be a good representation of the theoretical model that was tested, and as such actual behavioural control can be used to predict some level of perceived behavioural control, and ultimately safety behaviour.

5.2.3. Normative beliefs have an effect on subjective norms.

The results showed that hypothesis 4 achieved a statistically significant path coefficient of 0.22. It can therefore be concluded that this study did yield evidence to support the hypothesis that Normative Beliefs (NB) has a positive effect on Subjective Norm (SN).

Again, as expected the results show that this hypothesis proved to be a good representation of the theoretical model that was tested, and as such normative beliefs can be used to predict some level of subjective norm, and ultimately safety behaviour.

5.2.4. Attitude towards safety behaviour has an effect on behavioural intention.

The results showed that hypothesis 7 achieved a statistically significant path coefficient of 0.19. It can therefore be concluded that this study did yield evidence to support the hypothesis that Attitude towards safety behaviour (A) has a positive effect on Behavioural Intention (BI).

As expected the results show that this hypothesis proved to be a good representation of the theoretical model that was tested, and as such attitude towards safety behaviour can be used to predict some level of behavioural intention, and ultimately safety behaviour.

5.2.5. Stress has an effect on individual situational awareness.

The results showed that hypothesis 9 achieved a statistically significant path coefficient of 0.24. It can therefore be concluded that this study did yield evidence to support the hypothesis that Stress (STR) has an effect on Individual Situational Awareness (SA).

As expected the results show that this hypothesis proved to be a good representation of the theoretical model that was tested, and as such stress can be used to predict some level of situational awareness, and ultimately safety behaviour.

5.2.6. Behavioural intention has an effect on behaviour.

The results showed that hypothesis 12 achieved a statistically significant path coefficient of 0.55. It can therefore be concluded that this study did yield evidence to support the hypothesis that Behavioural Intention (BI) has an effect on Safety Behaviour (B).

As expected the results show that this hypothesis proved to be a good representation of the theoretical model that was tested, and as such behavioural intention can be used to predict some level of safety behaviour.

Insignificant Pathways

5.2.7. Control beliefs has an effect on perceived behavioural control.

The results showed that hypothesis 1 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Control Beliefs (CB) about safety behaviour effects Perceived Behavioural Control (PBC).

Contrary to the expectation, this hypothesis did not prove to be a good representation of the theoretical model that was tested based on the results of this study. As such, based on these results, control beliefs cannot be used as a predictor of perceived behavioural control, and ultimately safety behaviour. This hypothesis however forms part of Azjen's Theory of Planned Behaviour (2006), for which there is much supporting research. Therefore, this pathway needs to be explored in more depth in future research.

5.2.8.Subjective norms has an effect on behavioural intention.

The results showed that hypothesis 5 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Subjective Norms (SN) effects Behavioural Intention (BI).

Contrary to the expectation, this hypothesis did not prove to be a good representation of the theoretical model that was tested based on the results of this study. As such, based on these results, subjective norms cannot be used as a predictor of behavioural intention, and ultimately safety behaviour. This hypothesis however forms part of Azjen's Theory of Planned Behaviour (2006), for which there is much supporting research. Therefore, this pathway needs to be explored in more depth in future research.

5.2.9. Valence beliefs has an effect on attitude towards safety behaviour.

The results showed that hypothesis 6 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Valence Beliefs (VB) effects Attitude towards Safety Behaviour (A).

Contrary to the expectation, this hypothesis did not prove to be a good representation of the theoretical model that was tested based on the results of this study. As such, based on these results, beliefs of valence of safety behaviour cannot be used as a predictor of attitude towards safety behaviour, and ultimately safety behaviour. This hypothesis however forms part of Azjen's Theory of Planned Behaviour (2006), for which there is much supporting research. Therefore, this pathway needs to be explored in more depth in future research.

5.2.10. Fatigue has an effect on individual situational awareness.

The results showed that hypothesis 8 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Fatigue (FAT) effects Individual Situational Awareness (SA).

