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DETERMINING THE CONSTRUCT VALIDITY OF THE SAFETY SURVEY INSTRUMENT

By

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I, **Maritza Windbacher**, declare that ‘**’The Construct Validity of the Safety Survey Instrument’**’ is my own work. All the resources I used for this study are cited and referred to in the reference list by means of a comprehensive referencing system.

I declare that the content of this thesis/article has never before been used for any qualification at any tertiary institute.

Maritza Windbacher	Signature	Date

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ABSTRACT

Safety interventions must be approached in a holistic manner, by taking cognisance of the organisational system in which accidents present themselves. Thus, a need to understand the individual in context of the organisational system that he/she functions in exists. This study focuses on the relationship between attitudes, beliefs, intention, perception, control and the propensity of employees to engage in unsafe behaviour, with a view towards improving safety statistics. In this regard the study investigated the construct validity of a Safety Survey instrument, based on the responses (n=450) of employees in the mining industry. An Exploratory Factor Analysis showed that the Safety Survey instrument differentiated between two to three underlying factors. The result of the Confirmatory Factor Analysis tested two models by demonstrating the minimum requirements of the goodness of fit indexes. The construct validity of the Safety Survey instrument could be established for two nested models that identified an internal and external locus of control factor. The statistical evidence indicated an acceptable model fit. The statistical evidence validated the construct validity of the measurement model.

Determining the Construct Validity of the Safety Survey Instrument

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CHAPTER 1

1.1 INTRODUCTION

In South Africa, the safety and risk debate has been driven from a multidisciplinary perspective involving industry and government, as well as some degree of grass root involvement operationally.

A mining regulation advisory committee was established in 1995 by stakeholders in the mining industry, amongst other: the state, employers and employees, with a view to draft a new Mine Health and Safety Act. The new Act entrenched the principle of a tripartite partnership in Occupational Health and Safety with governance at an industry level, and the participation of employees at an operational level. The cornerstone of the tripartite arrangement under the Mine Health and Safety Act is the set of tripartite committees created by the Act. Stakeholder participation and joint ownership of health and safety issues and outcomes began on a structured basis with the establishment of tripartite committees.

The South African mining industry is characterized by many state initiated initiatives related to safety. But, it should be noted that the Mine Health and Safety Act has only started to path the way for participation of employees at operational level in the past ten years.

In an address at the Mine Health and Safety Summit hosted in 2001, the then deputy minister of Safety, Susan Shubangu confirmed the commitment of government, labour and business to the highest health and safety standards. She stated that their objective was to maintain zero tolerance for fatal accidents and to increase their vigilance (Department of Minerals and Energy, 2001).

This commitment was further echoed at the next Mine Health and Safety Summit, in 2003, where employers agreed that focused strategies at both mine and industry level will be required to achieve greater levels of improvement in occupational health and safety. Employers also recognized the necessity of setting targets and milestones that will enable greater improvements in the area of occupational health and safety in mining than what has been recorded over the past ten years (Chamber of Mines of South Africa, 2003).

One of the outcomes of these discussions was an agreement on 10-year milestones. These milestones were:

- In the Gold Sector: By 2013 achieve safety performance levels equivalent to current international benchmarks for underground metalliferous mines, at the least.
- In the Platinum, Coal, Diamond and Other Sectors: By 2013 achieve constant and continuous improvement equivalent to current international benchmarks, at the least.

When the statistics given in 2008 is taken into account, an improvement in safety performance of at least 20% a year is required (over the following 5 years – until 2013). Figure 1 below illustrates industry status against these targets:

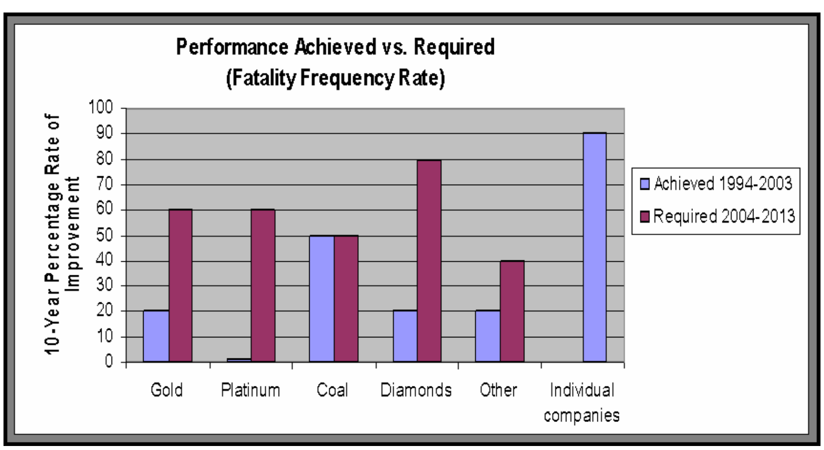


Figure 1: % Improvement in the Fatality Frequency Rate (Source: Chamber of Mines of South Africa, 2005)

The biggest improvement is required in the platinum, as well as the diamond industry. A 60% improvement in the Fatality Frequency Rate for the platinum and diamond sectors are required during the time period 2004 – 2013, to be in line with the targets set against international benchmarks. The coal industry seems to be on par with international benchmarks, whilst gold needs to improve with at least 40%. In his position as safety and sustainable adviser at the Chamber of Mines, Van der Woude stated his concerns with the milestones set during the 2003 Mine Health and Safety Summit. According to him (cited in Seccombe 2007) no improvements could be seen for 2006 and also not for 2007. He further states that there appears to be a plateau which is a major concern to the industry.

These statistics clearly illustrate the ambitious effort that needs to be exerted over the next seven years to be on par with international benchmarks. In this regard, the establishment of the tripartite institutions where labour, employers and the state play an equally vital role in shaping the statutory environment to improve occupational health and safety, has been pathing the way for operational involvement from a systemic perspective. As part of the tripartite commitment, to improve health and safety in the mining industry, the role of the employee at micro level can thus not be ignored. The aim of this research project is to investigate this role and to find additional initiatives that could contribute towards closing the gap between the South African Mining safety and health status with international benchmarks.

Safety interventions must be approached in a holistic manner, by taking cognisance of the organisational system in which accidents and incidents present themselves. Thus, a need to understand the individual in context of the organisational system that he/she functions in exists. The organisational system possibly presents numerous opportunities for improvement in safety trends and statistics. The researcher will aim with this study to continue and add value to this debate through focusing on the micro level, i.e. the employee and the relationship between attitudes, beliefs, intention, perception, and control and risk behaviour, with a view towards improving safety statistics.

In an attempt to close the existing gap in the safety statistics, this research project will establish the construct validity of a measuring instrument in order to accurately measure the safety risk profiles of individual employees.

1.2 PROBLEM STATEMENT

According to Denton (cited in Tomas, Melia and Oliver, 1999) the first attempts to reduce accidents from an engineering point of view were orientated towards the control of technical aspects and physical hazards. However, accidents still happened and researchers started to consider the ''human factor'' as primarily related to work related accidents. Denton as cited in Tomas et al. (1999) found that approximately 90% of accidents were caused by the unsafe actions of workers. Human behaviour is an integral part of everyday life and in the workplace one can never escape one's own and others behaviour (Cascio, 1998). It has become a common activity for psychologists to predict behaviour in certain situations and industrial psychologists specialise in the prediction of behaviour in the workplace. Today still, the question remain: Why do workers behave in an unsafe way? Is it due to a lack of attention, lack of training, co-workers' attitude to safety, their own attitude, or organisational problems?

Rundmo (1996) conducted research on safety matters and his research found that the majority of efforts to improve safety are focused on measures aimed at reducing and removing ''objective'' risks. Rundmo further found that employees perception of risk as well as their subjective assessment of the working conditions and work environment can influence their behaviour.

It is important for an organisation to be aware of both the objective and subjective safety situation within the organisation, this will identify areas and individuals where an unfavourable climate or attitude exists and interventions can be launched to improve this. It is however important that an individuals' propensity to engage in risk behaviour are measured accurately in order to determine the appropriate action and intervention.

Psychometric measurements deal with constructs that are not directly observable and only inferred the concept of validity is very important before an instrument can be used to assist with risk management, placing and training. This study sets out to determine the construct validity of an instrument that will measure safety and risk profiles at individual level in the South African context.

1.3 RESEARCH GOALS AND CHAPTER OUTLINE

This study aims to determine the construct validity of the Safety Survey. In achieving this aim it is important to address the following:

- To understand the concept of behaviour
- To determine the constructs that influence and determine behaviour
- To outline the statistical methods and steps that are necessary to validate psychometric instruments
- To evaluate the Safety Survey as a valid and reliable instrument

All these concepts are explained and dealt with in the literature review chapter of this research project. The following outline was followed:

- Chapter 2:

This chapter offers an in-depth explanation of behaviour and explores the psychological constructs related to behaviour and accidents. This chapter focuses on constructs such as attitude, locus of control, perception, intention, beliefs, perceived control and an individual's environment. Models such as the theory of reasoned action (Ajzen and Fishbein, 1975) and the theory of planned behaviour (Ajzen, 1988) will also be explored.

- Chapter 3:

The purpose of the analyses, the steps taken in the research and the research strategy are explained in this chapter. Statistical techniques are discussed in detail as well as how sampling was undertaken.

- Chapter 4:

The statistical analysis are given and discussed in detail in this chapter. All statistical tables and figures are demonstrated in this section.

- Chapter 5:

The results of the statistical procedures are given and discussed in detail in this chapter. This chapter concludes with recommendations for further studies.

1.4 CHAPTER SUMMARY

This chapter discussed the background and need for focused strategies at both mine and industry level to achieve greater levels of improvement in occupational health and safety statistics. This chapter also stressed the need for organisations to be aware of both the objective and subjective safety situation and the need for testing on a micro level i.e. safety attitudes and perceptions of employees. A general introduction and problem statement as well as a brief overview of the remainder of this document were given.

CHAPTER 2

LITERATURE REVIEW

This chapter offers a broad overview of the existing literature on the different dimensions that contribute to human behaviour. This includes a review of models in both the social and environmental psychology fields, with the aim to establish a theoretical framework to support the dimensions used in the Safety Survey instrument and to thereby demonstrate the construct validity of the instrument.

This chapter also reports on various theories in the literature to prove the underlying dimensions being measured in the survey which include: intention, locus of control, believes or perception and attitude toward safety.

2.1 THEORETICAL MODELS EXPLORING THE CONSTRUCT OF BEHAVIOUR

This research report deals with human behaviour in safety matters. It is therefore important to consider the determinants of behaviour. Understanding the fundamental determinants of behaviour has been a paramount focus for many theorists in the social sciences. Two theories that have greatly advanced the understanding of behaviour determinants are the theory of reasoned action (Fishbein and Ajzen, 1975) and the theory of planned behaviour (Ajzen, 1988). Both these theories declare that attitude, subjective norms and perceived control predict intention and that intention in turn predict behaviour. Greve (2001) affirmed that these theories are considered to be some of the most widely applied theories in social psychology. The latest addition to this field of study is the behavioural reasoning theory by Westaby (2005). The behavioural reasoning theory provides evidence of the relationship between people’s beliefs, reasons, global motives, intentions and behaviour.

Ajzen and Fishbein (1975) developed the theory of reasoned action. This theory demonstrated the relationship between attitude, beliefs, social norms, intention and behaviour within a systemic context. This model explains that behaviour drivers are based on attitudinal beliefs that lead to behavioural intention (Kollmuss and Agyeman, 2002). Glendon and Mc Kenna (1995) evaluated Ajzen and Fishbein's theory of reasoned action and confirmed that behaviour is driven cognitively, through behavioural beliefs, cognitive beliefs and control beliefs. Glendon and Mc Kenna (1995) described these beliefs as follows:

- *A Behavioural belief* is a person's belief that behaviour leads to a certain result, as well as their evaluation of these results
- *A Normative belief* is a person's belief that a specific individual or groups thinks he or she should perform the behaviour, and his/ her motivation to comply with these groups
- A *Control belief* is a person's belief that he or she has the opportunity, knowledge, skill, ability and resources to perform behaviour.

The theory of reasoned action also argues that behaviour can be predicted if a person's attitude and intention towards a particular behaviour is known. Furthermore, behaviour can be predicted if a person's beliefs about the consequences of that behaviour and the social norms which govern that behaviour are known. The theory further illustrates that attitudes are not necessary for or sufficient cause of behaviour, but attitudes do contribute to the cause. Behaviour is not only the result of attitudes, but also of habits, social norms and expectations, with regard to habits (Kollmuss and Agyeman, 2002). Wagenaar and Groeneweg (cited in Hofmann and Stetzer, 1996) found that inappropriate habits were a rather frequent contributor to accidents in the shipping industry. Fishbein (cited in Glendon and McKenna, 1995) proposed that variables not included in the theory that can possibly affect intention and consequently behaviour, are demographic variables and personality traits.

2.1.1 THEORY OF PLANNED BEHAVIOUR

Ajzen (1988) developed a theory called the theory of planned behaviour. This theory extended the theory of reasoned action by including perceived behavioural control as a determinant of both behavioural intention and behaviour. The relation among these variables is depicted in Figure 2 below. The theory of reasoned action is represented by the constructs with shading. The theory of planned behaviour is represented by all boxes and arrows.

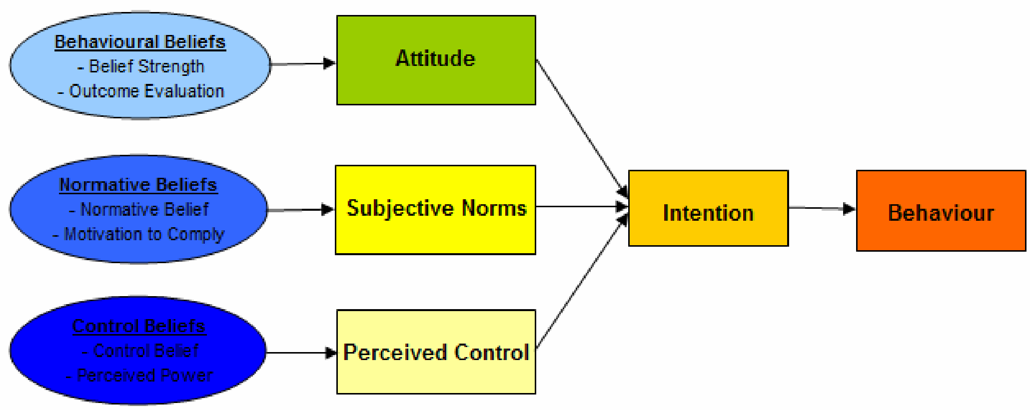


Figure 2: Traditional Behavioural Intention models (Westeby 2005:98)

The rationale for including perceived behavioural control as a predictor of behaviour is based on the assumption that if intentions are held constant greater perceived control will increase the likelihood that enactment of the behaviour will be successful (Bamberg, 2003 and Garling, Fujii, Garling and Jakobsson, 2003). Further to the extent to which perceived control reflects actual control, perceived behavioural control will directly influence behaviours.

Perceived control therefore acts as both proxy measure of actual control and a measure of confidence in ones ability (Ajzen cited in Bamberg, 2003). Within the theory of planned behaviour, perceived behaviour control is posited as a third determinant of intention. The easier a behaviour is the more likely one will intend to perform it (Armitage and Christian, 2003).

This theory addressed the issue of behaviours that occur without a person's volitional control. The perceived behavioural control component consists of control beliefs and perceived power. These factors state that motivation or intention is influenced by how difficult the task is perceived to be and whether the person expects to successfully complete the behaviour. Intention is assumed to be the immediate antecedent of behaviour (Ajzen cited in Bamberg, 2003).

Perceived behaviour control has also been linked to the self-efficacy concept. This refers to perceptions of control over internal resources, but also comprises of an external component. This component refers to perceptions of control over environmental constraints on behaviour (Ajzen, 2002). According to Van Hooft, Born, Taris, Van der Flier and Blonk (2005) perceived behaviour control is supposed to influence behaviour indirectly via intention as well as directly. This implies that people will be more likely motivated to perform behaviour if they think it is under their personal control.

According to Brandstatter and Gollwitzer in Garling *et al*. (2003) the determinants of behaviour includes both motivational and volitional components. In addition, they found that when holding intention constant individuals with high levels of perceived behavioural control will be more likely than others to perform the behaviour (Ajzen as cited in Van Hooft *et al.,* 2005).

Ajzen and Fishbein (1975) declared a general rule when dealing with intention. This rule stated that the more favorable the attitude and the subjective norm and the greater the perceived control, the stronger should the person's intention to perform the behaviour in question be. Glendon and McKenna (1995) support this ruling and they go further to describe a level of attitude which is internalisation. According to them a person will adapt a particular behaviour because of its functional value or because it is in accordance with their existing belief system. This relationship between attitude and behaviour is strong because whatever the external factors that are operating, an individual will engage in the behaviour because he or she believes that it is correct or inline with their own internal belief system.

Hines, Hungerford and Tomera (cited in Kollmuss and Agyeman, 2002) developed a model of responsible environmental behaviour which they based on Ajzen and Fishbein's (1975) theory of planned behaviour. During a meta analysis of 128 behavioural studies, they identified variables which include knowledge of the issue, knowledge of action strategies, locus of control, attitudes, verbal commitment as well as the individual's sense of responsibility to be associated with pro-environmental behaviour.

In a study conducted on aircraft maintenance workers, Forgarty and Shaw (2002) demonstrated the usefulness of Ajzen's theory of planned behaviour to understand violation behaviours in aircraft maintenance. The constructs measured through the survey included perceptions of management attitudes to safety, own attitude to violations, intention to violate, group norms, workplace pressures and violations. This study was based illustrated hypothetical connections among the variables. Within the safety climate milieu these variables are categorised to the level at which the variable exerts influence. That is, variables are classified at either the organisational, group, or individual level (Flin, Mearns, O'Connor and Bryden, 2000). To a large extent, the constructs included in the theory of planned behaviour mirror the individual, group and organisational level variables measured in safety climate studies (Mearns as cited in Forgarty and Shaw, 2002). The inclusion of group factors in safety climate studies have been supported by research cited in Zohar (2000). These studies investigated the role that group norms play in safety behaviour. Individuals in organisations tend to regard themselves as members of workgroups. The norms developed by these groups influence the behaviour of employees who feel they are a part of any such group.

Perceived behaviour control is also represented throughout the safety climate literature by way of workplace pressure that prevents employees from following procedures. Perceived behaviour control suggest that there are times where, despite best intentions, individuals experience that they lack the ability to accomplish an intended action. It is thus suggested that workplace pressures can be associated with the intention of employees to violate certain procedures, and with the actual behaviour of procedures being violated.

2.1.2 BEHAVIOUR REASONING THEORY

The behaviour reasoning theory is based on the theory of reasoned action and planned behaviour and was developed and tested by Westaby (2005). This theory proposed that “reasons'' serve as an important linkage between beliefs, global motives (attitude, subjective norms, and perceived control), intentions and behaviour. An underlying theoretical assumption in this framework is that reasons impact global motives and intentions. Reasons support individuals in justifying and defending their actions (Westaby, 2005). Westaby (2005) described reasons as the specific subjective factors people use to explain their anticipated behaviour. Westeby (2005) further explains that reasons have two broad sub-dimensions: reasons for and reasons against performing certain behaviour.

Pennington and Hastle (cited in Westaby, 2005) explained in the theory of explanation-based decision making that people use reasons to support the acceptability of decision alternatives. The more an explanation of a given decision alternative is coherently plausible with strongly supported reason the more likely the person will select that alternative with confidence. Westaby (2005) suggested that reasons motivate behaviour because they support people in justifying and defending their actions.

Westaby (2005) explained the behaviour reasoning theory in the context of other behaviour intention models such as the theory of reasoned action and the theory of planned behaviour. Conceptually, Westaby's theoretical framework also differentiates between global motives and context specific beliefs and reasons as other behavioural intentions models do. Global motives are defined in this theory as broad substantive factors that influence intentions across diverse behavioural domains. Attitude, subjective norms and perceived control are considered under this classification because they are estimated at a broader level of abstraction and have significantly predicted intentions across numerous studies done by Ajzen (1988). Furthermore, Westaby (2005) has classified context specific beliefs and reasons into the specific behaviour under investigation and presumably serves as the fundamental antecedents of global motives and intentions.

The study by Westaby (2005) found that ''reasons'' predicted all of the global motive factors i.e. attitude, subjective norms and perceived control, but that reasons contributed to the prediction of intentions beyond that explained by the global motives. Westeby further found that individuals used information from both global motives and reasons to form their intentions. Additionally, the behaviour reasoning theory also affirmed that beliefs and values serve as important antecedents of reasons.

Figure 3 below illustrates the behaviour reasoning theory and the correlation between reasons and global motives, intentions, beliefs and values. The un-shaded boxes denote context specific cognitions used to form and sustain global motives, intentions and behaviour.

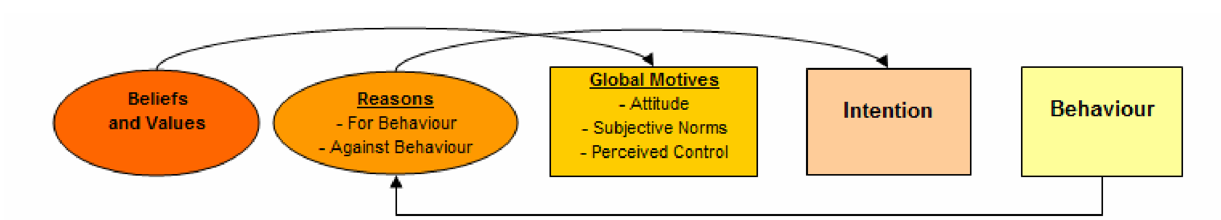


Figure 3: Behavioural Reasoning Theory (Westaby 2005:99)

According to Westaby (2005), reasons may be instrumental in predicting behaviour as these reasons help individuals make sense of their world by providing them with causal explanations for their behaviour, the behaviour of others and causal relationships in their environment. According to Rajecki (cited in Kollmuss and Agyeman, 2002) an individual's determination of what is "good'' or "bad'', the way in which an individual will predict or anticipate consequences and a person's feelings and emotions also play a part in forming a specific attitude. For example, someone who has witnessed a serious accident is likely to feel more strongly about safety than a person who has not learned through such an experience. According to Glendon and McKenna (1995) this is because of the powerful impact of the memory and how they felt or how they physically experienced the accident and this impacts on their decision to behave in a certain manner.

The behaviour reasoning theory presumes that individuals frequently search for behavioural options in memory that have the most justifiable and defensible set of reasons (Westaby, 2005). When those options are identified, decisions can be implemented with confidence. To support this, Fazio, Sanbonmatsu, Powell and Kardes (1986) argued that any construct based on associative learning, will vary in terms of attitude strength. Fazio *et al.* (1986) indexed strength using a reaction time paradigm, the more rapidly an attitude can be expressed the greater its strength would be, and the stronger the attitude the more accessible it is. Thus, for attitude to guide behaviour it must be accessible. Fazio *et al.* (1986) also demonstrated that the correlation between attitudes and behaviour are much higher among people with highly accessible attitudes. They demonstrated that accessible attitudes are activated spontaneously upon presentation of the attitude issue. Their emphasis on the automatic activation of attitudes differs distinctly from Ajzen and Fishbein's (1980) view that attitudes result from a controlled effortful process of attribute consideration and evaluation. This attribution theory also suggested attitudinal influences on safety behaviour. For example, the tendency to attribute negative occurrences involving others to internal causes and negative events involving oneself to external or situational causes has been observed in previous risk research by DeJoy (1994). De Joy (1994) argued that these 'self-other' biases could inhibit safety behaviour. Accidents are statistically singular events and risk taking and risk exposure over time can also lead to a perception that 'it won't happen to me'. Saari conducted research on foreman in 1988 and reported that 40% of foremen in his survey attributed occupational accidents to chance, and that this is an attitude that is likely to discourage workers from taking appropriate preventive action.

2.1.3 ORGANISATIONAL ACCIDENT MODEL

The organisational accident model was developed for use in attempts to understand the chain of events that leads to an accident or adverse outcome and to identify methods of accident prevention. Reason (cited in Meurier, 2000) argued that medical mishaps share many important causal similarities with the breakdown of complex socio technical systems. According to Reason (cited in Meurier, 2000) human decisions and actions may contribute to accidents through active failures and latent failures. Meurier (2000) describe active failures as unsafe acts committed by people at the sharp end of the system (e.g. pilots, doctors, miners etc.) whose actions can have immediate consequences. He further explains that latent failures on the other hand arise often from fallible decisions taken by people not directly involved in the workplace such as a member of senior management. Vincent (cited in Meurier, 2000) argued that fallible decisions taken at management level may provide the conditions in which unsafe acts may occur. These fallible decisions may cause difficulties in the form of poor planning and scheduling of work, heavy workloads, inadequate training and supervision and inadequate maintenance of equipment etc. Latent failures may lie dormant for a long time, become apparent only in unusual circumstances such as emergencies, shortage of appropriately experienced staff and other forms of crises. Latent failures may then precipitate active failures (e.g. errors) which may then affect outcomes negatively.

In this section theories have been described which identified dimensions such as beliefs, reasons, perceived control, intention, attitude, subjective norms, and demographic factors as predictors of behaviour. The following section will further explore these dimensions.

2.2 ENVIRONMENTAL PSYCHOLOGY

Phares as cited in Lotz (2005) defined the unit for the study of the personality as the interaction of the individual with his or her environment. In order to understand behaviour one must take both the individual and the environment into account.

Earlier definitions of environmental psychology by Garbers and Holahan in Barnes (1989) described it as an investigation of relationships between an individual's environment and behaviour or the interaction between human behaviour and experience and the physical context within which such interaction takes place. Creak, in Barnes (1989) explained that environmental psychology came into being through pressures exerted by advancing technologies and accompanied rapid population growth. Maloney and Ward (as cited in Bamberg, 2003) noted that during the 1970's the insight that environmental problems were the cause of 'maladaptive human behaviour', motivated social scientist to engage in the analysis of individual motives underlying this kind of maladaptive behaviour.

The oldest and simplest model of pro-environmental behaviour, according to Kollmuss and Agyeman (2002), was based on a linear progression of environmental knowledge and leads to environmental awareness and concern (environmental attitude). This in turn led to pro-environmental behaviour. Kollmuss and Agyeman (2002) proved the assumption that educating people and making them aware of their environment would automatically lead to pro-environmental behaviour, wrong.

Kollmuss and Agyeman (2002) referred to a study that was conducted to determine why people act environmentally. The study found that certain internal factors like motivation, knowledge, awareness, values, attitudes, emotion, locus of control, responsibility, priorities and certain external factors such as; institutional, economic social, cultural as well as demographic factors had an influence on behaviour.

Several studies have been devoted to understanding which variables are related to or determine the occurrence of accidents and/or unsafe behaviours. Viljoen (as cited in Barnes, 1989) described an environmental psychology model of safe performance or behaviour. According to Viljoen a number of components relevant to the propensity of safe behaviour exist, which include; the objective environment, the perceived environment, person–environment fit and demographic factors. Tomas *et al.* (1999) supported Barnes's model by stating that worksite variables, personal characteristics and interpersonal and organisational variables may be implicated in the occurrence of work related accidents.

The following section reports on the environmental model of man as described by Viljoen (cited in Barnes, 1989).

2.2.1 The transactional nature of the relationship that exists between the individual and his environment

According to Viljoen's environmental model of man, an objective environment exist which influence human behaviour. This environment consists of three dimensions: social, natural-physical and cultural-physical environments.

According to Viljoen (cited in Barnes, 1989) the objective environment must be distinguished from the perceived psychological environment as experienced by the individual. Veldsman (1987) explained that the perceived psychological environment is the result of the interaction between the individuals own psychological, physiological and social make-up of his personality and the objective environment. Veldsman further explains that because a lot of distortion of stimuli from the objective environment takes place during an individual's interpretation, the individual's cognitive world may not be a photographic representation of his objective situation. Interpretation, according to Veldsman, is a set of beliefs held by an individual about his environment and this depicts the way he/she see things. According to Viljoen in Barnes (1989) and Veldsman (1987) it is the perceived psychological environment which eventually determines a person's behavioural response.

2.2.2 The importance of perceptions of the environment as a bridge between the individual and his environment

Viljoen in Barnes (1989) further explains in his environmental model of man that there are different bridges between the individual's environment and behaviour. These bridges can be in the form of cognitive, emotional or perceptual responses. Another theorist, Hunt in Barnes (1989), supports Viljoen's model and describe a model where conceptual levels refer to cognitive complexity and interpersonal maturity. Hunts' model also takes into account the level of cognitive development of individuals and just like Viljoen, as cited in Barnes (1989), considers cognitive responses as bridges between behaviour and the environment. Cox and Cox (1991) also stated that cognitive factors such as perception of risk and/or attitudes toward safety have been proposed as influencing motivation and safety behaviour.

Veldsman (1987) argued that it is an employee's perception of the objective safety situation that will affect their concern with safety. Cooper (1994) explained that the relationship between attitude and behaviour is a tenuous one. According to him, an attitude is often an expression of how we would like to see ourselves behaving, rather than the behaviours that we actually engage in. To this extend Veldsman (1987) further explained that an organisation might very well have a good objective safety situation as reflected in their safety statistics but a poor safety climate as measured from a subjective dimension.

Some research carried out by the South African Chamber of Mines during the 1970's (as cited in Barnes, 1989) highlighted perception as a bridge between the environment and performance. This research investigated the possible strategies that could be used to understand and enhance mine employees' ability to detect and respond to hazards underground. The findings of this study suggested that the underground environment could be thought of as providing a large number of cues from which the worker extracted relevant ones, assessed their value and combined the information they provided into a single overall judgment about the hazard in the situation. The accuracy with which the judgment was made on repeated occasions depended on three considerations: the validity of the cues, consistency with which the workers made use of the information provided by the cues and lastly the extent to which the worker's judgment matched the actual situation. This research managed to link behavioural responses, workers' perceptions of their work environment and the safety of the environment.

Research conducted by Tomas *et al.* (1991) to establish a structural equation model of accidents found safety climate (organisational factors) as a significant predictor of safety response. Safety response then further significantly affected co worker's response, attitude and safety behaviour. They also found that attitudes affected behaviour, whilst behaviour influenced the actual probability of accidents occurring. Actual risk or worker's perception of the real probability of suffering an accident was found to be the main predictor of accidents.

2.2.3 The importance of the person-environment fit and its effect on stress

Viljoen, as cited in Barnes (1989), explains his model in terms of a person-environment fit. According to him, coping behaviour is an important part of man's adaptation to his environment. According to Barnes (1989) research has suggested that man possesses a limited capacity to process incoming stimuli and when environmental stimulation exceeds the capacity to attend to it, coping strategies are brought into operation. Depending on whether these strategies are successful or not, stress in the individual will increase or decline, a continuous increase in stress will eventually lead to maladaptive behaviour. Lerner, as cited in Barnes (1989), supports this by stating that at any age period, if environmental demands and expectations are dissonant with the individual's capacities, abilities, motivations and temperament a poorness of fit will exist and unfavourable psychological functioning will occur.

2.2.4 The effects of personal/cultural and job related factors on perceived environment

The last section of Viljoen's model, as cited in Barnes (1989), looked at the influence of job and personal characteristics on the individual's perceived environment. Studies conducted by Leigh, as cited in Tomas *et al.* (1999), found that job and personal characteristics had a joint effect on the propensity to have an accident. Leigh further found that when job-related variables were omitted from a regression analysis that included age, years of schooling and marital status as predictors, then these latter personal factors became significant. It was however found in this study that if the job-related factors were included, neither age, schooling or marital status remained significant predictors of accidents.

According to Kollmuss and Agyeman (2002) demographic factors that have been found to influence environmental attitude and pro-environmental behaviour are gender and years of education. This is further supported by Ferguson, McNally, Both and Leigh, cited in Tomas *et al.* (1999), who stated that educational level and gender are statistically significant predictors of accidents. External factors such as the necessary infrastructure, economic incentives and cultural norms and internal factors such as motivation, knowledge and awareness of the environment, values, attitude, locus of control and emotional involvement also had an influence.

Evans (cited in Donald and Siu, 2001) referred to physical characteristics as the unresponsive components of the work setting. These components include ambient conditions (e.g. air quality, noise, temperature), layout and arrangement of space (e.g. proximity to others, boundaries), architectural design (e.g. lighting, colour, furniture) and ergonomic factors (e.g. equipment design, machine pacing, automation). Research on the role of physical stressors revealed that the most common physical stressors are noise, vibrations, temperature, air movement and pollution and lighting (Melamed, Luz, Najenson, Jucha and Green cited in Tomas *et al.* 1999). According to Warr, Cox and Baron (cited in Donald and Siu, 2001) there is evidence that suggests that poor working conditions affect both workers experience of stress and their psychological and physical health.

According to Dwyer, Raftery and Leather (cited in Tomas *et al.* 1999) interpersonal relations such as co-workers attitude and behaviour or pressure from a supervisor and the direct control of management have been mentioned as being implicated in safety. Also organisational characteristics such as training, management organisation, management attitude towards safety, the effect of safety practices on promotion, safety officer or committee status, foreman's behaviour, safety equipment, perceived likelihood of injuries and priority given to safety by management are important factors in the explanation of accidents.

The model presented in Figure 4 developed by Barnes (1989) shows that job related factors and organisational factors could be expected to influence perceived control on the job. Perceived control could influence job satisfaction and psychological stress that can lead to risk behaviour and an individual's propensity to have an accident. Rundmo (1996) stated that when an employee feels unsafe, this may cause workload and stress, which in turn enhances the probability of accidents. Rundmo conducted a study on employees at an offshore oil instillation in Norway, found that employees that experienced most job stress and felt most unsafe were also more often subject to accidents and near-misses. Both organisational and social factors explained why the employees felt at risk and experienced job stress, the respondents who experienced the stress to the greatest extent and also felt most at risk were most dissatisfied with the status of safety, contingency measures, management and employee commitment and involvement in safety work. Their attitudes towards safety and accident prevention were also less ideal. In addition, they also experienced a greater psychical workload. From the finding of this study it became clear that organisational, social and physical predictor variables seemed to affect risk perception as well as risk behaviour, near-misses and accidents, hence there is a correlation between perceived risk and accidents. The model by Barns below confirms the findings from Rundmo's study by showing the correlations between perception, satisfaction, stress and risk taking.