Contrary to the expectation, this hypothesis did not prove to be a good representation of the theoretical model that was tested based on the results of this study. As such, based on these results, fatigue cannot be used as a predictor of individual situational awareness, and ultimately safety behaviour.

5.2.11. Mindfulness has an effect on individual situational awareness.

The results showed that hypothesis 10 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Mindfulness (MND) effects Individual Situational Awareness (SA).

Contrary to the expectation, this hypothesis did not prove to be a good representation of the theoretical model that was tested based on the results of this study. As such, based on these results, mindfulness cannot be used as a predictor of individual situational awareness, and ultimately safety behaviour.

5.2.12. Individual situational awareness has an effect on behavioural intention.

The results showed that hypothesis 11 did not achieve a statistically significant path coefficient. This means that this study did not yield evidence to support the argument that Individual Situational Awareness (SA) effects Behavioural Intention (BI).

Contrary to the expectation, this hypothesis did not prove to be a good representation of the theoretical model that was tested based on the results of this study. As such, based on these results, individual situational awareness cannot be used as a predictor of behavioural intention, and ultimately safety behaviour.

5.4. CONCLUSIONS

This study set out to achieve several research objectives as follows.

Literature Objectives

- To review the meaning of safety behaviour.
- To determine the antecedents and the meaning of the antecedents of safety behaviour.
- To develop a structural model that explains the influence of human factors on safety behaviour OR that explains the relationship between human factors and safety behaviour.

Empirical Objectives

- To investigate the relationship between the antecedents to safety behaviour and safety behaviour in the high-risk industries in South Africa, specifically the construction industry.
- To test the safety behaviour structural model.

In terms of reaching the research objectives, this study was successful. The meaning of safety behaviour was explored, and a complex network of relationships between various antecedents to safety behaviour was explored which yielded in the construction of a structural model for human factors and safety behaviour. As far as the empirical research objectives, the relationships between the factors that were unearthed and safety behaviour was tested in terms of structural equation modelling.

The results showed that of the 12 hypothesized pathways in the abridged model, 6 proved to be statistically significant. Of the hypotheses that proved to have statistically significant pathways 5 were derived based on literature about the Theory of Planned Behaviour. The conclusion can therefore be drawn that the TPB is a valid theory when applied to the decision-making process in terms of safety behaviour. Many of the factors within this theory are factors that can be influenced through training and development of employees and thus gives organisations a firm set of variables to aim for when aiming to impact on safety behaviour within the organization.

The theoretical model that was put forth from the research study included 6 causal pathways from the Theory of Planned behaviour. These pathways have been tested empirically in a number of studies and is widely supported in research. However, the results of this study showed that 3 of the 6 pathways were not supported in this case. This can be attributed to several factors such as deficient theorising. The researcher however in this study attributes the lack of support for these pathways to the small sample size of 217 construction workers that completed the safety behaviour questionnaire. A small sample size poses a number of challenges when it comes to data analysis. In this case the question must be asked if the sample that responded to the questionnaire portrayed an accurate representation of the larger population of construction workers in South Africa?

Each of the variables within the Theory of Planned Behaviour model was assessed using two items each in the safety behaviour questionnaire. Consideration must therefore be given to whether two items is sufficient to accurately measure these variables.

The implications thereof is that because the results of this study is in conflict with other studies, that when future research is done a considerably larger sample size must be used, and the development of items used to measure the variables in question must be scrutinized more closely

Most surprisingly the results showed that Mindfulness did not show to be a valid indicator of situational awareness although the literature (Zhang and Whu, 2014) supports this hypothesis. The conclusion that can be drawn from this result is simply that this hypothesis must be explored more thoroughly in future research as a single study such as this in a relatively small sample population certainly cannot discredit the body of literature and research that has been done in this regard as no apparent flaws can be detected in the formulation of the hypothesis.