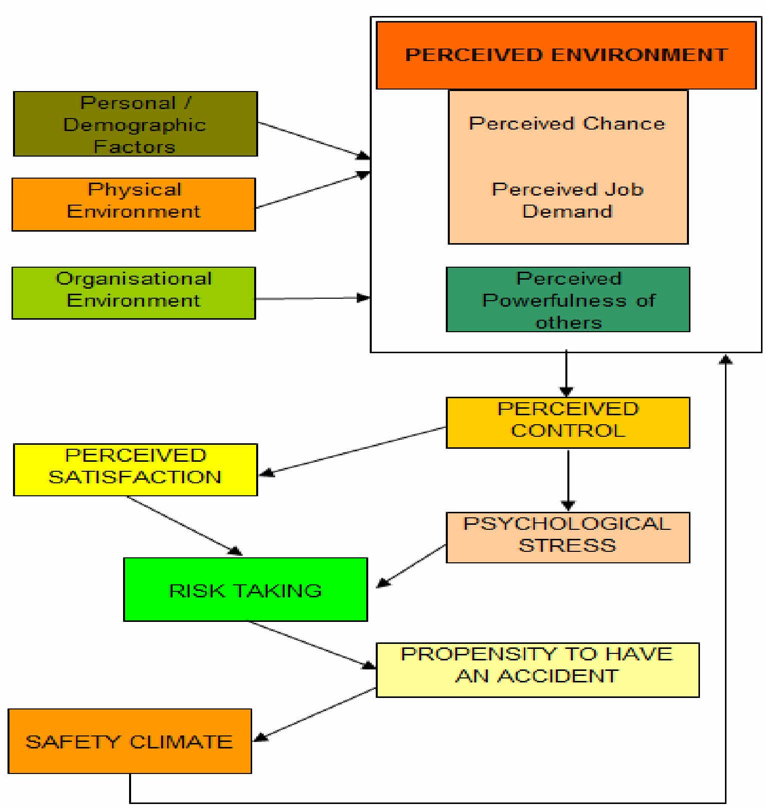


Figure 4: The relationship between job factors and safety climate (Barnes 1986)

2.3 AN ATTITUDINAL APPROACH TOWARDS BEHAVIOUR

The general safety literature contains much information about the role that attitudes play in shaping safety behaviour. Social psychology theories have postulated a causal relationship between attitudes and behaviour (Fishbein and Ajzen 1975, Ajzen 1991). The following definitions illustrate this strong conceptual link between attitude and behaviour. Allport, as cited in Armitage and Christian (2003), defined attitude as a mental state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects or situations with which it is related. Glendon and McKenna (1995) supported the definition by Allport and stated an attitude is a learned tendency to act in a consistent way to a particular object or situation. Fishbein and Ajzen (cited in Armitage and Christian 2003) defined attitude as a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object.

McSween and Matthew (1997) noted that from a behavioural perspective attitudes are statements that typically describe our behaviour in certain situations. Attitudes may also describe emotional response to, or how someone might feel about a given situation. To oversimplify the situation McSween and Matthew (1997) stated that there are two different kinds of behaviour: what one says about how one will act in a given situation and how one actually acts in that given situation. Glendon and McKenna (1995) affirmed that the best predictor of future events is what happened in similar circumstances in the past.

In a safety context it could be said that a safe work approach begin with a safe attitude. Thus, keeping a positive safety attitude can be an important aspect in accident prevention, however, having a safe work approach would constitute more than just keeping to rules. The thoughts, feelings and emotions of a person that make safety part of their job will create a safety attitude. Kroon (1990) supports this view and describes attitudes as a function of what a person thinks and feels. These thoughts are beliefs and the feelings are called values. According to Kroon, beliefs lead to the development of attitudes, especially where emotions are linked to one of the components of belief.

In the social psychological literature, it is generally accepted that attitudes consist of three components, namely a cognitive component, an affective component, as well as a conative component. The cognitive component represent cognitive beliefs about the attitude object, the affective component represent feelings and preferences that the incumbent have towards the attitude object, and the cognitive component embodies behavioural tendencies toward the attitude object (Aronson, Wilson and Akert, 2004).

Glendon and McKenna (1995) describe everyday theories regarding attitude and behaviour to take one of the following forms:

The first view explains that if someone's attitude about something is known then their behaviour can be predicted in respect of that same thing with a reasonable degree of certainty. It also implies that if the ability to change a person's attitude to something exists, then this will also influence and by implication also change the relevant behaviour. A study by Ajzen and Fishbein (cited in Glendon and McKenna 1995) showed that it is possible to predict behaviour if attitudes are known providing that the attitudes are highly specific in respect of that behaviour. This study also considered that there are four particularly important factors involved in the attitude-behaviour relationship which include: action, target, situation and time frame. Thus, if behaviour is altered by the route of attitude change, then those attitudes which are directly and specifically related to that behaviour must be addressed (Hofmann and Stetzer, 1996).

Donald and Canter (1994) identified a significant correlation between safety attitudes and accident rates. According to Donald and Canter (1994) attitudinal theories acknowledge that attitudes can be changed and therefore, it is possible that beliefs about occupational health and safety risk and the salience of occupational health and safety in one's job can be influenced by organisational interventions, including training.

The second point of view argued that attitudes and behaviour mutually reinforce each other. This view of attitude and behaviour by Glendon and McKenna (1995) describes a mutual influence between attitude and behaviour. This theory reflects one obvious conclusion from the dual premises represented in the two unidirectional theories already described and is characterised by the notion of consistency between attitudes and behaviour.

The third type of theory, as described by Glendon and McKenna (1995), is based on the premise that while there may be consistency between attitudes and behaviour, this is not necessary a basis to be a prime casual agent in respect of the other. In terms of workplace safety, attitude may be to the effect that because I use personal protective equipment (behaviour component), then it must be sensible to do so (attitude component) – i.e. attitude is influenced by relevant behaviour. The behaviour of using personal protective equipment comes about because of the attitude that it is sensible to do so – i.e. behaviour is reinforced by reference to presumed favourable attitude.

These types of theories also explain that certain underlying factors such as a safety campaign and incentives like bonuses may influence behaviour. Active reminders in the form of posters or publishing achieved results will influence the attitude towards the target. According to Glendon and McKenna this approach to safety may be represented in a general strategic model as shown in Figure 5 below. This model shows that in order to effect change in workplace behaviour it is necessary to address both cognitions (e.g. attitudes, perceptions, motivation) and behaviour directly in order to make progress.

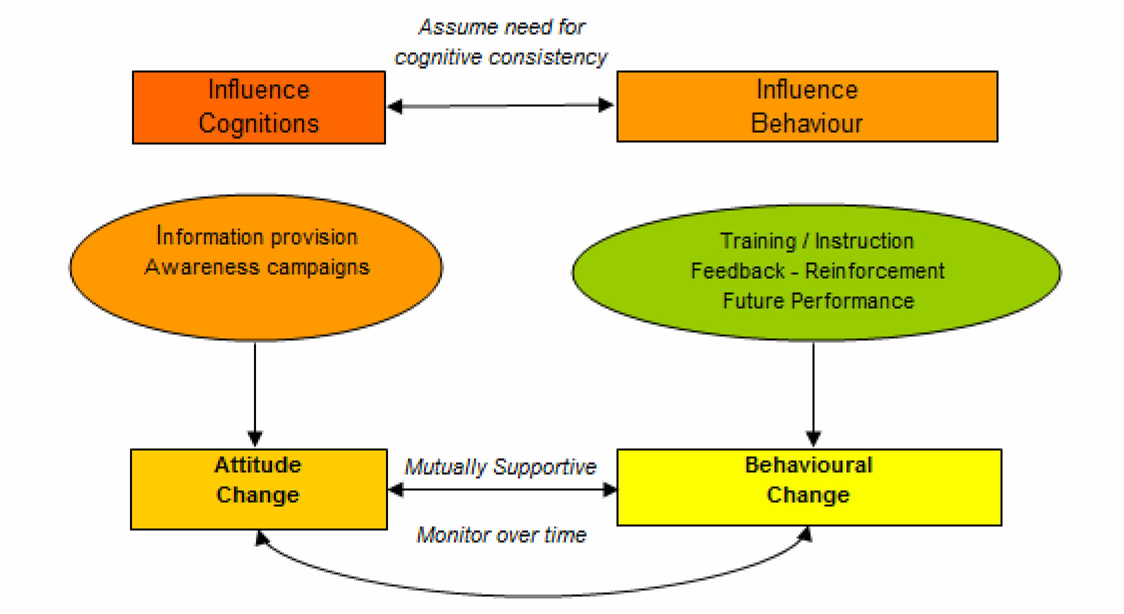


Figure 5: Health and Safety intervention strategy (Adopted from Glendon McKenna 1995:82)

Cooper (1994) stated that people like to be consistent in both their behaviour and attitude and if there is a mismatch between the way they behave and their attitudes, internal tension will result. This would mean that people will consciously change their behaviour to achieve some end point. People will tend to justify their reasons for change by rearranging their attitudes and belief systems to fit with the new behaviour. Thus, to some extent behaviour reflects and represents attitude. Research cited in Barnes (1989) noted that people under stress are likely to become dysfunctional i.e. tend to make mistakes or to be less alert.

From a theoretical perspective it is thus clearly illustrated that attitude is a strong driver of behaviour. It can also be concluded that attitude has both affective and belief components and that attitudes and behaviour should be consistent i.e. people with a positive attitude should behave positively toward the attitude object.

2.4 INTENTION TO BEHAVIOUR

According to Ajzen and Fishbein (1980) a person's behaviour is determined by his/her intention to perform the behaviour and that this intention is in turn a function of his/her attitude toward the behaviour and his/her subjective norms. Ajzen and Fishbein argued that the best predictor of behaviour is intention and that intention is the cognitive representation of a person's readiness to perform a given behaviour and it is considered to be the immediate forerunner of behaviour. Krause (1995) agreed with this by stating that attitude becomes more predictive of behaviour as the sum of a person's attitudes towards something forms an "intention to perform'' a specific behaviour. A person's intention is thus formed from three sources: beliefs, subjective norms and perceived controls.

Ajzen (cited in Van Hooft *et al.* 2005) identified people's perceived control over the behaviour as a second determinant of human behaviour in cases where complete volitional control is lacking. These two theories of predicting behaviour through intention have, according to Van Hooft *et al.,* a common limitation in that they ignore the psychological processes that turn intentions into actions. In filling this void Gollwitzer (cited in Van Hooft *et al.* 2005) introduced the concept of implementation intentions that distinguishes between two phases preceding the occurrence of behaviour. During the pre-decisional or deliberative phase the individual consciously premeditate which goal to pursue and ends with the forming of a goal intention. The post decisional or implemental phase is concerned with planning when, where and how to act in accordance with the goal intention. These plans, known as implementation intentions, are supposed to mediate the goal intention behaviour relation because they describe the processes how goal intentions translate into behaviour.

2.5 LOCUS OF CONTROL

Thomas, Kelly and Lillian (2006) explained that in the organisational science the differentiation between internal and external locus of control is important for explaining how employees approach work, both attitudinally and behaviorally. According to Newhouse in Kollmuss and Agyeman (2001) locus of control represents an individual's perception of whether he or she has the ability to bring about change through his or her own behaviour. Thomas *et al.* (2006) explained locus of control as the extend to which people believe that they have control over their own fate. According to Kollmuss and Agyeman (2001), Ajzen (2002) and Rotter (cited in Thomas *et al.* 2006) people with a stronger internal locus of control believe that their actions can bring about a certain change whilst people with an external locus of control feel that their actions are of no consequence and that change can only be brought about by powerful others.

Research, as noted in Barnes (1989), had shown that locus of control scores were relatable when compared with individual's perception of risk and responsibility, and with factors that influence the likelihood of accidents. Further research cited in Barnes (1989) also showed that locus of control scores correlated with demographic variables such as social class, personality and job related variables. Some evidence has also linked locus of control to risky behaviour, and evidence supported the hypothesis that external locus of control individuals tended to take greater risks. To support this Kahle (cited in Thomas *et al.* 2001) found that when subjects were asked to choose between tasks that require either luck or skill, internal locus of control subjects preferred a task requiring skill whereas externals locus of control subjects preferred a task requiring luck. Thomas *et al.* (2001) explained that locus of control proximally predict people's behavioral propensity to exert control at work.

In conclusion, Viljoen's model suggests that job-related factors and organisational factors could be expected to influence perceived control on the job. Perceived control could influence job satisfaction and psychological stress which can in turn influence risky behaviour (Viljoen as cited in Barnes, 1989).

Rajecki (2007) stated that there are two major factors that influence behaviour, one is attitude and the other is the situation the individual happens to be in. The factor that has the most effect on an individual will depend on the type of person i.e. high self-monitor or low self-monitor. According to Rajecki (2007) high self-controllers will change and adapt their behaviour according to their surroundings, simply to fit in, while low self-controllers will let their own feelings be their guide as to how they will act. Rajecki (2007) concluded that if you have a high level of self-control, attitude will play an increasingly less significant role in determining your behaviour. Covey (1989) supported this by stating that highly pro-active people will recognize their responsibility and would not blame their conditions or environment. Their behaviour would be a product of their own conscious decisions that are based on their values. Covey further explained that the physical environment will influence reactive people and the circumstances will to a large extent determine their behaviour. They are driven by feelings, circumstances and conditions in their environment, whereas pro-active people will be influenced by the external stimuli, social or psychological, but their response to the stimuli, conscious or unconsciously, remains a value based choice or response.

2.6 CHAPTER CONCLUSION

As discussed in earlier sections, interventions for successful safety management is seated in a systemic organisational environment and needs to be looked at taking this context into account. This section attempted to demonstrate through theories and literature the relationship between various dimensions and behaviour within this systemic context. This section explained through theory that the drivers for behaviour are based on attitudinal beliefs, leading to behavioural intention. Behaviour is therefore driven cognitively, through behavioural beliefs, cognitive beliefs and control beliefs. Behaviour was found to be the result of attitudes, habits, social norms and expectations.

Perceived behavioural control has also been discussed as a dimension to behaviour and theory revealed that intention is influenced by how difficult the task is perceived to be and whether the person expects to successfully complete the behaviour. Intention is assumed to be the immediate antecedent of behaviour.

This section also discussed an environmental model of man that explained that there are a number of components relevant to the propensity of safe behaviour; the objective environment, the perceived environment, person–environment fit and demographic factors.

From a literature point of view this section has shown a definite correlation between behaviour and attitude, perceived control, intention, beliefs and the objective environment. The next sections will contest the validity of a measurement instrument that measures an individual's propensity to behave in an unsafe manner. The measurement instrument are based on the following dimensions; safety control, quality control, stress tolerance, risk avoidance and attitude. Literature has shown that these dimensions can be valid predictors of behaviour.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter provided the background information on the study and clarified the theoretical aspects taken from existing literature. It was indicated that there is a correlation between behaviour and other constructs such as attitude, locus of control, perception, intention, beliefs, perceived control and an individuals' environment. The validity of the safety measurement instrument that measures constructs based on these factors i.e. safety control, quality control, stress tolerance, risk avoidance and attitude are being contested in this study.

The theoretical framework has been established and the research design will be presented in this chapter. Mouton (1996) refers to research design as a set of guidelines and instructions on how to determine construct validity of a measurement instrument. The aim of this chapter is to clarify the research methodology in terms of the research approach, the population and sample, research design, data collection procedure and techniques used to analyse the data.

3.2 THE RESEARCH APPROACH

The construct validity of the Safety Survey instrument was demonstrated by accumulating evidence through a self administrated questionnaire. Data was collected using quantitative analysis by means of a survey to ensure a structured data collection method. According to Babbie (2005) quantitative analysis is the numerical manipulation and representation of observations made, in order to explain the phenomena that the observations reflect. On the other hand qualitative analysis will examine non-numerical observations in order to discover underlying meanings and patterns of relationships.

The collected qualitative data resulted from a self-administered instrument handed out to respondents in the mining industry during a safety training session. The research approach is descriptive and responses were collected once only, to determine the association between variables. A pattern of relationships between the various dependent variables was established to determine how many different factors are needed to explain the pattern, what the nature of these factors are and how much purely random or unique variance each observed variable includes (Kim and Mueller, 1978).

3.2 THE SAMPLE

In order to do valid and reliable research a sufficient sample is necessary (De Vos, Strydom, Fouche and Delport, 2004). To determine the minimum number of respondents required the following ''rules of thumb'' was employed, based on the expectation to determine the construct validity through factor analysis:

- STV ratio: Subject-to-variables ratio should be no lower than 5 (Bryant and Yarnold, 1995).
- Rule of 100: Number of subjects should be the larger of 5 times the number of variables or 100 (Hatcher, cited in Garson, 2006).

For this study the number of items being measured equals 80, making the sample population required for factor analysis based on the rules of thumb N=400. For this research project a sample of N=450 was collected from a platinum mine in South Africa. The sample was collected daily over a two month period and collection came to a close when the researcher arrived at a sufficient sample required to perform the statistical methods described in this chapter. The sample was gathered purposive rather than random; according to De Vos *et al*. (2004) this sampling method is typical of a cross sectional/one-shot case study.

Based on a recommendation made by Tabachnick and Fidell (2001) all respondents who omitted four or more items (five percent of the data) from any scale of the Safety Survey instrument were removed. Respondents with less than four omitted items were given an average of the group for that specific item. This process deleted 25 respondents from the study and N=425 were used. The sample obtained was further divided; N=213 was used for the Exploratory Factor Analysis and N=212 for the Confirmatory Factor Analysis.

Table 1 below provides the demographic information of the respondents that were targeted for this study. The demographic information shows that the majority of the respondents were black males (96.7%). The findings further shows that 84% of the respondents were between the age group of twenty to forty years, and that 74.7% work more than six hours per day in a high risk environment. All respondents were given an equal opportunity to participate in the research project on a voluntary basis. No respondent was discriminated against based on any biographical characteristics.

TABLE 1

DEMOGRAPHICAL INFORMATION OF THE RESPONDENTS

		Job Grade	Years of experience	Gender	Race	Age	Hours underground
N = 450	Valid	361	414	426	428	420	424

JOB GRADE		Frequency	Percent	Cumalitive Percent
Valid	Cat 3-8	47	13.01	13.01
	B4 - B6	32	8.86	21.87
	C1 - C2	88	24.37	46.24
	B1 - B3	61	16.92	63.16
	B7	21	5.82	68.98
	other	112	31.02	100
	Total	361	100	
	Omitted data	89		

YEARS EXPERIENCE		Frequency	Percent	Cumalitive Percent
Valid	Less than 1 year	86	20.77	20.77
	1-2 years	86	20.77	41.54
	3-5 years	104	25.13	66.67
	5-10 years	48	11.59	78.26
	more than 10 years	90	21.74	100
	Total	414	100	
	Omitted data	36		

GENDER		Frequency	Percent	Cumalitive Percent
Valid	Male	412	96.71	96.71
	Female	14	3.29	100
	Total	426	100	
	Omitted data	24		

RACE		Frequency	Percent	Cumalitive Percent
Valid	Asian	2	0.47	0.47
	Coloured	11	2.57	3.04
	Black	365	85.28	88.32
	White	50	11.68	100
	Total	428	100	
	Omitted data	22		

AGE GROUP		Frequency	Percent	Cumalitive Percent
Valid	Younger than 20	8	1.9	1.9
	21 - 30	191	45.48	47.38
	31 - 40	154	36.67	84.05
	41 - 50	53	12.62	96.67
	over 50	14	3.33	100
	Total	420	100	
	Omitted data	30		

HOURS UNDERGROUND		Frequency	Percent	Cumalitive Percent
Valid	0 Hours p/d	7	1.65	1.65
	4 - 6 Hours p/d	88	20.75	22.4
	1 - 3 Hours p/d	12	2.83	25.23
	more than 6 hours p/d	317	74.77	100
	Total	424	100	
	Omitted data	26		

3.4 THE RESEARCH DESIGN

Neumann (2000) stated that surveys are the most appropriate approach for research questions related to self-reported beliefs and attitudes. This is an appropriate research method for this study as the personal belief of a person's attitude, perception, intention etc. towards safety are researched.

The research design for this study is a quasi-experimental design. According to Cascio (1998) there are a number of quasi-experimental designs offered to investigate constructs. The quasi-experimental design used in this study is that of a factorial design. According to Neumann (2000) in this type of design, attention is given to the simultaneous effects of more than one independent variable. Neumann further stated that during such a study, two or more independent variables are combined and every combination is examined. The quasi-experimental design was applied in this study for the simple reason that more than one variable was combined to form factors. These factors were correlated with one another and conclusions were drawn from the results obtained.

This study collected quantitative data to quantify relationships between specific variables. The factorial design used in this study allowed the researcher to manipulate more than one independent variable at a time. Every combination of the categories in the variables was examined to determine whether a factor analysis could be employed. The major strength of this approach is that the casual relationship between the indicators of the measurement instrument and the actual measurement, construct validity can be determined (Ezekiel and Fox as cited in Lotz, 2005).

This study used Factor analysis to determine the reliability and validity of the instrument.

3.5 THE MEASUREMENT INSTRUMENT

According to Monette (cited in De Vos *et al*., 2004) measurement refers to the process of describing abstract concepts in terms of specific indicators by assigning numbers or other symbols to these indicators in accordance with specific rules. The objective of the questionnaire in this study is to establish the safety profile of employees by means of quantitative methods. It is foreseen that the immediate application of the Safety Survey instrument might be in recruitment and training, as well as in pro-active risk assessment and management.

The rational for the development of the Safety Survey instrument stemmed from a study conducted by one of the designers of the instrument, this study investigated the influence of attitudes on behaviour. The attitudinal theory by Ajzen and Fishbein (1975) was applied as basis for the survey development, together with an in depth knowledge and understanding of the drivers, attitudes, culture, work context and production pressure that employees face within the mining industry. Other benchmarked surveys were used to develop the Safety Survey instrument. These benchmarked surveys were adjusted and were re–interpreted with the designer's knowledge of the mining industry, new dimensions were added to the existing surveys and questions were re-written to be more practical and to relate to the mining industry. This instrument was never validated before and no statistical information is available.

The survey consists of 80 questions in five dimensions of measurement. These dimensions are described below:

I: Safety Control: The extent to which individuals assume responsibility for job safety and accident prevention

II: Risk Avoidance: The extent to which the candidate will avoid to engage in dangerous behaviour

III: Stress Tolerance: The extent to which the candidate is able to manage/withstand stress

IV: Quality Control: The extent to which the candidate will take responsibility, adhere to standard operating procedures and work plans in order to deliver high quality work

V: Perception of the organisational safety culture: The candidate's general attitude toward which the organisation is engaging in safety practices

Table 2 below demonstrates the variables per scale for the Safety Survey instrument. There are between 12 -18 items per scale, satisfying Garson's (2006) requirements that having several score indicator variables for each factor will tend to yield a model with more reliability, have greater validity and higher generalisability when using Confirmatory Factor Analysis within Structural Equitation Modeling.

TABLE 2

ITEMS PER FACTOR FOR THE SAFETY SURVEY INSTRUMENT

I: Safety Control	II: Risk Avoidance	III: Stress Tolerance	IV: Quality Control	V: Perception of Safety Culture
Q4	Q3	Q13	Q1	Q27
Q5	Q14	Q15	Q2	Q30
Q9	Q18	Q19	Q6	Q33
Q12	Q22	Q20	Q7	Q36
Q17	Q24	Q23	Q8	Q38
Q26	Q34	Q29	Q10	Q40
Q28	Q37	Q35	Q11	Q42
Q31	Q39	Q50	Q16	Q43
Q32	Q47	Q53	Q21	Q46
Q41	Q51	Q54	Q25	Q49
Q44	Q60	Q56	Q61	Q52
Q45	Q62	Q63	Q67	Q55
Q48	Q71	Q65	Q72	Q57
Q58	Q73	Q68	Q74	Q59
Q64			Q75	Q79
Q66			Q76	Q80
Q69			Q77	
Q70			Q78	

According to De Vos *et al.* (2004) validity and reliability are two of the most important concepts in the context of measurement. A valid measuring instrument is described as one doing what it is intended to do, measuring what it is supposed to measure and yielding scores whose differences reflect the true differences of the variable being measured rather than random or constant errors. Moser and Shuler (1989) support this by stating that there are normally two questions asked when developing or validating a measurement instrument, these are: how precisely can an object me measured (Reliability) and which conclusions are possible or allowed (Validity)?

For the questionnaire a semantic differential interval-ratio scale was used. Bailey (cited in De Vos *et al.*, 2004) refers to the principle that one of the functions of a scale is to provide an indirect or underlying measure of a concept. The function of this type of scale is to measure a concept without biasing the subject's answers, and to measure the underlying, even perhaps subconscious feelings of a subject about a particular concept. This research measured perceptions, beliefs, attitude and intention.

The response categories for the semantic differential used in this questionnaire consists of 5 categories ranging from one extreme to the other, with the middle category representing neutral. The two end categories of this scale are a pair of opposite adjectives thought to express the subject's feelings about the concept.

Annexure B shows the layout and content of the Safety Survey instrument used for this study.

3.6 STATISTICAL ANALYSIS

The statistical analysis of the collected data will aim to determine the construct validity of the measurement instrument used. It is vital for the successful application in organisations that the Safety Survey instrument is considered to be valid, and that it measures what it claims to measure. Furthermore it is important that no logical errors exist when conclusions are drawn or interventions are undertaken from the findings (Brown, 1996). The research will take on a correlational form that allows the researcher to determine simultaneously the degree and direction of the relationship with a single statistic.

3.6.1 RELIABILITY

According to Neumann (2000) measurement consistency exists where test scores do not increase or decrease in a test-re-test situation, and the scores remain constant when applied on more than one occasion. Reliability through measurement is thus obtained when the information provided by the indicators of the measurement instrument does not vary as a result of the indicator, instrument or the measurement device itself. According to Smit (1991) the use of test-retest methods is not always practical; according to Smith internal consistency coefficients are a more viable alternative to estimate reliability. Internal consistency measures indicate how consistently individuals respond to the items on a scale, by grouping items that measure the same concept on the questionnaire. Inter-item consistency is where the means correlation between all items of a scale is determined; this is referred to as Cronbach’s alpha coefficient (Smit, 1991).

The following statistical method has been used in this study to analyse the reliability of the quantitative data obtained from the questionnaire.

3.6.1.1 Descriptive Statistics

Descriptive statistics are used to summarize data and to provide a description of the features of a set of observations, via percentage, means, frequency distribution, kurtosis, skewness, variance, standard error of the mean and standard deviations. According to Cooper and Schindler (2001) skewness is a measure of a distribution deviation from symmetry. In a symmetrical distribution the mean, median and mode are in the same location. A distribution that has cases stretching toward one tail or the other is called skewed. Kurtosis is a measure of a distribution's peakedness (or flatness). Distributions where scores cluster heavily or pile up in the center are peaked. The value for Ku for a normal distribution is 0. As with skewness, the larger the absolute value of the index, the more extreme is the characteristic. According to Wuensch (2005), it is important to recognize the significance of the skewness, as this can reduce the reliability of the measurement and indicate a need to investigate the outliers.

3.6.2 VALIDITY

A measurement instrument is considered valid if it measures what it claims to measure and no logical errors exist when drawing conclusion from the data (De Vos, Strydom, Fouche and Delport, 2004). Brown (1996) views it as the extent to which a test measures the psychological construct that it is supposed to measure. Construct Validity is thus the degree of fit between a construct and the indicators of that construct. This study is specifically concerned with the construct validity of the Safety Survey instrument, to determine whether the associated indicators or dimensions actually measure the construct that it claims to measure.

Every combination of categories of variables was examined in this research to determine the construct validity of the instrument. According to Neumann (2000) it is possible to statistically determine the relationship between the dimensions of the Safety Survey instrument and the actual measurement of the construct.

3.7 RESEARCH TECHNIQUES AND PROCEDURES

Due to the complexity of the research techniques and procedures some theoretical concepts were clarified before the data was analysed. To prevent confusion more common techniques are discussed when applied in Chapter Four.

3.7.1 FACTOR ANALYSIS

Factor analysis is the generic term used for various statistical techniques that are concerned with the reduction of a set of observable variables in terms of a smaller number of latent factors. Factor analysis is primarily used in research studies to analyse the relationships among a number of measurable entities like survey items. According to Stapleton (1997) factor analysis answers the question asked by construct validity: will the scores in the test measure what it is supposed to measure, thus determining whether the identified scales are correlated? This method is used as the primary technique for this study.

Factor analysis was employed to reduce the number of variables into smaller factors for modeling purposes. The result of the factor analysis was integrated into Structural Equation Modeling. Factor analysis was employed to validate the scale by demonstrating that its items load on the same factor and to exclude proposed scale items which load on more than one factor (Fabrigar, Wegener, MacCallum and Strachan, 1999). Hair, Anderson, Tatham and Black (1998) recommended that the factors should have a correlation of at least 0.3 to be minimal and 0.4 to be more important and 0.5 to have a meaningful effect on the variables and be practically significant.

In order to test how underlying constructs influence the responses on a number of questions, De Coster (1998) explains that both Confirmatory Factor Analysis and Exploratory Factor Analysis are the main statistical approaches used to test how underlying constructs influence the responses on a number of questions.

Anderson and Gerbing (1988) explained that an Exploratory Factor Analysis in which there is no prior measurement of the number of factors is exclusively exploratory. Using a maximum likelihood or generalized least squares exploratory program represents the next step in the progression in that a hypothesized number of underlying factors can be specified and the Goodness of Fit of the resulting solution can be tested. At this point, there is a separation, where one moves from an exploratory program to a confirmatory program (Anderson and Gerbing, 1988).

Exploratory Factor Analysis is usually used to discover the factor structure of a measure when there is little theoretical basis available to specify the number and patterns of common factors (Kim and Muellller, 1978). Confirmatory Factor Analysis on the other hand requires that a particular factor structure be specified and that there is an indication as to which items load on which factors. According to Kelloway (as cited in Hurley, Scandura, Schriesheim, Brannick, Seers, van den Berg and Williams,1997) Exploratory Factor Analysis is often considered to be more appropriate than Confirmatory Factor Analysis in the early stages of scale development because Confirmatory Factor Analysis does not show how well one's items load on the non-hypothesized factors. Confirmatory Factor Analysis on the other hand is preferred where measurement models have a well developed underlying theory for hypothesised patterns of loadings. Hurley *et al.* (1997) recommend that a line of research should start out with studies utilising Exploratory Factor Analysis while later work would show what can be confirmed.

Both Exploratory and Confirmatory Factor Analysis were employed to investigate the theoretical construct or factors that are represented by the set of items in the Safety Survey instrument.

3.7.1.1 Exploratory Factor Analysis

According to Hurley *et al.* (1997) and confirmed by Gorsuch (1997) Exploratory Factor Analysis should be used for scale development and evaluation as this method helps to develop scales that show good internal consistency while minimising overlap with other scales. Factor analysis can be used as a purely exploratory technique when a set of items are developed to represent an area of interest with the sampling being broad and without specific sub areas. The question being addressed in factor analysis is whether one scale, one scale that can be subscales or a set of scales is needed to measure a construct (Gorsuch, 1997).

Exploratory Factor Analysis was specifically applied in this study to determine the number of factors that underlie the set of measurements and to determine which factors should be retained. Criteria such as the Scree test and Kaiser's criterion were used. The Scree test is a test that computes the eigenvalues of the correlation matrix and then plots it in order of descending values to identify the last substantial drop in the magnitude of the eigenvalues. Kaiser's criterion was applied to determine the number of factors to retain (Fabrigar *et al.* 1999).

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was specifically used to predict if the data were likely to factor well based on the correlation and partial correlation caused by underlying factors. According to Tabachnick and Fidell (2001) a KMO value less than 0.5 should be considered unacceptable.

Bartlett's test of sphericity, tested the null hypothesis i.e. that a correlation matrix is an identity matrix. According to Tabachnick and Fidell (2001) an associated probability less than 0.05 will indicate that the correlation matrix is not an identity matrix and that the variables are unrelated and therefore suitable for factor analysis.

Once an initial solution was obtained the loadings were rotated to maximize higher loadings and to minimize lower loadings to ensure that the simplest possible structure is obtained. Factor rotation makes the output more understandable and is conducted to facilitate the interpretation of factors (Duntemann as cited in Lotz, 2005).

When deciding on a factor rotation method, Anastasi and Urbina (cited in Lotz, 2005) points out that some investigators maintain that orthogonal factor rotation should always be employed because it provides clearer and simpler pictures of trait relationships. Others insist that the oblique method should be used when they fit the data better because the most meaningful categories need not necessary be uncorrelated. According to Tabachnick and Fidell (2001) the loading matrix becomes the pattern matrix in an oblique rotation. The values in the pattern matrix, when squared, represents the unique contribution of each factor to the variance of each variable but do not include segments of variance that comes from the overlap between correlated factors. The oblique method was applied in this study, as the factors identified in the Safety Survey instrument are theoretically to a great extent related. According to Tabachnick and Fidell (2001) a researcher who believes that underlying processes are correlated uses an oblique rotation.

Confirmatory Factor Analysis was also applied in this study to test whether the pre-existing theoretical model underlies a particular set of observations made. Confirmatory Factor Analysis however requires clear predictions as to which factors exist, how they relate to the variables and how they relate to each other. Without such predictions, exploratory analyses are needed (Gorsuch, 1997), thus the reason for first conducting the Exploratory Factor Analysis in this study.

3.7.1.2 Confirmatory Factor Analysis

Confirmatory Factor Analysis provides a fit of the given or hypothesized factor structure to the observed data. This method is typically used to determine the discriminant and convergent validity of a set of measures, thereby to validate a scale by demonstrating that its constituent items load on the same factor. Furthermore

Confirmatory Factor Analysis is used to drop proposed scale items that cross-load on more than one factor (Garson, 2006).

Confirmatory Factor Analysis was utilised within Structural Equation Modeling to determine the discriminate construct validity of the Safety Survey instrument and to test whether the pre-existing theoretical model underlies a particular set of observations made. Structural Equation Modeling is a statistical technique that incorporates and integrates path analysis and factor analysis (Garson, 2006). This technique takes into account the Modeling of interactions, non-linearity's, correlated independents, measurement error, correlated error terms and multiple latent independents. The ability of this method to use Confirmatory Factor Analysis to reduce measurement error by having multiple indicator per latent variable, the attraction of Structural Equation Modeling's graphical modeling interface, the desirability of testing models overall rather than coefficients individually, the ability to test models with multiple dependents and the ability to model error terms, makes it an optimal choice of multivariate statistical analysis. The characteristic of Structural Equation Modeling to represent latent variables based on their relation to observed indicator variables makes it especially attractive (Garson, 2006).

Structural Equation Modeling was applied in this study to test the extent to which the data fit the proposed Safety Survey instrument. The data was analysed by means of a series of maximum likelihood Confirmatory Factor Analyses. According to Cheung and Rensvold (2002) this technique requires the researcher to specify a theoretical model that will explain the covariances between observable and latent variables in advance. The observable variables in this study were the scores of the Safety Survey instrument and the latent variables that underlie the scores of the observable variables. According to Cheung and Rensvold (2002) Confirmatory Factory Analyses allows the researcher to evaluate the fit between the hypothesized model and the observed data. A model is considered suitable if the covariance structure implied by the model is similar to the covariance structure of the sample data, as indicated by an acceptable value of Goodness-of-Fit Index. In this study, a series of fit indexes were used, which included: the Chi-squared statistic, the Root Mean Square Error of Approximation (RMSEA), the Goodness of Fit Index (GFI), the Normed Fit Index (NFI) and the Comparative Fit Index (CFI).

The Chi-squared test statistic is normally used as a test of overall model fit in Structural Equation Modeling, however this test is repeatedly criticized by various authors such as Bentler, Bonett and Hu (cited in Worthington and Whittaker, 2006) as well as Garson (2006) and Kelloway (1998). This sample size sensitivity and dependency of the Chi-squared test statistic has led to the proposal of numerous alternative fit indices that evaluate model fit and supplement the Chi-square test statistic. Kline (cited in Worthington and Whittaker, 2006) classified these fit indices into incremental, absolute, or predictive fit indices. According to Worthington and Whittaker (2006) incremental fit indices measure the improvement in a model's fit to the data by comparing a specific Structural Equation Model to a baseline Structural Equation Model. Absolute fit indices measure how well a Structural Equation Model explains the relationships found in the sample data. Predictive fit indices measure how well the Structural Equation Model would fit in other samples from the same population.