5.5. RECOMMENDATIONS FOR FUTURE RESEARCH

This research has identified a complex safety behaviour structural model, but due to practical reasons the model could not be tested in its entirety from the outset. It is therefore recommended that future research focus on testing the complete model in an effort to find empirical data to support the hypothesised pathways. It is recommended that focus be placed on the moderating effects of personality on many of the hypothesised pathways, as well as the effect of safety training, culture, and climate on the individual's intention to behave safely as these represent factors which are to some extent present in many organisations in the high-risk industries already.
Due to the previous government and past unfair social and labour practices enforced by the apartheid regime it is found that the floor level employees in the high risk industries are constituted mainly of those that have been subject to unfair discrimination and as a result are to a large degree from what has been identified as labour sending areas (LSAs) (Cronje, Reyneke, & van Wyk, 2013). The social conditions of these residential areas have certain psychological effects on the

employee with regards to the beliefs and attitude towards safety behaviour. Beliefs of fatalism have been identified as a major factor(Cronje, Reyneke, & van Wyk, 2013), but it is certainly not the only factor that influences beliefs and attitudes towards safety behaviour (Havold et al., 2011). It is therefore recommended that future studies focus on expanding the safety behaviour structural model in such a way as to include more of the factors that arise as a result of LSAs.

Lastly, it is recommended that research be done with regard to the effect of safety behaviour on safety outcomes, as well as the other antecedents to safety outcomes within an organisation. The purpose of studying safety behaviour is at the end of the day to determine the role it plays in safety outcomes so that they can be improved in some way. If the effect of safety behaviour is not known as well as what the other factors are that determine safety outcomes the research is of no practical use to organisations and society.

The safety behavioural structural model must continually be expanded in meaningful ways driven by literature and studies that have been done in an effort to explain the complex nature of safety behaviour in a manner that accurately represents reality. Only once the complex nature of the phenomenon has been acknowledged and understood can goal directed and meaningful interventions and instrument be produced that add value to organisations within the high-risk industries.

5.6. LIMITATIONS OF THE STUDY

Due to the use of non-probability convenience sampling, sampling error cannot be calculated (Blumberg, Cooper & Schindler, 2008). At the outset of this study the aim was to target respondents in a number of high risk industries in South Africa, but due to a number of factors such as time, permission, and operational requirements of the companies approached this was not possible. As a result the sample consisted of 217 construction workers in the Western Cape winelands region. This in turns means that the results of this study should be viewed with that in mind as the results cannot be generalized to all workers in all high risk industries in South Africa.

The manner in which data was collected in this study was also limitation. Sallis and Saelens (2000) report that the use of a self-report method as one of the most widely used methods of data collection. The strengths include, amongst other, that self-report is useful in collecting a large number of information at a relatively low cost. This was a major deciding factor in using this data collection method. Regardless of the strengths, response bias is described as a limitation when self-report is utilised. This is defined as “the tendency to respond to questions in a manner that, although systematic, interferes with the validity of the response” (Paulhus & Vazire, 2007, p. 228).

Lastly, sample size was limitation of this study. At the outset of this the intention was to use LISREL to conduct CB SEM, but due to the relatively small sample size of 217 respondents this was not possible. As a result PLS SEM was used, which resulted in meaningful results. Future research however, would benefit from a much larger sample size, in more varied companies in high risk industries in South Africa. This would provide a more accurate representation of reality than this research.

5.7. MANAGERIAL IMPLICATIONS

This research study aimed to investigate possible antecedents to safety behaviour in an attempt to direct organisations to target interventions at those antecedents that will most likely influence safety behaviour in workers in high risk industries in South Africa. This would ultimately lead to safer working environments with less safety incidents and less loss of life, income, and operational hours. This saves the organisations money as well as increasing the quality of working environment for workers which in turn positively effects the bottom line of the organisation.

The results of this study provided insights into how organisations can target interventions. The results indicated that although not all the hypothesised causal pathways proved to be significant, six of the pathways did prove to be significant. This section therefore aims to discuss the implications of those pathways that did prove to be significant.

At the centre of the safety behaviour structural model was the Theory of Planned Behaviour (Azjen, 2006), which the results of this study corroborated for the most part. Much of the interventions that organisations can direct their efforts towards therefore address factors in this theory.