Kline (cited in Worthington and Whittaker, 2006) and Jackson, Dezee, Douglas, and Shimeall (2005) recommend a minimum collection of indices to report on, which consist of: the Chi-square test statistic, the Root Mean Square Error of Approximation (RMSEA) with corresponding 90% confidence intervals, the Comparative Fit Index (CFI) and the Squared Root Mean Residual (SRMR). Hu and Bentler (cited in Worthington and Whittaker, 2006) further recommend that the SRMR should at least be reported with one of the following indices; Non-normed Fit Index (NNFI), Incremental Fit Index (IFI), Comparative Fit Index (CFI), Gamma Hat, McDonald's Centrality Index (MCI) or Root Mean Square Error of Approximation (RMSEA).

The Chi-squared statistic is reported to indicate if the model has a good fit with the data and that the difference between the original covariance matrix and the covariance matrix that is reconstructed on the basis of the hypothesized model is insignificantly small (Worthington and Whittaker, 2006). According to Kelloway (1998) the ration of Chi-square to degrees of freedom has been proposed, however it appears to suffer from somewhat un-informed standards of interpretation. With regard to the Chi-square statistic, a non-significant Chi-square indicates that the model shows a good fit with the data and that the difference between the original covariance matrix and the covariance matrix that is reconstructed on the basis of the hypothesized model is insignificantly small, to this regard Browne and Cudeck (as cited in Bollen and Long, 1993) pointed out that the Chi-square is often too strict a test, as it is unreasonable to expect that any reconstructed covariance matrix will display a perfect fit with the original covariance matrix.

The RMSEA was also reported, this index is based on an analysis of residuals and it estimates the lack of fit in a model compared to a perfect model. Hair *et al.* (1998) regard RMSEA values between .05 and .08 as indicative of an acceptable fit. Bryant and Yarnold (1995) commended that the RMSEA should generally be less than .05 to demonstrate a satisfactory model fit, they further stated that an estimate smaller or equal to .06 in terms of the RMSEA should be used as a cut-off for a good model fit, an RMSEA below .08 would show a reasonable fitting model. Browne and Cudeck (as cited in Bollen and Long, 1993) confirm the indicators from the researchers mentioned above and they have formulated a general guideline that RMSEA values of .05 and smaller indicate a close fit between the hypothesized model and the observed data. Values of .08 and smaller indicate a reasonable fit and values of greater than .08 indicate an unsatisfactory fit.

The Goodness of Fit Index (GFI), the Normed Fit Index (NFI) and the Comparative Fit Index (CFI) indices have also been reported, these indices are based on the ratio of the sum of the squared discrepancies to the observed variance (Kelloway, 1998), and they are normed to yield numbers that range from 0 to 1. Values above 0.90 indicate a good fit with the data. According to Kelloway (1998) a general guideline for the interpretation of the GFI, NFI and CFI is that values of 0.90 and higher indicate a satisfactory fit between the hypothesized model and the observed data.

All the Confirmatory Factor Analyses for this study were carried out within Structural Equation Modeling. Each of the hypothesized models that were tested in this study will be set out in Chapter 4.

3.8 CONCLUSION

This chapter documented the sample, the research design, measurement instrument, reliability and validity estimates and an overview of the statistical procedures that were employed in this study. It was indicated that the research was designed in such a way that it would adequately answer the research question in order to attain to the objective of the study. In the next chapter the results of the statistical analysis will be discussed, conclusions will be drawn from the results and recommendations will be made.

CHAPTER 4

STATISTICAL ANALYSIS

4.1 INTRODUCTION

The previous chapter provided a theoretical overview of the statistical methods that was used in this study. It described the methods used to enable the researcher to make meaningful findings, generalisations and recommendations. The statistical procedures and techniques were selected on the basis of their suitability to report on the construct validity of the Safety Survey instrument.

The results of the descriptive statistics, reliability estimates and internal consistency coefficients for the factors in the Safety Survey instrument are demonstrated in this chapter. An Exploratory Factor Analysis is used to determine the number of factors that can be extracted from the variables of the Safety Survey instrument. This chapter also reports on the use of Confirmatory Factor Analysis, with the help of Structural Equation Modeling and Goodness of Fit Measures to indicate whether the measures that were created during the Exploratory Factor Analysis, present the latent variable, and in fact belong together. Descriptive statistics, internal consistency estimations, test of sampling adequacy and Bartlett's test of sphericity are also demonstrated to determine whether a factor analysis could have been conducted.

4.2 ITEM ANALYSIS

This section give explanation of the statistical methods applied to conduct an item analysis for the variables in the Safety Survey instrument. The process followed to eliminate variables from the sample collected is also explained.

In line with recommendations by Tabachnick and Fidell (2001) all respondents who omitted four or more items (five percent of the data) from any scale of the Safety Survey instrument were removed. Respondents with less than four omitted items were given an average of the group for that specific item. This process deleted 25 respondents, and in total N=425 were used for the study. The sample obtained was divided for this study and N=213 was used for the Exploratory Factor Analysis and N=212 for the Confirmatory Factor Analysis. According to Anderson and Gerbing (1988) a researcher would ideally want to split a sample, using one half to develop a model and the other half to validate the solution obtained from the first half.

According to Gorsuch (1997), the goal of item analysis is to select those items that are mostly related to a specific construct. This goal is aided by evaluating how each item relates to its own construct, as well as how it relates to other constructs, as illustrated in the findings above. Factor analysis was used to delete items if it failed to load high on any of the five scales of the Safety Survey instrument, or if it had small loading on the identified five scales and lastly if it had large loadings on the wrong scale.

The next section reports on the findings regarding the factors explored in the Safety Survey instrument. According the Gorsuch (1997) the purpose of factor analysis is to identify the fewest possible constructs that are needed to reproduce the original data.

4.3 TOTAL VARIANCE EXPLAINED

The analysis in Table 3 below indicates three factors with eigenvalues above two and with a cumulative variance of 21.90 % that was retained. Hayton, Allen and Scarpello (2004) noted that no general consensus exists, but proposed that it seemed reasonable for a decent model to retain as many common factors as may be required to explain at least fifty percent of the variance in the variables. Hair et al. (1998) reported that as many factors as there are eigenvalues larger than one for the correlation matrix, should be taken. With regard to the eigenvalues obtained, more than eight factors loaded above the required 1.0 to be retained. According to Hair et al. (1998) retaining factors with a loading above one, is a good rule if there are twenty to fifty variables, but that it tends to take too many if there are more than fifty variables.

TABLE 3

TOTAL VARIANCE EXPLAINED

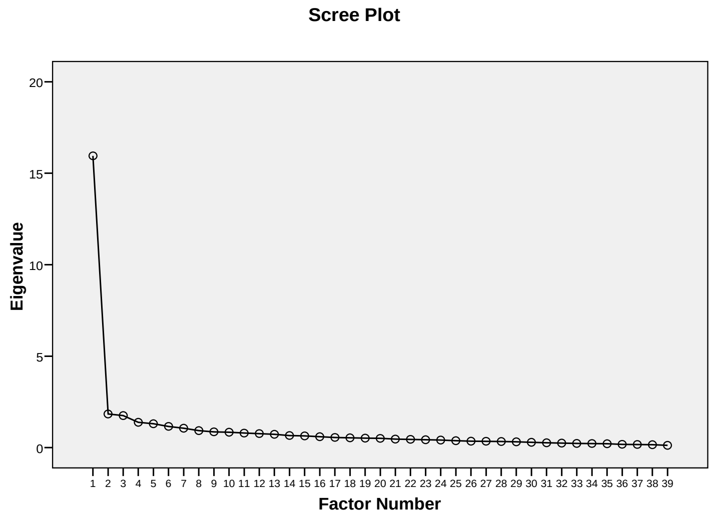
	Initial Eigenvalues		
Initial Factors	**Total**	**% of Variance**	**Cumulative %**
1	16.6489	16.0770	16.0770
2	4.69288	4.1028	20.1798
3	2.28281	1.7290	21.9088
4	1.83237		
5	1.53121		
6	1.48941		
7	1.46700		
8	1.26749		

To further determine the number of factors that would be considered as appropriate for retention purposes, Cattell's (1966) scree plot was used and is demonstrated in the next section.

4.4 SCREE PLOT

The Scree test, in which the eigenvalues of the correlation matrix are computed and then plotted in order of descending values to identify the last substantial drop in the magnitude of the eigenvalues, was used to reduce the number of factors form the items in the Safety Survey instrument. The geographical scree plot proposed by Cattell (1966) was applied.

FIGURE 6: SCREE PLOT



Based on the result of the Scree-test, Figure 6 indicates two significant factors from the originally defined five factors that can be identified (Cattell, 1966). A clear break can be observed in the scree-plot between factors one and two.

However to avoid under factoring and due to a total variance less than fifty percent explained by the eigenvalues on the first few factors (Hayton *et al.*, 2004), both a two and three factor model were employed for the pattern matrix. The next section contains the rotated factor loadings that have been extracted.

4.5 ROTATED FACTOR ANALYSIS

Hair *et al*. (1998) recommend that variables should have correlations of at least 0.3 and preferably of 0.5 to be considered as significant. Table 4 contains the rotated factor loadings that have been extracted for the proposed three-factor model.

Factor pattern matrixes show the regression weights or correlations between factors and observed variables. The entries in the matrix correspond to the eigenvalues, that is, the entries are the weights that result in the first eigenvalues being the largest variance, the second being the largest uncorrelated with the first, and so on (Hair et al.,1998). According to Scheepers (1995) an initial factor pattern matrix is an un-rotated one and usually hard to interpret, in order to assist with the interpretation Scheepers noted that several different methods of rotation were developed. This study used an oblique rotation method, because the factors for the Safety Survey instrument are considered to be related. All items with a factor loading <0.30 in the rotation matrix were removed (Tabachnick and Fidell, 2001). Items that cross-loaded and that had significant loadings on multiple factors, became candidates for deletion. However, the final choice of deletion was based on the researcher's understanding of the theoretical underpinnings of the construct measured.

The pattern matrix contains values representing the unique contribution of each factor to the variance in the variables (Tabachnick and Fidell, 2001).

TABLE 4

ROTATED PATTERN MATRIX FOR

THREE FACTOR MODEL

	Factor 1	**Factor 2**	**Factor 3**
Factor Loading per Item			
Q1	**0.616**	-0.079	-0.018
Q2	**0.672**	-0.035	0.112
Q5	**0.579**	0.020	0.171
Q6	**0.548**	0.118	0.264
Q15	**0.538**	0.131	0.236
Q16	**0.622**	-0.089	0.056
Q17	**0.663**	-0.104	0.282
Q19	**0.560**	0.072	0.543
Q21	**0.512**	0.153	0.129
Q23	**0.557**	0.066	0.037
Q24	**0.761**	-0.067	-0.004
Q25	**0.644**	0.007	0.129
Q27	**0.576**	-0.055	-0.043
Q28	**0.663**	-0.011	-0.195
Q30	**0.625**	-0.038	0.029
Q33	**0.431**	0.259	-0.038
Q38	**0.329**	0.291	0.028
Q40	**0.690**	0.015	0.021
Q41	**0.423**	0.133	0.204
Q42	**0.574**	0.106	-0.092
Q43	**0.705**	0.007	-0.112
Q46	**0.773**	-0.031	-0.131
Q47	**0.660**	-0.107	-0.197

Q49	**0.729**	0.058	-0.080
Q51	**0.510**	0.044	-0.050
Q52	**0.649**	0.016	0.141
Q53	**0.618**	-0.040	0.039
Q55	**0.658**	-0.075	-0.068
Q57	**0.771**	-0.048	-0.071
Q59	**0.498**	0.296	0.002
Q60	**0.707**	0.050	-0.000
Q61	**0.748**	-0.096	-0.021
Q62	**0.618**	0.004	0.107
Q68	**0.453**	-0.063	-0.059
Q71	**0.613**	-0.045	-0.113
Q72	**0.643**	-0.025	-0.001
Q73	**0.564**	-0.018	0.057
Q75	**0.648**	0.059	-0.013
Q77	**0.734**	-0.204	-0.098
Q4	0.094	**0.737**	0.148
Q12	0.163	**0.353**	-0.248
Q26	0.102	**0.378**	-0.391
Q32	-0.020	**0.629**	-0.063
Q36	0.299	**0.419**	-0.156
Q44	0.024	**0.580**	-0.027
Q45	-0.088	**0.520**	0.034
Q58	-0.135	**0.702**	-0.048
Q64	-0.057	**0.643**	0.153
Q66	0.032	**0.615**	-0.035
Q69	0.100	**0.155**	-0.401
Q70	-0.148	**0.716**	-0.043
Q8	0.400	0.212	**0.474**
Q10	0.385	0.145	**0.556**
Factor Correlation Matrix			
Factor	**1**	**2**	**3**
1	1.000		
2	0.191	1.00	
3	0.110	-0.027	1.00

Table 4 above, contains the rotated factor loadings that were extracted for the proposed three-factor model. The extracted rotated pattern matrix demonstrate thirty nine significant variables loading on the first factor and twelve variables loading on the second factor and only two variables on the third factor. Johnson (1998) and Stevens (2002) recommend that at least three variables with loadings of 0.80 on a factor are required for the factor to be recognised. Table 4 contains clear signs of over factoring with limited variables loaded above 0.30 on the third factor. In accordance with the recommendations by Johnson and Stevens, the third factor for this proposed model should be discarded as the proposed three-factor model only presents two significant factors.

The correlation matrix between the three factors in this model shows no correlation between the factors, indicating that the factors might exist on two opposite sides of a continuum. The two factors identified were labeled according to the general content of their significant related items and theoretically the factors were identified as internal and external locus of control.

Further Exploratory Factor Analysis was conducted on the factors of the Safety Survey instrument. The twelve variables that have been identified as a significant factor within the first model, but which did not correlate well with the other significant factor, were excluded from a second round of exploratory oblique rotation. Table 5 contains the rotated factor loadings for the proposed model that demonstrate that seventeen significant variables load on a first factor and twenty two variables load on a second factor. The inter-factor correlation matrix shows a relationship between factors one and two (0.598).

TABLE 5

ROTATED PATTERN MATRIX FOR

TWO FACTOR MODEL

	Factor 1	**Factor 2**
Factor Loading per Item		
Q1	**0.612**	0.037
Q2	**0.703**	0.039
Q5	**0.780**	-0.113
Q6	**0.582**	0.080
Q8	**0.606**	-0.041
Q10	**0.539**	0.007
Q15	**0.537**	0.114
Q16	**0.536**	0.126
Q17	**0.920**	-0.162
Q19	**0.617**	0.095
Q23	**0.425**	0.192
Q25	**0.599**	0.120
Q53	**0.336**	0.320
Q68	**0.293**	0.165
Q71	**0.386**	0.238

Q73	**0.592**	0.022
Q77	**0.386**	0.334
Q21	0.261	**0.337**
Q24	0.306	**0.485**
Q27	0.146	**0.447**
Q28	0.194	**0.467**
Q30	0.319	**0.349**
Q33	-0.068	**0.560**
Q40	0.024	**0.713**
Q42	-0.019	**0.627**
Q43	-0.055	**0.780**
Q46	0.101	**0.686**
Q47	0.213	**0.424**
Q49	-0.009	**0.779**
Q51	0.243	**0.300**
Q52	0.051	**0.665**
Q55	-0.091	**0.760**
Q57	0.176	**0.620**
Q59	-0.125	**0.711**
Q60	0.331	**0.428**
Q61	0.338	**0.433**
Q62	0.293	**0.386**
Q72	0.201	**0.474**
Q75	0.136	**0.561**
Factor Correlation Matrix		
Factor	**1**	**2**
1	1.000	
2	0.598	1.000

Statistics point to the suitability of the data set for factor analysis and identified the factors and related items for the Safety Survey instrument. The next section demonstrates the descriptive statistics for the two models tested.

4.6 DESCRIPTIVE STATISTICS

The skewness and kurtosis were analysed for the factors extracted from the Safety Survey instrument in order to understand the symmetry and peakedness of the data distribution. Skewness is a measure of the degree to which a distribution of data is asymmetrical, whilst the kurtosis measures the peakedness of the data distribution (Hair *et al*., 1998).

Table 6 represents the descriptive statistics of the Safety Survey instrument for three extracted factors.

TABLE 6

DESCRIPTIVE STATISTICS

	Factor 1	Factor 2	Factor 3
N	425	425	425
Mean	3.97016807	3.91932773	2.61433155
Std. Error	0.02994655	0.03155137	0.03451435
Std. Deviation	0.617364	0.65044824	0.71153148
Variance	0.3811383	0.42308291	0.50627705
Skewness	-2.2061024	-1.92544	0.29849889
Kurtosis	8.04888049	6.37621341	0.17303709
Coeff Variation	15.5500721	16.5959135	27.216574
Alpha Coefficient	0.9562	0.8366	-

Mean, standard deviation, coefficient alpha and correlation with total score were calculated for the sample scores on three factors of the Safety Survey instrument. From the table it is evident that the summated scores of the sample on the three factors are approximately normally distributed, with a tendency towards negative skewness. The statistics indicate that the distribution of factor one and factor two's measure of the Safety Survey instrument was negatively skewed. According to Morgan and Griego (1998) the assumption of normality requires that the key statistics i.e. skewness and kurtosis, be less than 2.5 times the standard error. The descriptive statistics for the three factors of the Safety Survey instrument indicated that only one of the three factors are within the norms indicated by Fabriger (1999). According to Fabriger (1999) the maximum likelihood extraction method is favored when skewness is larger than two (>2) and kurtosis larger than seven (>7).

4.7 KAISER-MEYER-OLKIN (KMO) AND BARTLETT'S TEST

In order to determine the sampling adequacy and sphericity, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were carried out on fifty three items of the Safety Survey instrument. The results are depicted in Table 7 and 8. The KMO measure is 0.903 for the first model and 0.935 for the second model. According to Hutcheson and Sofroniou (1999) KMO measures vary between 0 to 1.0 and the KMO should be 0.60 or higher to proceed with factor analysis. The KMO obtained for both the proposed models are above 0.90 which is considered as excellent and very suitable for factor analysis.

Bartlett's test of sphericity is significant for both models and reflects an associated probability of less than 0.05. In both models the correlation matrix was not identified as an identity matrix. The variables are thus unrelated and therefore suitable for factor analysis (Tabachnick and Fidell, 2001).

TABLE 7

KMO AND BARTLETT'S TEST FOR THE PROPOSED 3 FACTOR MODEL

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.903
Bartlett's Test of Sphericity	Approx. Chi-square	6465.379
	df	1378
	Sig.	.000

TABLE 8

KMO AND BARTLETT'S TEST FOR THE PROPOSED 2 FACTOR MODEL

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.935
Bartlett's Test of Sphericity	Approx. Chi-square	4926.906
	df	741
	Sig.	.000

The statistics shown on the previous page, point to the suitability of the data set for factor analysis. The next section demonstrates the analyses related to Confirmatory Factor Analysis and consist mostly of Goodness-of-Fit indices.

4.8 CONFIRMATORY FACTOR ANALYSIS

The Confirmatory Factor Analysis procedure in Structural Equation Modeling (SEM) was used as an additional measure to validate the constructs of the measurement model (Garson, 2006 and Rigdon, 1996). A Confirmatory Factor Analysis was conducted to confirm that the observed variables sort themselves into factors corresponding to the latent variables (Garson, 2006). A Confirmatory Factor Analysis was also conducted to test the overall quality of the solution and the specific factor loadings that constitute the measurement model (Kelloway, 1998). The observable variables in the present study are the sub-scale scores of the Safety Survey instrument. The latent variables are the postulated factors that underlie the scores for the observable variables. This study tested two models; these two hypothesized models will consequently be set out in this chapter.

The Confirmatory Factor Analysis was done using the SAS Proc Calis programme with maximum likelihood (ML) estimation, as described by Garson (2006). The Proc Calis programme provided a number of Goodness of Fit Indices (GFI). For the purpose of this study the following Goodness of Fit Indices demonstrated in Table 10 shown on the next page, were used to analyse the degree of likeness between the covariance matrices of the latent variables and the observed variables.

The Satorra-Bentler scaled Chi-square statistical calculation output was 2749.2965 on 1324 degrees of freedom ($p= 0.001$) for the sample measured against the three-factor model and 1611.8901 on 701 degrees of freedom ($p= 0.001$) for the sample measured against the two-factor model. Satorra-Bentler scaled chi-square statistics was employed, as suggested by Tabachnick and Fidell (2001). The Satorra-Bentler scaled

Chi-square is an adjusted Chi-square statistic that attempts to correct for the bias introduced when data are markedly non-normal in distribution (Garson, 2002). The findings indicated that the Chi-square for both models were statistically significant (p=0.001). According to Garson (2006), the Chi-square value should not be significant to indicate good model fit. A significant Chi-square indicates that the model's covariance structure is significantly different from the observed covariance matrix. According to Garson (2006) a model with a Chi-square <0.05 is significant and should be rejected.

Carmines and McIver (cited in Garson, 2006) claim that relative Chi-square reaches acceptable modular tolerance in a range of 2:1 to 3:1. Ullman as well as Kline (both cited in Garson, 2006) support this ration and indicate 2 or less as a good fit, and 3 or less, as an acceptable fit. The Chi-square ration was 2.076 for the three-factor model and 2.299 for the two-factor model. The Chi-square ration result for this research demonstrates an acceptable overall fit for both the three- and two-factor models measured.

TABLE 9

GOODNESS OF FIT ANALYSIS

Fit Indices	**Model 1**	**Model 2**
Goodness of Fit Index (GFI)	0.6767	0.7122
GFI Adjusted for Degrees of Freedom (AGFI)	0.6506	0.6798
Square Root Mean Residual (SRMR)	0.0824	0.0644
Chi-square	2749.2965	1611.8901
Chi-square DF	1324	701
Chi-square / df ration	2.076	2.299
Pr > Chi-square	<.0001	<.0001
RMSEA Estimate	0.0714	0.0785
RMSEA 90% Lower Confidence Limit	0.0677	0.0734
RMSEA 90% Upper Confidence Limit	0.0752	0.0835
Bentler's Comparative Fit Index (CFI)	0.7406	0.7850
Bentler & Bonett's (1980) Non-normed Fixed Index (NNFI)	0.7300	0.7727
Bentler & Bonett's (1980) (NFI)	0.6000	0.6762

The Root Mean Squared Error of Approximation was estimated at 0.0714 for the three-factor model and 0.0785 for the two-factor model. The RMSEA is based on an analysis of residuals and it estimates the lack of fit in a model compared to a perfect model. The RMSEA value support the contention of a good model fit. A value of less than or equal to 0.05 indicate an excellent fit (Brown and Cudeck, 1992 and Kelloway, 1998). Hair *et al.* (1998) consider RMSEA values between 0.05 and 0.08 as indicative of an acceptable fit, whilst Steiger (1995) would consider RMSEA values of less than 0.10 as acceptable. The 90 percent lower confidence interval of the RMSEA indicated 0.0677 for the three-factor model and 0.0734 for the two-factor model, and confirmed the acceptable fit of both measurement models to the data.

The standardised Squared Root Mean residual estimated 0.0824 for the three-factor model and 0.0644 for the two-factor model. According to Garson (2006) a SRMR closer to 0 is a better model fit. Based on the criteria by Garson, the SRMR estimate indicates the two-factor model to be a slightly better fit when compared to the three-factor model.

All the other comparative fit indices did not indicated suitable values that were within the required limits for an acceptable model fit. The NFI, CFI and GFI indices are based on the ratio of the sum of the squared discrepancies to the observed variance, and they are normed to yield numbers that range from 0 to 1, values above 0.90 indicate a good fit with the data (Kelloway, 1998). According to Garson (2006) a general guideline for the interpretation of the GFI, NFI and CFI is that values of 0.90 and higher, indicates a satisfactory fit between the postulated model and the observed data. According to Bentler (1990) and Steiger (1995), values closer to 1 demonstrate a perfect fit.

The CFI (Model 1 = 0.7406, Model 2 = 0.7850), NNFI (Model 1 = 0.7300, Model 2 = 0.7727) and NFI (Model 1 = 0.6000, Model 2 = 0.6762) values are all less than the required 0.90, to indicate a good model fit. Based on these criterions, none of the two proposed models met any of the required estimates and should be rejected.

However, Gorsuch (1997) indicated that Confirmatory Factor Analysis could fail to provide clear results when correlations between latent factors are too high. It can thus be concluded that the items that were used to construct the Safety Survey instrument scales might overlap to the extent that the scales cannot be considered factorially pure. Gorsuch (1997) commend that factor analysis can be used as a purely exploratory technique when a set of items are developed to represent an area of interest with the sampling being broad and without specific sub areas. According to Gorsuch (1997) factor analysis addressed whether one scale, one scale that can be subscales or a set of scales is needed in the area for a measurement instrument to be valid.

The objective of the Confirmatory Factor Analysis is to evaluate the factor structure for the Safety Survey instrument. The results from the Confirmatory Factor Analysis indicate that the two models tested are both acceptable fits with the sample data, based on the Chi-square ration, the Root Mean Squared Error of Approximation and the standardized Squared Root Mean residual. These two models however do not appear to be competing models and may be equivalent models. According to MacCallum, Wegner, Uchino and Fabriger cited in Worthington and Whittaker (2006) models are mathematically equivalent even when their parameter configurations appear to be different and these models will have a different configuration but yield the same Chi-square statistics and goodness of fit indices. According to Withington and Whittaker (2006) theory would play the strongest role in selecting the appropriate model when comparing equivalent models. Theoretically the models can be differentiated on a external locus of control factor.

In further theoretical examination of the two hypothesized models, it became apparent that both an internal and external locus of control factor were identified in the Exploratory Factor Analysis and subsequently modeled as the three-factor model. It is further apparent that the external locus of control factor is absent from the second two-factor model identified. Theoretically it appears that the two-factor model is in actual fact a sub-set of the three-factor model. According to Worthington and Whittaker (2006) two models where one forms a sub-set of another to which it is compared, are nested or hierarchically related models. In this study the two hypothesized models appear to be nested models, as the two-factor model (restricted model) is nested within the three-factor model (unrestricted model).

To test these nested models Worthington and Whittaker (2006) as well as Garson (2006) note that the Chi-square difference test is used to examine if a significant loss occurs when going from the unrestricted model to the nested/ restricted model. According to Garson (2006) the Chi-square difference is simply the Chi-square fit statistic for one model minus the corresponding value for the second model, the degrees of freedom for this difference is the *df* for the first model minus the *df* for the second model. Chi-square difference = 1137 and the Degrees of freedom difference = 623.

According to Garson (2006) if the Chi-square difference is not significant >0.05, then the two models have a comparable fit to the data, and for parsimony reasons the subset model is preferred. Worthington and Whittaker (2006) further note that if one model is not a sub-set of another model the Chi-square difference test would be an inappropriate method to determine model fit differences, the reason being that the two models can not serve as a baseline comparison model.

CHAPTER 5

RESULTS

5.1 INTRODUCTION

The primary objective of the research was to determine the construct validity of the Safety Survey instrument by means of Structural Equation Modeling. As an additional measure an Exploratory Factor Analysis was first conducted to determine the number of underlying factors, derived from the indicator variables for Confirmatory Factor Analysis purposes. The findings of the Exploratory Factor Analysis will first be discussed, followed by the findings of the Confirmatory Factor Analysis. The limitations related to this study and the recommendations for future research will also be discussed in this chapter.

5.2 RESULTS RELATED TO THE EXPLORATORY FACTOR ANALYSIS

Factor loadings, correlation between factors and internal consistency of reliability were performed in an attempt to provide statistical evidence of the number of factors that underlie the Safety Survey instrument. The findings from the factor analysis are presented in this section.

Firstly, the items included in the Safety Survey's proposed five factors were scrutinised. All the items which had factor loading less than 0.30 or which seemed to be exceedingly similar in content were omitted (Tabachnick and Fidell, 2001). Only fifty three items were retained and they were subjected to a second round of Exploratory Factor Analysis. According to Worthington and Whittaker (2005) the primary reason for using Exploratory Factor Analysis is that it allows items to be related to any of the factors underlying examinee responses. As a result, the instrument developer can easily identify items that do not measure an intended factor or that simultaneously measure multiple factors, in which case they could be poor indicators of the desired construct and eliminated from further consideration (Worthington and Whittaker, 2005).

Three factors with eigenvalues >1 were extracted. These factors explained 21.890 percent of the total variance in the data. The scree plot presented also suggests that there are only two significant factors underlying the variables of the Safety Survey instrument. However to avoid under factoring it was decided to conclude a third factor for testing.

The Exploratory Factor Analysis delivered a rotated pattern matrix that only identified two significant factors; the third factor only loaded two variables. Johnson (1998) recommends that at least three variables per factor are required for the factor to be recognised. Based on Johnson's recommendation the third factor was discarded. Worthington and Whittaker (2005) state that conceptual interpretability should be the definitive factor-retention criterion and the researcher should retain a factor only if they can interpret it in a meaningful way, no matter how solid the evidence for its retention based on the empirical criteria is. Exploratory Factor Analysis is ultimately a combination of empirical and subjective approaches to data analysis.

Scales were created for each identified component and these were labeled according to the general content of their significant related items. According to Tabachnick and Fidell (2001) five or six marker variables can be used to identify factors. The two factors were labeled internal locus of control and external locus of control. The Exploratory Factor Analysis identified twelve variables that loaded very high on the second factor and very low on the first factor, these marker variables identified the factor as external locus of control. This construct however, was not identified in the original description of the instruments measurement dimensions.

A second Exploratory Factor Analysis was conducted and the identified external locus of control items was excluded. Two factors with eigenvalues >1 were extracted.

Scales were created for each factor and these were labeled according to the general content of their significant related items. The two factors were labeled perceived behaviour control and attitude towards safety. The inter correlation matrix from the Exploratory Factor Analysis also indicated a high correlation (0.598) between the two factors; perceived control and safety attitude. These highly correlated factors are labeled to be internal locus of control as identified in the first Exploratory Factor Analysis.

The primary aim of the Exploratory Factor Analysis was to determine the number of underlying factors for the purpose of conducting a Confirmatory Factor Analysis.

Before the main statistical analysis was conducted the sample size and the relationship between the responses to the items were examined to determine whether the data was suitable for factor analysis. The number of responses (450) was more than five times the number of variables (80). The inter-correlation matrix revealed that underlying structures do exists. Both Bartlett's test of sphericity ($p<.001$ for both models) and the KMO measure of sample adequacy (0.903 and 0.935) and significant sphericity (0.000) for both models confirmed that the properties of the correlation matrix of the item scores were suitable for factor analysis, in terms of the guidelines recommended by Hair *et al*. (1998).

5.3 RESULTS RELATED TO THE CONFIRMATORY FACTOR ANALYSIS

Confirmatory Factor Analysis was used to test the extent to which the two measurement models for the Safety Survey instrument fitted the data. The variances of the factors in the two models were fixed to unity in order to identify the models. According to Anderson and Gerbing (1988) a confirmatory measurement model specifies the relation of the observed measures to their posited underlying constructs, with the constructs allowed to inter-correlate freely. The factor pattern coefficients of the factors in the models are estimated freely from the observed data. A confirmatory structural model then specifies the causal relations of the constructs to one another, as posited by some theory (Anderson and Gerbing, 1988).

In Exploratory Factor Analysis, factors are assumed to be un-correlated; whilst in Confirmatory Factor Analysis, specific co-variation among particular unique factors can be tapped (Byrne, 2005). In an Exploratory Factor Analysis model, all observed variables are directly influenced by all common factors, whilst with Confirmatory Factor Analysis; each factor influences only those observed variables with which it is supposed to be linked (Byrne, 2005). The measurement model in conjunction with the structural model enables a comprehensive, confirmatory assessment of construct validity (Bentler cited in Anderson and Gerbing, 1988).

Model 1 specifies a third identified factor that underlies the sub-scales of the Safety Survey instrument. According to Tabachnick and Fidell (2001) marker variables can be used to identify factors. It is clear from the results that the third factor can theoretically be identified as an external locus of control construct that contains marker variables in the Safety Survey instrument such as bad luck, chance and fate.

Model 2 specifies that two prominent factors underlie the sub-scales of the Safety Survey instrument. In correspondence with identifying the marker variables as suggested by Tabachnick and Fidell (2001) and the theory on which the Safety Survey instrument is based, these two factors nested within the internal locus of control construct were identified as perceived control and safety attitude. In accordance to theoretical expectations, this model further specifies that the following sub-scales are correlated with each other and form the factor called perceived control, they are; safety control, quality control and stress tolerance. The model further indicates, risk avoidance and perception of the organisations safety culture to make up the factor; attitude towards safety.

The Confirmatory Factor Analysis deepens the insight into the factor structure of the Safety Survey instrument. Even though the Goodness of Fit Indices (NFI, CFI, GFI) are not indicative of an acceptable match between the models and the empirical data. However, the RMSEA and the Chi-square methods suggest an acceptable match for both the models tested.

To conclude, the Confirmatory Factor Analysis failed to provide clear results; this might be due to the high correlations between the latent factors (Gorsuch, 1997). It can thus be concluded that the items that were used to construct the Safety Survey instrument scales might overlap to the extent that the scales cannot be considered as factorially pure, and thus the finding that two nested models exist.

5.4 LIMITATIONS AND RECOMMENDATIONS RELATED TO THIS STUDY

Based on the findings of the Exploratory Factor Analysis, three factors were identified for retention. However, low recordings were found on the respective factors and the three factors only account for an inadequate 21.90% variance. In addition the relationship between the factors, especially the second and third factor is difficult to observe and hard to interpret. Most variables load on the first factor, with only a few variables loading on the identified second and third factors.

The factor analysis conducted in this study identified an internal locus of control factor that consist of two sub-factors from the original five factors of the Safety Survey Instrument. These sub-factors are; attitude and perceived control. According to literature cited in this study, the more favourable the attitude, subjective norms and perceived behaviour control, the stronger a person's intention to perform certain behaviour. This is described as a level of attitude that is internalised. It has also been established in the quoted literature that a person will adapt certain behaviour because it is in accordance with their existing belief system. The relationship between attitude and behaviour is thus a strong one, and whatever the external factors operating are, an individual will still engage in the behaviour he or she believes is correct and in-line with their internal belief system.

The factor analysis also identified a second prominent factor in the Safety Survey instrument i.e. external locus of control that consists of elements like fate, change and bad luck. From literature quoted, it became evident to the researcher that a person with a higher external locus of control, or a belief system that is based on low perceived control, will most probably see no value in obeying rules, procedures and systems pertaining to safety. Thus, a person with a high external locus of control will consequently have a low internal locus of control.

It is recommended that further research explore the external locus of control factor identified in this study. In the South African context further investigation into the afro-centric belief system, cultural values and behaviour should be undertaken and be further expanded in the Safety Survey instrument. Further investigation and inclusion of this factor would enable the Safety Survey instrument to clearly identify low safety risk and high safety risk employees.

Overall, the results provided acceptable statistical support for both the two- and the three-factor models. It was noted that the two and three-factor models are not necessarily competing models. The question might be raised as to which approach has the most utility for understanding employee's perception, attitude and ultimately intention towards safe behaviour in order to target areas for training and address the problems associated with safety behaviour. It is also important for future studies to validate these factors externally. This could be done by using multi-trait, multi-method procedures, including information other than from the Safety Survey instrument, in future tests of the latent constructs that were identified. The components identified in the study might also be refined by integrating data from other sources, such as dimensional measures of personality traits. Finally, an important area of study will be to test the stability of the factors and their relationship to various sample groups.