Perceived behavioural control refers to the perception an individual has of their ability to perform the behaviour of interest, which is determined by the total available set of control beliefs and perception of the resources the individual has access to that will either allow or impede them to perform the behaviour (Ajzen, 1991). According to Ajzen (1991) opinions of referent others or normative beliefs refer to the perceived behavioural expectations of such important referent individuals or groups as the person's spouse, family, friends, and, depending on the population and behaviour studied, teacher, doctor, supervisor, and in this case, co-workers. Attitude toward behaviour is the degree to which performance of the behaviour is positively or negatively valued (Ajzen, 1991). It also includes the evaluation of the outcomes of performing the behaviour of interest.

It is therefore suggested that organisations develop interventions that target the above-mentioned factors; namely perceived behavioural control, normative beliefs, and attitude towards safety behaviour. Such interventions could include an awareness drive that reinforces why safety behaviour is so important. This should include highlighting both the positive outcomes of safety behaviour as well as the negative consequences of not behaving in safe ways such as accidents, loss of life and limbs, operational downtime, loss of personal or organisational income, etc. These interventions should focus on changing the opinions of individuals and groups with attention given to the perception individuals have on the control they have over certain behaviours. This leads to the next point that deals with actual behavioural control.

Actual behavioural control refers to the actual resources and factors that an individual has access to that will support them in performing the behaviour. Turning an intention into a behaviour is not solely dependent on the strength of the intention, but also on the actual behavioural control and individual has (Ajzen, 1991). Organisations should therefore ensure that workers have the resources necessary available to them to influence their behaviour. This includes making sure workers have access to proper personal protective equipment, safety rules and guidelines, as well as any other resources that may influence their ability to act in a manner that is safe. This also means that organisations must put employees in a position that they have control over their own behaviour, and ensure there are no operational or managerial demands on workers that my encourage or require them to behave in manners that are not safe.

5.7. CONCLUSION

The purpose of this study was to put forward a possible complex nomological network of factors influencing safety behaviour in employees working in high risk industries in South Africa as a means to better understand and conceptualise the psychological processes underlying safety behaviour. The study provided insights into the complexity of safety behaviour and to a few antecedents to that. The insights presented in this research study can enable organisations to design and implement interventions that will positively influence the saving safety behaviour, in turn leading to safer workplaces with less safety incidents within the high risk industries in South Africa.

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APPENDIX A: ETHICAL CLEARANCE CERTIFICATE

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

APPROVED WITH STIPULATIONS
REC Humanities New Application Form

8 March 2019

Project number: IPSY-2018-1361

Project title: Masters Thesis

Dear Mr Rigardt Griessel

Your REC Humanities New Application Form submitted on 22 November 2018 was reviewed by the REC: Humanities and approved with stipulations.

Ethics approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
8 March 2019	7 March 2022

REC STIPULATIONS:

The researcher may proceed with the envisaged research provided that the following stipulations, relevant to the approval of the project are adhered to or addressed:

1) The researcher should first encrypt or de-identify the data before storing it on a cloud/open storage platform such as Google Drive. It is preferred that the lucky draw entries (with contact details) not be stored on Google Drive. The researcher should explore more secure options like OneDrive or storing his data on an encrypted external hard drive.

2) The researcher is reminded to submit proof of permission from participating organisations via the REC system once all permissions have been obtained. Data collection may only proceed at the organisations that have confirmed permission to conduct the research.

3) The researcher mentions that he will approach participating organisations to identify appropriate persons or departments e.g. HR or site managers, whom participants may approach, should they need further support, counselling or training. The researcher is requested to include the contact details of these departments or persons in the consent form or as a separate flyer so that participants are able to contact these departments directly.

4) The researcher acknowledges that some companies might not have these support programmes in place. What will be the mitigation strategy for those participants who identify a need for further support in a case where the company does not have this support? The researcher may want to explore external organizations or helplines to assist these participants as completion of the questionnaire might trigger a negative response or an awareness for further support.