5.5 CONCLUSION

A review of the literature available revealed that research in this field primarily looked at safety as a technical problem that could possibly be “engineered out” through improved design of workplace settings (Donald and Canter, 1994; Donald and Siu, 2001). Other studies in literature show that technical approaches alone are inadequate to reduce accident rates to desired levels (Ajzen and Fishbein, 1975; De Joy, 1994; Armitage and Christian, 2003; Westaby, 2005). These organisational researchers and theorists explored alternative perspectives that take into account the broader social context in which accidents occur. One of these perspectives is safety culture that consists of shared attitudes, beliefs, intentions, norms, and practices related to the minimisation and/or control of hazards within an industry or organisation.

The primary objective of this study was to determine the validity of the Safety Survey instrument in the mining industry in order to, determine the perception and ultimately intention of employees towards safety behaviour. The Safety Survey instrument was developed by Industrial Psychologists and Organisational Development Practitioners within the mining industry, to survey employees in the mining industry on their perception regarding safety, attitude toward safety and the intention to behave safely. A total of eighty (80) items were initially included in the Safety Survey instrument. After the application of item analysis and Exploratory Factor Analysis, fifty three (53) of the original items yielded a three-factor solution. Exploratory Factor Analysis firstly identified two factors (internal and external locus of control) and further investigation revealed that the internal locus of control factor consisted of two sub-factors; perceived behaviour control and safety attitude. Confirmatory Factor Analysis confirmed that the observed factors correspond with the latent variables and that an acceptable model fit had been achieved between the multi-factor solution for the Safety Survey instrument and the data.

The factors or dimensions associated with the Safety Survey instrument were labeled; internal locus of control (i.e. perceived behaviour control and safety attitude) and external locus of control. The first factor found within the internal locus of control construct, consisted of seventeen items and referred to the perception that employees have towards controlling their own behaviour. The second factor found within the internal locus of control construct, consisted of twenty two items and referred to the general attitude employees have towards safety. The third factor identified was found within the external locus of control construct, and consisted of twelve items that referred to employee's perception or believe that they have little control over what happens to them.

Factor 1 and Factor 2 were identified as internal locus of control and the correlation between these two factors were demonstrated in the two-factor model tested in this study. However, the three-factor model tested in this study demonstrated together with the combined Factor 1 and Factor 2 (internal locus of control) that a third factor i.e. external locus of control was evident. Table 10 below, illustrates the items found in the three factors identified. It can be concluded that these fifty-three items will constitute the Safety Survey instrument for future use. It is however recommended that the external locus of control factor is further investigated and that the unique external locus of control factor as found in an afro-centric approach are cross-validated with definitions of external locus of control as cited in this study.

TABLE 10

FINAL ITEMS PER FACTOR

Internal Locus of Control		External Locus of Control
Factor 1: Perceived Behaviour	**Factor 2: Safety Attitude**	**Factor 3: External Locus of Control**
Q1	Q21	Q4
Q2	Q24	Q12
Q5	Q27	Q26
Q6	Q28	Q32
Q8	Q30	Q36
Q10	Q33	Q44
Q15	Q40	Q45
Q16	Q42	Q58
Q17	Q43	Q64
Q19	Q46	Q66
Q23	Q47	Q69

Q25	Q49	Q70
Q53	Q51	
Q68	Q52	
Q71	Q55	
Q73	Q57	
Q77	Q59	
	Q60	
	Q61	
	Q62	
	Q72	
	Q75	

Several researchers have directly or indirectly confirmed the factors or dimensions identified in the Safety Survey instrument. According to Rotter (1966) locus of control is a generalised expectancy of the extent to which a person perceives that events or circumstances in his/her life are consequences of his/her behaviour. According to Rotter (1966) employees with an internal locus of control will be the ones that believe that they can exercise control over events that can affect them within the work environment. In terms of safety in the workplace, this would imply having control over the possibility of being involved in accidents by exercising control over behaviour. Employees with an external locus of control in contrast will believe that they have very little control over what happens to them in terms of accidents.

Schermerhom, Hunt and Osborn (1997) confirm the possibility of measuring the factors identified in the Safety Survey instrument by stating that people have very clear personal conceptions about whether the outcomes of their actions are dependent on what they do, or on factors outside of their personal control.

The statistical analysis of the Safety Survey instrument has indicated that the questionnaire has acceptable factorial validity, internal consistency and uni-dimensionality. Hence, the instrument can be used with confidence to gather valid and reliable data about employee perception, attitude and intention toward safety behaviour, held by mining employees in South Africa.

Mining companies have become increasingly reliant on knowledge and information to ensure optimal performance and safety. To be able to objectively measure and assess employee related perception, attitudes and intention towards safety behaviour, an instrument like this may be able to help researchers, human factor specialists, psychologists and safety instructors to understand and manage key concepts and issues associated with believes, attitudes, norms and values in the mining industry.

The Safety Survey instrument can provide the data needed to convince management to address any unjust perceptions, attitudes and believes in the workplace. For example employees might believe that accidents are not in their control and that safety behaviour will not influence whether they will be involved in an accident or not.

The data collected by means of the Safety Survey instrument can also be disseminated for discussion, to create an awareness of diversity in the operational context and to improve the culture of the organisation. Knowing and understanding people's attitudes, beliefs, perceptions and intention toward safety behaviour can do much to advance the development of better targeted training interventions in order to increase safety.

CHAPTER 6

THE ARTICLE

DETERMINING THE CONSTRUCT VALIDITY OF THE SAFETY SURVEY INSTRUMENT

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ABSTRACT

Safety interventions must be approached in a holistic manner, by taking cognisance of the organisational system in which accidents present themselves. Thus, a need to understand the individual in context of the organisational system that he/she functions in exists. This study focuses on the relationship between attitudes, beliefs, intention, perception, control and the propensity of employees to engage in unsafe behaviour, with a view towards improving safety statistics. In this regard the study investigated the construct validity of a Safety Survey instrument, based on the responses (n=450) of employees in the mining industry. An Exploratory Factor Analysis showed that the Safety Survey instrument differentiated between two to three underlying factors. The result of the Confirmatory Factor Analysis tested possible factors residing within two hypothesized models by demonstrating the minimum requirements of the goodness of fit indexes. The construct validity of the Safety Survey instrument could be established for both the hypothesized models that were identified as two nested models. The statistical evidence indicated acceptable model fit and validated the construct validity of the measurement model.

Vincent (cited in Meurier, 2000) stated that fallible decisions taken at management level may provide the conditions in which unsafe acts may occur. These fallible management decisions may cause difficulties in the form of poor planning and scheduling of work, heavy workloads, inadequate training, supervision and inadequate maintenance of equipment that may only become apparent in unusual circumstances such as emergencies, shortage of appropriately experienced staff and other forms of crises. These latent failures may thus precipitate active failures (e.g. errors) which can affect outcomes negatively.

According to Denton (cited in Tomas, Melia and Oliver, 1999) the first attempts to reduce accidents from an engineering point of view were orientated towards the control of technical aspects and physical hazards. However, accidents still happened and researchers started to consider the ‘’human factor’’ as primarily connected to work related accidents. Denton as cited in Tomas et al. (1999) found that approximately 90% of accidents were caused by the unsafe actions of workers. Human behaviour is an integral part of everyday life and, in the workplace one can never escape one’s own and others behaviour (Cascio, 1998).

Garbers and Holahan in Barnes (1989) defined the relationship between an individual’s environment and behaviour or the interaction between human behaviour and experience and the physical context within which such interaction takes place, as environmental psychology. Several studies within the field of environmental psychology have been devoted to understanding which variables are related to or determine the occurrence of accidents and/or unsafe behaviours. Viljoen (as cited in Barnes, 1989) described an environmental psychology model of safe performance or behaviour and according to Viljoen a number of components relevant to the propensity of safe behaviour exist, they include; the objective environment, the perceived environment, person–environment fit and demographic factors.

When taking into consideration the organisational system in which accidents present themselves, averting unsafe behaviour in the work environment might have to be looked at in a more holistic manner. A need to understand the individual in context of the organisational system that he/she functions in as well as the relationship between the employee's attitudes, beliefs, intention, perception, control and the individual engaging in unsafe behaviour might exist.

Understanding the fundamental determinants of individual's behaviour has been a paramount focus for many theorists in the social sciences. Two theories that have greatly advanced the understanding of behaviour determinants are the theory of reasoned action (Fishbein and Ajzen, 1975) and the theory of planned behaviour (Ajzen, 1988). Both these theories affirm that attitude, subjective norms and perceived control predict intention and that intention in turn predict behaviour. The theory of reasoned action argues that behaviour can be predicted if a person's attitude and intention towards a particular behaviour is known. Furthermore, behaviour can be predicted if a person's beliefs about the consequences of that behaviour and the social norms which govern that behaviour are known. From a theoretical perspective attitude is identified as a strong driver of behaviour and has both affective and belief components. The theory of reasoned action however illustrates that attitudes are not necessary for or sufficient cause of behaviour, but that attitudes do contribute to the cause. Behaviour is thus not only the result of attitudes, but also of habits, social norms and expectations (Kollmuss and Agyeman, 2002). The theory of planned behaviour added to the theory of reasoned action and includes perceived behavioural control as a determinant of both behavioural intention and behaviour. The rationale for including perceived behavioural control as a predictor of behaviour is based on the assumption that if intentions are held constant, greater perceived control will increase the likelihood that enactment of the behaviour will be successful (Bamberg, 2003 and Garling, Fujii, Garling and Jakobsson, 2003).

Ajzen and Fishbein (1975) declared a general rule when dealing with intention to behaviour. This rule stated that the more favorable the attitude and the subjective norm and the greater the perceived control, the stronger should the person's intention to perform the behaviour in question be. This relationship between attitude and behaviour is strong because whatever the external factors that are operating, an individual will engage in the behaviour because he or she believes that it is correct or inline with their own internal belief system.

Rajecki (2007) stated that there are two major factors that influence behaviour, one is attitude and the other is the situation the individual happens to be in. The factor that has the most effect on an individual will depend on the type of person i.e. high self-monitor or low self-monitor. Thomas, Kelly and Lillian (2006) support this and stated that in order to explain how employees approach work, both attitudinally and behaviorally, the differentiation between internal and external locus of control is important.

According to Newhouse in Kollmuss and Agyeman (2001) locus of control represents an individual's perception of whether he or she has the ability to bring about change through his or her own behaviour. Thomas *et al.* (2006) explained locus of control as the extend to which people believe that they have control over their own fate. According to Kollmuss and Agyeman (2001), Ajzen (2002) and Rotter (cited in Thomas *et al.* 2006) people with a stronger internal locus of control, believe that their actions can bring about a certain change, whilst people with an external locus of control feel that their actions are of no consequence, and that change can only be brought about by powerful others.

Rajecki (2007) concluded that if you have a high level of self-control, attitude will play an increasingly less significant role in determining your behaviour. Covey (1989) supported this by stating that highly pro-active people will recognise their responsibility and would not blame their conditions or the environment. Their behaviour would be a product of their own conscious decisions that are based on their values. On the other side, Covey explained that the physical environment will influence reactive people and circumstances will to a large extent determine their behaviour. These individuals are more driven by feelings, circumstances and conditions in their environment, whereas pro-active people will be influenced by the external stimuli, social or psychological, but their response to the stimuli, conscious or unconsciously, remains a value based choice or response.

There is a basic need in the evolution of behavioural psychology to understand which people are more prone to unsafe behaviour and why. The need to understand, predict and measure behaviour exists in all aspects of life, and relates directly to the need for safety control. In order to make assessments, predictions and interventions related to safety behaviour, it is clear that some form of measurement is needed and that validity will have to be established with the view to reduce accidents.

According to De Vos, Strydom, Fouche and Delport (2004) validity and reliability are two of the most important concepts in the context of measurement. A valid measuring instrument is described as one doing what it is intended to do, measuring what it is supposed to measure and yielding scores whose differences reflect the true differences of the variable being measured rather than random or constant errors. Thus before any test or questionnaire can be administered the validity of the test must first be established to ensure that it measures what it claims to measure and there are no logical errors drawing conclusions from the data.

This article focuses primarily on the construct validity of the Safety Survey instrument and will report on the findings of the statistical analysis.

METHOD

Sample

For this study a sample of N=450 was collected from employees at a platinum mine in South Africa. The sample was collected daily over a two month period and collection came to a close when the researcher arrived at the sufficient sample required to perform the required statistical analysis that would determine construct validity. All respondents were given an equal opportunity to participate in the research project on a voluntary basis. No respondent was discriminated against based on any biographical characteristics.

From the data collected the majority of the respondents were black males (96.7%). The findings further show that 84% of the respondents were between the age group of twenty to forty years, and that 74.7% work more than six hours per day in a high risk environment. This might be explained by the traditional role of men, where underground mining positions are predominantly filled by men, who largely dominate the population.

<PLACE TABLE 1 HERE>

Data Collection Procedure

All the data were collected by means of a survey to ensure a structured data collection method, to eliminate interviewer bias and to ensure that the same definitions are applied consistently to all participants.

Measuring Instrument

The objective of the questionnaire in this study is to establish the propensity of employees to engage in unsafe behaviour, by means of quantitative methods. The rational for the development of the Safety Survey instrument stemmed from a study conducted by one of the developers of the instrument, this study investigated the influence of attitudes on behaviour. The attitudinal theory by Ajzen and Fishbein (1975) was applied as basis for the survey development, together with an in depth knowledge and understanding of the drivers, attitudes, culture, work context and production pressure that employees face within the mining industry. Other benchmarked surveys were also used to develop the Safety Survey instrument, and were adjusted and re–interpreted with the designer’s knowledge of the mining industry, new dimensions were added to the existing surveys and questions were re-written to be more practical and to relate to the mining industry. This instrument was never validated before and no statistical information is available.

The originally developed survey consists of 80 questions in five dimensions of measurement. These dimensions are: safety control, risk avoidance, stress tolerance, quality control and perception of the organisational safety culture.

Statistical Analysis

The construct validity of the Safety Survey instrument was calculated by estimating coefficients for internal consistency (alpha), and by conducting an Exploratory and Confirmatory Factor Analysis.

Exploratory Factor Analysis was specifically applied in this study to determine the number of factors that underlie the set of measurements and to determine which factors should be retained. Cronbach alpha coefficients, as well as the average correlations between the items of each scale, were calculated to examine the internal consistency and uni-dimesionality of the retained factors of the Safety Survey instrument. Further criteria such as the Scree test and Kaiser's criterion were also applied to compute the eigenvalues of the correlation matrix and to plot it in order of descending values to identify the last substantial drop in the magnitude of the eigenvalues. Kaiser's criterion was applied to determine the number of factors to retain (Fabrigar *et al.* 1999).

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was specifically used to predict if the data were likely to factor well based on the correlation and partial correlation caused by underlying factors and to access compliance with the distribution requirements.

Bartlett's test of sphericity, tested the null hypothesis i.e. that a correlation matrix is an identity matrix. According to Tabachnick and Fidell (2001) an associated probability less than 0.05 will indicate that the correlation matrix is not an identity matrix and that the variables are unrelated and therefore suitable for factor analysis.

Once an initial solution was obtained the loadings were rotated to maximize higher loadings and to minimize lower loadings to ensure that the simplest possible structure is obtained. The oblique method was applied in this study, as the factors identified in the Safety Survey instrument are theoretically to a great extent related.

The Confirmatory Factor Analysis procedure was done in BMDP using Structural Equation Modeling to test whether the pre-existing theoretical model underlies a particular set of observations made (Garson, 2002). Confirmatory Factor Analysis however requires clear predictions as to which factors exist, how they relate to the variables and how they relate to each other. Without such predictions, exploratory analyses are needed (Gorsuch, 1997), thus the reason for first conducting the Exploratory Factor Analysis in this study.

The Confirmatory Factor Analysis was done, using the SAS Proc Calis program. The data was analysed by means of a series of maximum likelihood estimations. According to Cheung and Rensvold (2002) this technique requires the researcher to specify a theoretical model that will explain the covariances between observable and latent variables in advance. The observable variables in this study were the scores of the Safety Survey instrument and the latent variables that underlie the scores of the observable variables. According to Cheung and Rensvold (2002) Confirmatory Factory Analyses allows the researcher to evaluate the fit between the hypothesized model and the observed data. Kline (cited in Worthington and Whittaker, 2006) and Jackson, Dezee, Douglas, and Shimeall (2005) recommend a minimum collection of indices to report on. In this study, a series of fit indexes were used, which included: the Chi-squared statistic, the Root Mean Square Error of Approximation (RMSEA), the Goodness of Fit Index (GFI), the Normed Fit Index (NFI) and the Comparative Fit Index (CFI).

The RMSEA index is based on an analysis of residuals and it estimates the lack of fit in a model compared to a perfect model. Hair, Aderson, Tatham and Black (1998) regard RMSEA values between .05 and .08 as indicative of an acceptable fit. The Goodness of Fit Index (GFI), the Normed Fit Index (NFI) and the Comparative Fit Index (CFI) indices are based on the ratio of the sum of the squared discrepancies to the observed variance (Kelloway, 1998), and they are normed to yield numbers that range from 0 to 1. According to Kelloway (1998) a general guideline for the interpretation of the GFI, NFI and CFI is that values of 0.90 and higher indicate a satisfactory fit between the hypothesized model and the observed data.