5) The researcher should also check the consent form for consistency as the lucky draw information provided in the response letter to the DESC does not correspond with the information included in the consent form (i.e. 2xR.1000 cash prize, versus 4xR.500 cash prizes).

HOW TO RESPOND:

Some of these stipulations may require your response. Where a response is required, you must respond to the REC within six (6) months of the date of this letter. Your approval would expire automatically should your response not be received by the REC within 6 months of the date of this letter.

Your response (and all changes requested) must be done directly on the electronic application form on the Infonetica system: https://applyethics.sun.ac.za/Project/Index/1464

Where revision to supporting documents is required, please ensure that you replace all outdated documents on your application form with the revised versions. Please respond to the stipulations in a separate cover letter titled "**Response to REC stipulations**" and attach the cover letter in the section **Additional Information and Documents**.

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: Humanities, the researcher must notify the REC of these changes.

Please use your SU project number (1361) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

FOR CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

Please note that a progress report should be submitted to the Research Ethics Committee: Humanities before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

Included Documents:

Document Type	File Name	Date	Version
Research Protocol/Proposal	Proposal 31:10:2018	31/10/2018	3.0
Informed Consent Form	Informed Consent Form	31/10/2018	2.0
Data collection tool	Questionnaire	31/10/2018	3.0
Request for permission	Letter to ASLA	31/10/2018	1.0
Request for permission	Letter to The Power Group	31/10/2018	1.0
Default	Letter to The Power Group	20/11/2018	2.0
Default	Letter to ASLA	20/11/2018	2.0
Default	Response to DESC report_comments 20112018	20/11/2018	3.0

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham

REC Coordinator: Research Ethics Committee: Human Research (Humanities)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.
The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

Investigator Responsibilities

Protection of Human Research Participants

Some of the general responsibilities investigators have when conducting research involving human participants are listed below:

1. Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.

2.Participant Enrollment. You may not recruit or enrol participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use.

3.Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents/process, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.

4.Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the progress report in a timely fashion to ensure a lapse in REC approval does not occur.** If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.

5.Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6.Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research-related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouche within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7.Research Record Keeping. You must keep the following research-related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

8.Provision of Counselling or emergency support. When a dedicated counsellor or psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

9.Final reports. When you have completed (no further participant enrollment, interactions or interventions) or stopped work on your research, you must submit a Final Report to the REC.

10.On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

APPENDIX B: INFORMED CONSENT FORM AND LETTER REQUESTING PERMISSION TO CONSTRUCTION SITES

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STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Research on Human Factors and Safety Behaviour

You are asked to participate in a research study conducted by Rigardt Griessel MCom (Industrial Psychology), from the Department of Industrial Psychology at Stellenbosch University. The results of this research will contribute to the degree MCom (Industrial Psychology). You were selected as a possible participant in this study because you are employed by an organisation that operates in an industry where accident and incidents are usually high when compared to other industries.

1. PURPOSE OF THE STUDY

The purpose of this study is to understand the safety behaviours of individuals in certain industries in South Africa, and furthermore to determine the factors which influence safety behaviour choices and the beliefs that accompany safety behaviour. The goal of the research is to contribute towards an understanding of the causes of unsafe behaviour. Understanding is important as it informs interventions aimed at improving employees' behaviour with the goal of decreasing workplace accidents, injuries, and deaths.

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:
- Complete a survey questionnaire.

Completion of questionnaires will take place in a single session which will last roughly 30 minutes.

3. POTENTIAL RISKS AND DISCOMFORTS

There are no foreseeable risks or discomforts which may result from partaking in this study.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

There will be no short-term benefits for you for taking part in this study, but the results will further the understanding of safety behavior and the factors that influence it. In the long run this can be used to develop interventions to improve the safety in organisations such as yours. This could result in a decrease in the number of workplace accidents, injuries, and deaths.

5. PAYMENT FOR PARTICIPATION

There will be an incentive for participation in the form of a lucky draw. The prizes will consist of 4x R500 cash prizes. The procedure for the lucky draw will be as follows:

When questionnaires are returned to the researcher/representative collecting questionnaires the participant will be asked if they want to be considered for the lucky draw, if so they will be asked to provide their contact number which will be recorded once questionnaires have been handed in. This will not be connected to any questionnaire in order to protect anonymity.
The contact numbers will be entered into a lucky draw and 4 winners will be selected at random using an Excel formula, and contacted via the telephone number given in order for prizes to be distributed. The lucky draw will take place on the 19th of November 2018. Winners of the lucky draw will be contacted on or before the 23rd of November 2018, if winners of the prizes cannot be contacted after three attempts new winners will be drawn.

6. CONFIDENTIALITY

We will not require any personal details from you as the study is completely anonymous. Any information that is obtained about this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of the safeguarding of all test results or information given to us. Only the researchers involved in the study will have access to data, and results and conclusions will be drawn only from group aggregates.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact:

- Rigardt Griessel: Researcher (Mcomm Industrial Psychology Student)
  072 0158 146
  16061780@sun.ac.za

- Tendai Mariri: Research Supervisor
  (021) 808 9440
  tmariri@sun.ac.za

9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development at Stellenbosch University.

SIGNATURE OF RESEARCH SUBJECT

The information above was described to me by Rigardt Griessel in [*Afrikaans/English]* and I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I confirm that I have read and understood the information provided for the current study.	YES	NO
	☐	☐
I agree to take part in this survey and that the data may be used for future research purposes	YES	NO
	☐	☐

20 November 2018

Good day Shaun,

I hope you are well.

As discussed with you telephonically, I am currently completing my master's degree in Industrial Psychology through the University of Stellenbosch. As part of the requirement to complete my degree I must do a Thesis which involves a research aspect, which I hope to conduct at The Power Group. My Thesis is entitled "Safety Behaviour in High Risk Industries", and focuses on the human factors that drives safety behaviour in employees in high risk industries such as the petrochemical, mining, and construction industries where accidents and incidents are of a high risk.

With the Power Group being in the construction industry, the company fits the bill perfectly as a candidate for me to conduct my research at. In order for me to conduct my research and collect the necessary data I would need access to a number of your employees that physically work on construction sites as well as any other employees that access construction sites as a part of their job. Data collection would entail a physical pen and paper questionnaire that would take roughly 30 minutes to complete.

I want to stress that should the Power Group allow me to conduct my research within the company, participation in the questionnaire will be completely optional for employees in order to adhere to ethical guidelines. In keeping with this, I plan to invite the employees via e-mail to partake in the research project (sent via yourself so that I do not have to gain access to employee contact details). In the case where employees do not have access to e-mail I will explain to them on site the purpose of the study and invite them to participate after a time and place has been organised for them to convene. I will also provide an incentive of 4 lucky draw cash prizes of R500 each, of which all participants will be eligible to win.

I also want to point out that the confidentiality of all individuals taking part in the study will be protected. At no point will I collect any personal or identifying information of any individuals, and the data collected will only be used on an aggregated level. The confidentiality of The Power Group will also be protected, at no point in my thesis will I publish the name of the company. The results of my data collection will however be reported on in my master's thesis, which could possibly be published in an academic journal.

Please find attached for your perusal my research proposal which explains the purpose and aim of the study, as well as the questionnaire that will be administered to participants.

With your permission I would like to commence with the data collection process on the 21st of November 2018.

If you have any questions regarding the above please feel free to contact me via e-mail or on 072 0158 146.

Thank you once again for your consideration in this regard.

Kind regards,

Rigardt Griessel

APPENDIX C: SAFETY BEHAVIOUR IN HIGH RISK INDUSTRIES QUESTIONNAIRE

Section 1: The Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you felt or thought a certain way.

0 = Never; 1 = Almost Never; 2 = Sometimes; 3 Fairly Often; 4 = Very Often

1. **In the last month, how often have you been upset because of something that happened unexpectedly?**

   0 1 2 3 4

2. **In the last month, how often have you felt that you were unable to control the important things in your life?**

   0 1 2 3 4

3. **In the last month, how often have you felt nervous and "stressed"?**

   0 1 2 3 4

4. **In the last month, how often have you felt confident about your ability to handle your personal problems?**

   0 1 2 3 4

5. **In the last month, how often have you felt that things were going your way?**

   0 1 2 3 4

6. **In the last month, how often have you found that you could not cope with all the things that you had to do?**

   0 1 2 3 4

7. **In the last month, how often have you been able to control irritations in your life?**

0 1 2 3 4

8. In the last month, how often have you felt that you were on top of things?

0 1 2 3 4

9. In the last month, how often have you been angered because of things that were outside of your control?

0 1 2 3 4

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

0 1 2 3 4

Section 2: The Mindfulness Awareness Scale

Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every another item.

1 = Almost Always; 2 = Very Frequently; 3 = Somewhat Frequently; 4 = Somewhat Infrequently; 5 = Very Infrequently; 6 = Almost Never

1. I could be experiencing some emotion and not be conscious of it until sometime later.

1 2 3 4 5 6

2. I break or spill things because of carelessness, not paying attention, or thinking of something else.

1 2 3 4 5 6

3. I find it difficult to stay focused on what's happening in the present.

1 2 3 4 5 6

4. **I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.**

1 2 3 4 5 6

5. **I tend not to notice feelings of physical tension or discomfort until they grab my attention.**

1 2 3 4 5 6

6. **I forget a person's name almost as soon as I've been told it for the first time.**

1 2 3 4 5 6

7. **It seems I am "running on automatic," without much awareness of what I'm doing.**

1 2 3 4 5 6

8. **I rush through activities without being attentive to them.**

1 2 3 4 5 6

9. **I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.**

1 2 3 4 5 6

10. **I do jobs or tasks automatically, without being aware of what I'm doing.**

1 2 3 4 5 6

11. **I find myself listening to someone with one ear, doing something else at the same time.**

1 2 3 4 5 6

12. **I drive places on 'automatic pilot' and then wonder why I went there.**

1 2 3 4 5 6

13. **I find myself preoccupied with the future or the past.**

1 2 3 4 5 6

14. I find myself doing things without paying attention.

1 2 3 4 5 6

Section 3: The Fatigue Questionnaire

We would like to know more about any problems you have had with feeling tired, weak or lacking in energy in the last month. Please answer ALL the questions by ticking the answer which applies to you most closely. If you have been feeling tired for a long while, then compare yourself to how you felt when you were last well.

0 = Less than usual; 1 = no more than usual; 2 = more than usual; 3 = much more than usual

1. **Do you have problems with tiredness?**

   0 1 2 3

2. **Do you need more rest?**

   0 1 2 3

3. **Do you feel sleepy or drowsy?**

   0 1 2 3

4. **Do you have problems starting things?**

   0 1 2 3

5. **Do you lack energy?**

   0 1 2 3

6. **Do you have strength in your muscles?**

   0 1 2 3

7. **Do you feel weak?**

   0 1 2 3

8. **Do you have difficulties concentrating?**

   0 1 2 3

9. **Do you make slips of the tongue when speaking?**

   0 1 2 3

10. Do you find it more difficult to find the right words?

0 1 2 3

Section 4: Planned Behaviour

We would like to know more about your safety behavior at work. Please answer each of the questions by selecting the option that is the most applicable to you. Please treat each question on its own.

1. Me adhering to safety guidelines and rules while on site would be

bad 1 2 3 4 5 6 7 good

2. Me adhering to safety guidelines and rules while on site would lead to less accidents happening

disagree 1 2 3 4 5 6 7 agree

3. Most of my co-workers approve of me adhering to safety guidelines and rules while on site

agree 1 2 3 4 5 6 7 disagree

4. My co-workers believe that following safety guidelines and rules help reduce accident.

disagree 1 2 3 4 5 6 7 agree

5. Most of my co-workers adhere to safety guidelines and rules while on site

agree 1 2 3 4 5 6 7 disagree

6. It is expected of me that I follow safety guidelines and rules while on site

disagree 1 2 3 4 5 6 7 agree

7. I am confident that I am able to follow all safety guidelines and rules while on site

true 1 2 3 4 5 6 7 false

8. It is mostly up to me whether I follow safety guidelines and rules when on site.

disagree 1 2 3 4 5 6 7 agree

9. **My following all safety guidelines is dependent on the influence of people other than myself.**

   disagree 1 2 3 4 5 6 7 agree

10. **Me following all safety guidelines and rules is**

    impossible 1 2 3 4 5 6 7 possible

11. **I intend to follow all safety guidelines and rules while on site**

    likely 1 2 3 4 5 6 7 unlikely

12. **I plan to follow all safety guidelines and rules in the future**

    disagree 1 2 3 4 5 6 7 agree

13. **In the past I have adhered to safety guidelines and rules**

    false 1 2 3 4 5 6 7 true

14. **I have been able to follow safety guidelines and rules in the past**

    disagree 1 2 3 4 5 6 7 agree

15. **It is important for me to follow safety guidelines and rules**

    disagree 1 2 3 4 5 6 7 agree

16. **Me following safety guidelines and rules does not matter**

    agree 1 2 3 4 5 6 7 disagree

Section 5: Situational Awareness

We would like to know more about your situational awareness at work. Please answer each of the questions by selecting the option that is the most applicable to you, answers vary on a scale from 1 to 7. Please treat each question on its own.

1. **Is your daily work situation unstable and like to change often, or is it very stable and straightforward?**

stable 1 2 3 4 5 6 7 unstable

2. **How complicated is your work, is it complex with many interrelated tasks, or is it simple and straightforward?**

simple 1 2 3 4 5 6 7 complicated

3. **Are there many variables changing within your work situation, or do variables largely stay the same?**

low variability 1 2 3 4 5 6 7 high variability

4. **Are you usually highly alert in your daily work situation, or are you less alert?**

less alert 1 2 3 4 5 6 7 highly alert

5. **When performing your daily tasks, are you concentrating on many factors at once (high) or only on one factor at a time (low)?**

low 1 2 3 4 5 6 7 high

6. **Do you have sufficient capacity to attend to many variables (high), or nothing extra to spare at all (low)**

low 1 2 3 4 5 6 7 high

Section 6: Safety Behaviour

We would like to know more about your safety behaviour in at work. Please answer all questions by selecting the answer that applies most accurately to you. Please treat each question its own.

1. **When the company offers safety training or structured safety programs that are voluntary I will go if I am able to.**

never 1 2 3 4 5 6 7 always

2. **When I am at structured safety training or programs I pay attention to the content of the**

program.

never 1 2 3 4 5 6 7 always

3. When I am at structured safety training or programs I try to be actively involved in the program.

disagree 1 2 3 4 5 6 7 agree

4. I see the value in structured safety training programs, they will help me to do my work safely and will reduce accidents.

disagree 1 2 3 4 5 6 7 agree

5. I try to identify risks in the work place in order to minimize accidents that may take place.

disagree 1 2 3 4 5 6 7 agree

6. I listen to instruction regarding my safety and the safety of my colleagues from management or supervisors while on site.

disagree 1 2 3 4 5 6 7 agree

7. I try to help my colleagues and co-workers do their jobs in a safe manner.

disagree 1 2 3 4 5 6 7 agree

8. I regularly discuss safety issues with my co-workers or supervisor.

never 1 2 3 4 5 6 7 always

9. I use all prescribed safety gear an equipment provided for me.

never 1 2 3 4 5 6 7 always

10. I follow all safety procedures and guidelines as set out by the company.

never 1 2 3 4 5 6 7 always

11. I will never take risks to complete my work faster or because it may be easier.

disagree 1 2 3 4 5 6 7 agree

12. I only follow safety guidelines and rules because I am being supervised and will get in trouble if I do not.

agree 1 2 3 4 5 6 7 disagree

--- END ---

Thank you for your participation.

APPENDIX D: RESULTS

Appendix D attached a separate PDF document.