RESULTS

The analysis in Table 2 below indicates three factors with eigenvalues above two and with a cumulative variance of 21.90 % that was retained. Hayton, Allen and Scarpello (2004) noted that no general consensus exists, but proposed that it seemed reasonable for a decent model to retain as many common factors as may be required to explain at least 50% of the variance in the variables. Hair *et al*. (1998) reported that as many factors as there are eigenvalues larger than one for the correlation matrix, should be taken. With regard to the eigenvalues obtained, more than eight factors loaded above the required 1.0 to be retained. According to Hair *et al.* (1998) retaining factors with a loading above one, is a good rule if there are twenty to fifty variables, but that it tends to take too many if there are more than fifty variables, as in the case with this study.

<PLACE TABLE 2 HERE>

Based on the result of the Scree-test, Figure 1 indicates two significant factors from the originally defined five factors that can be identified. A clear break can be observed in the Scree-plot between factors one and two. However to avoid under factoring and due to a total variance less than 50% explained by the eigenvalues on the first few factors (Hayton *et al.*, 2004), both a two and three factor model were employed for the pattern matrix.

<PLACE FIGURE 1 HERE>

Table 3 below, contains the rotated factor loadings that were extracted for the proposed three-factor model. The extracted rotated pattern matrix demonstrate thirty nine significant variables loading on the first factor and twelve variables loading on the second factor and only two variables on the third factor. Table 3 contains clear signs of over factoring with limited variables loaded above 0.30 on the third factor. Furthermore, the correlation matrix between the three factors shows no correlation between any of the factors, indicating that the factors might exist on two opposite sides of a continuum.

<PLACE TABLE 3 HERE>

Further Exploratory Factor Analysis was conducted on the factors of the Safety Survey instrument. The twelve variables that have been identified as a significant factor within the first model, but which did not correlate well with the other significant factor, were excluded from a second round of exploratory oblique rotation. Table 4 contains the rotated factor loadings for the proposed model that demonstrate that seventeen significant variables load on a first factor and twenty two variables load on a second factor. The inter factor correlation matrix shows a strong relationship (0.598) between factor one and factor two of the second hypothesized model that were tested in the exploratory oblique rotation.

<PLACE TABLE 4 HERE>

Mean, standard deviation, coefficient alpha and correlation with total score were calculated for the sample scores on three identified factors of the Safety Survey instrument and are shown in table 5 below.

<PLACE TABLE 5 HERE>

From the table it is evident that the summated scores of the sample on the three factors are approximately normally distributed, with a tendency towards negative skewness. The statistics indicate that the distribution of factor one and factor two's measure of the Safety Survey instrument was negatively skewed. According to Morgan and Griego (1998) the assumption of normality requires that the key statistics i.e. skewness and kurtosis, be less than 2.5 times the standard error. The descriptive statistics for the three factors of the Safety Survey instrument indicated that only one of the three factors are within the norms indicated by Fabriger (1999). According to Fabriger (1999) the maximum likelihood extraction method is favored when skewness is larger than two (>2) and kurtosis larger than seven (>7).

The KMO measure is 0.903 for the first model and 0.935 for the second model. According to Hutcheson and Sofroniou (1999) KMO measures vary between 0 and 1.0 and the KMO should be 0.60 or higher to proceed with factor analysis. The KMO obtained for both the proposed models are above 0.90 which is considered as excellent and very suitable for factor analysis.

Bartlett's test of sphericity is significant for both models and reflects an associated probability of less than 0.05. In both models the correlation matrix was not identified as an identity matrix. The variables are thus unrelated and therefore suitable for factor analysis.

<PLACE TABLE 6 HERE>

<PLACE TABLE 7 HERE>

The Confirmatory Factor Analysis was done using the SAS Proc Calis programme with maximum likelihood (ML) estimation, as described by Garson (2006). For the purpose of this study the following Goodness of Fit Indices demonstrated in Table 8 below were used to analyse the degree of likeness between the covariance matrices of the latent variables and the observed variables.

The Satorra-Bentler scaled Chi-square statistical calculation output was 2749.2965 on 1324 degrees of freedom (p= 0.001) for the sample measured against the three-factor model and 1611.8901 on 701 degrees of freedom (p= 0.001) for the sample measured against the two-factor model. Satorra-Bentler scaled Chi-square statistics was employed, as suggested by Tabachnick and Fidell (2001). The Satorra-Bentler scaled Chi-square is an adjusted Chi-square statistic that attempts to correct for the bias introduced when data are markedly non-normal in distribution (Garson, 2002). The findings indicated that the Chi-square for both models were statistically significant (p=0.001). According to Garson (2006), the Chi-square value should not be significant to indicate good model fit. A significant Chi-square indicates that the model's covariance structure is significantly different from the observed covariance matrix. According to Garson (2006) a model with a Chi-square <0.05 is significant and should be rejected.

Carmines and McIver (cited in Garson, 2006) claim that relative Chi-square reaches acceptable modular tolerance in a range of 2:1 to 3:1. Ullman as well as Kline (both cited in Garson, 2006) support this ration and indicate 2 or less as a good fit, and 3 or less, as an acceptable fit. The Chi-square ration was 2.076 for the three-factor model and 2.299 for the two-factor model. The Chi-square ration result for this research demonstrates an acceptable overall fit for both the three- and two-factor models measured.

<PLACE TABLE 8 HERE>

DISCUSSION

The primary objective of the research was to determine the construct validity of the Safety Survey instrument. The instrument was devised to survey employees' propensity to engage in unsafe behaviour. No validation on the Safety Survey instrument has previously been undertaken. The Safety Survey instrument initially included a total of 80 items. After the application of Exploratory Factor Analysis, 53 of the original items yielded a two-factor solution. The Confirmatory Factor Analysis confirmed that the observed factors corresponded with the latent variables, and that an acceptable fit had been achieved between the multifactor solution for the Safety Survey instrument and the data collected.

The primary aim of the Exploratory Factor Analysis undertaken was to determine the number of underlying factors for the purpose of conducting a Confirmatory Factor Analysis. The Exploratory Factor Analysis delivered a rotated pattern matrix that identified two significant factors, a third factor only loaded two variables. Based on Johnson's (1998) recommendation that at least three variables per factor are required for the factor to be recognised, this third factor was discarded.

Scales were created for each identified factor and these were labeled according to the general content of their significant related items. The two factors identified were labeled; internal locus of control and external locus of control.

A second Exploratory Factor Analysis was conducted and the identified external locus of control items was excluded. Two factors with eigenvalues >1 were extracted and scales were created for each factor. These scales were labeled according to the general content of their significant related items as; perceived behaviour control and attitude towards safety. The inter correlation matrix from the Exploratory Factor Analysis on the two-factor model indicated a high correlation between these two factors.

Confirmatory Factor Analysis was used to test the extent to which the two identified measurement models for the Safety Survey instrument fitted the data. Model 1 specified a third identified factor that underlies the sub-scales of the Safety Survey instrument. According to Tabachnick and Fidell (2001) marker variables can be used to identify factors. It is clear from the results that the third factor can theoretically be identified as an external locus of control construct that contains marker variables in the Safety Survey instrument such as bad luck, chance and fate. Model 2 specified that two prominent factors underlie the sub-scales of the Safety Survey instrument. In correspondence with identifying the marker variables as suggested by Tabachnick and Fidell (2001) and the theory on which the Safety Survey instrument is based, these two factors were identified as perceived control and safety attitude. In accordance to theoretical expectations, this model further specifies that the following sub-scales are correlated with each other and form the factor called perceived control, they are; safety control, quality control and stress tolerance.

The Confirmatory Factor Analysis deepened the insight into the discussed factor structure of the Safety Survey instrument. Even though the Goodness of Fit Indices (NFI, CFI, GFI) were not indicative of an acceptable match between the models and the empirical data, the RMSEA and the Chi-square suggested an acceptable match for both the models.

CONCLUSION

It can be concluded that the instrument has reasonable construct validity and that the results provided statistical support for both the two- and the three-factor models. There appeared to be very little distinction between the two models tested, thus indicating that the items measure a very narrow construct. Factor 1 and Factor 2 were identified as two elements of the internal locus of control factor and the correlation between these two elements were demonstrated in the two-factor model tested in this study. However, the three-factor model tested in this study demonstrated together with the combined Factor 1 and Factor 2 (internal locus of control) that a third factor i.e. external locus of control was evident. Table 10, illustrates the items found in the three factors identified. It can be concluded that these fifty-three items will constitute the Safety Survey instrument for future use. It is however recommended that the external locus of control factor is further investigated and that the unique external locus of control factor as found in an afro-centric approach are cross-validated with definitions of external locus of control as cited in this study.

<PLACE TABLE 10 HERE>

The findings from the study undertaken provided enough evidence that the Safety Survey instrument can provide valid data to convince management to address any unjust perceptions, attitudes and believe in the workplace. The data collected by means of the Safety Survey instrument can also be disseminated for discussion, to create an awareness of diversity in the operational context and to improve the culture of the organisation. Knowing and understanding people's attitudes, beliefs, perceptions and intention toward safety behaviour can do much to advance the development of better targeted training interventions in order to increase safety.

LIMITATIONS AND RECOMMENDATIONS

Based on the findings of the Exploratory Factor Analysis, three factors were identified for retention. However, low recordings were found on the respective factors and the three factors only account for an inadequate 21.90% variance. The factor analysis conducted in this study identified one of the factors as internal locus of control that consist of attitude and perceived control. The factor analysis also identified a second prominent factor in the Safety Survey instrument i.e. external locus of control that consists of elements like fate, change and bad luck. From literature quoted, it became evident to the researcher that a person with a higher external locus of control, or a belief system that is based on low perceived control, will most probably see no value in obeying rules, procedures and systems pertaining to safety. Thus, a person with a high external locus of control will consequently have a low internal locus of control.

It is recommended that further research explore the external locus of control factor identified in this study. In the South African context further investigation into the afro-centric belief system, cultural values and behaviour should be undertaken and be further expanded in the Safety Survey instrument. Further investigation and inclusion of this factor would enable the Safety Survey instrument to clearly identify low safety risk and high safety risk employees.

It is also important for future studies to validate the identified factors externally. The components identified in the study might also be refined by integrating data from other sources, such as dimensional measures of personality traits. Finally, an important area of study will be to test the stability of the factors and their relationship to various sample groups.

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TABLE 1

DEMOGRAPHICAL INFORMATION OF THE RESPONDENTS

		Job Grade	Years of experience	Gender	Race	Age	Hours underground
N = 450	Valid	361	414	426	428	420	424

JOB GRADE

		Frequency	Percent	Cumalitive Percent
Valid	Cat 3-8	47	13.01	13.01
	B4 - B6	32	8.86	21.87
	C1 - C2	88	24.37	46.24
	B1 - B3	61	16.92	63.16
	B7	21	5.82	68.98
	other	112	31.02	100
	Total	361	100	
	Omitted data	89		

YEARS EXPERIENCE

		Frequency	Percent	Cumalitive Percent
Valid	Less than 1 year	86	20.77	20.77
	1-2 years	86	20.77	41.54
	3-5 years	104	25.13	66.67
	5-10 years	48	11.59	78.26
	more than 10 years	90	21.74	100
	Total	414	100	
	Omitted data	36		

GENDER

		Frequency	Percent	Cumalitive Percent
Valid	Male	412	96.71	96.71
	Female	14	3.29	100
	Total	426	100	
	Omitted data	24		

RACE

		Frequency	Percent	Cumalitive Percent
Valid	Asian	2	0.47	0.47
	Coloured	11	2.57	3.04
	Black	365	85.28	88.32
	White	50	11.68	100
	Total	428	100	
	Omitted data	22		

AGE GROUP

		Frequency	Percent	Cumalitive Percent
Valid	Younger than 20	8	1.9	1.9
	21 - 30	191	45.48	47.38
	31 - 40	154	36.67	84.05
	41 - 50	53	12.62	96.67
	over 50	14	3.33	100
	Total	420	100	
	Omitted data	30		

HOURS UNDERGROUND

		Frequency	Percent	Cumalitive Percent
Valid	0 Hours p/d	7	1.65	1.65
	4 - 6 Hours p/d	88	20.75	22.4
	1 - 3 Hours p/d	12	2.83	25.23
	more than 6 hours p/d	317	74.77	100
	Total	424	100	
	Omitted data	26		

TABLE 2

TOTAL VARIANCE EXPLAINED

	Initial Eigenvalues		
Initial Factors	**Total**	**% of Variance**	**Cumulative %**
1	16.6489	16.0770	16.0770
2	4.69288	4.1028	20.1798
3	2.28281	1.7290	21.9088
4	1.83237		
5	1.53121		
6	1.48941		
7	1.46700		
8	1.26749		

FIGURE 1: SCREE PLOT

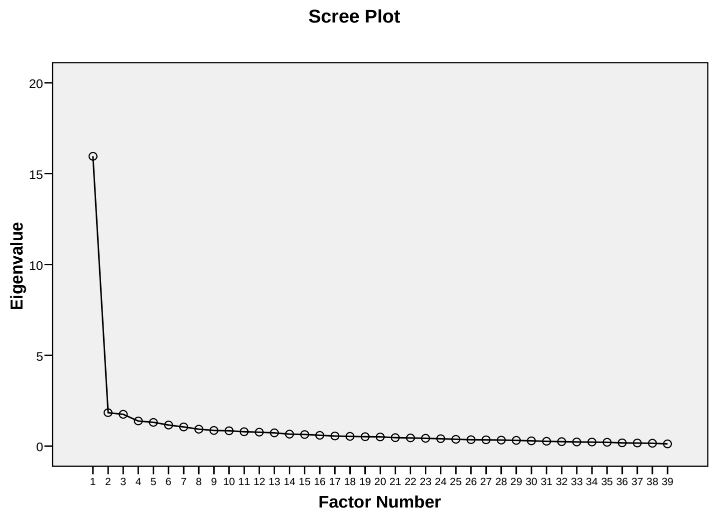

TABLE 3

ROTATED PATTERN MATRIX FOR THREE FACTOR MODEL

	Factor 1	Factor 2	Factor 3
Factor Loading per Item			
Q1	**0.616**	-0.079	-0.018
Q2	**0.672**	-0.035	0.112
Q5	**0.579**	0.020	0.171
Q6	**0.548**	0.118	0.264
Q15	**0.538**	0.131	0.236
Q16	**0.622**	-0.089	0.056
Q17	**0.663**	-0.104	0.282
Q19	**0.560**	0.072	0.543
Q21	**0.512**	0.153	0.129
Q23	**0.557**	0.066	0.037
Q24	**0.761**	-0.067	-0.004
Q25	**0.644**	0.007	0.129
Q27	**0.576**	-0.055	-0.043
Q28	**0.663**	-0.011	-0.195
Q30	**0.625**	-0.038	0.029
Q33	**0.431**	0.259	-0.038
Q38	**0.329**	0.291	0.028
Q40	**0.690**	0.015	0.021
Q41	**0.423**	0.133	0.204
Q42	**0.574**	0.106	-0.092
Q43	**0.705**	0.007	-0.112
Q46	**0.773**	-0.031	-0.131
Q47	**0.660**	-0.107	-0.197
Q49	**0.729**	0.058	-0.080
Q51	**0.510**	0.044	-0.050
Q52	**0.649**	0.016	0.141
Q53	**0.618**	-0.040	0.039
Q55	**0.658**	-0.075	-0.068
Q57	**0.771**	-0.048	-0.071
Q59	**0.498**	0.296	0.002
Q60	**0.707**	0.050	-0.000
Q61	**0.748**	-0.096	-0.021
Q62	**0.618**	0.004	0.107
Q68	**0.453**	-0.063	-0.059
Q71	**0.613**	-0.045	-0.113
Q72	**0.643**	-0.025	-0.001
Q73	**0.564**	-0.018	0.057
Q75	**0.648**	0.059	-0.013
Q77	**0.734**	-0.204	-0.098
Q4	0.094	**0.737**	0.148
Q12	0.163	**0.353**	-0.248
Q26	0.102	**0.378**	-0.391
Q32	-0.020	**0.629**	-0.063
Q36	0.299	**0.419**	-0.156
Q44	0.024	**0.580**	-0.027
Q45	-0.088	**0.520**	0.034
Q58	-0.135	**0.702**	-0.048
Q64	-0.057	**0.643**	0.153
Q66	0.032	**0.615**	-0.035
Q69	0.100	**0.155**	-0.401
Q70	-0.148	**0.716**	-0.043
Q8	0.400	0.212	**0.474**
Q10	0.385	0.145	**0.556**
Factor Correlation Matrix			
Factor	**1**	**2**	**3**
1	1.000		
2	0.191	1.00	
3	0.110	-0.027	1.00

TABLE 4

ROTATED PATTERN MATRIX FOR TWO FACTOR MODEL

	Factor 1	Factor 2
Factor Loading per Item		
Q1	**0.612**	0.037
Q2	**0.703**	0.039
Q5	**0.780**	-0.113
Q6	**0.582**	0.080
Q8	**0.606**	-0.041
Q10	**0.539**	0.007
Q15	**0.537**	0.114
Q16	**0.536**	0.126
Q17	**0.920**	-0.162
Q19	**0.617**	0.095
Q23	**0.425**	0.192
Q25	**0.599**	0.120
Q53	**0.336**	0.320
Q68	**0.293**	0.165
Q71	**0.386**	0.238
Q73	**0.592**	0.022
Q77	**0.386**	0.334
Q21	0.261	**0.337**
Q24	0.306	**0.485**
Q27	0.146	**0.447**
Q28	0.194	**0.467**
Q30	0.319	**0.349**
Q33	-0.068	**0.560**
Q40	0.024	**0.713**
Q42	-0.019	**0.627**
Q43	-0.055	**0.780**
Q46	0.101	**0.686**
Q47	0.213	**0.424**
Q49	-0.009	**0.779**
Q51	0.243	**0.300**
Q52	0.051	**0.665**
Q55	-0.091	**0.760**
Q57	0.176	**0.620**
Q59	-0.125	**0.711**
Q60	0.331	**0.428**
Q61	0.338	**0.433**
Q62	0.293	**0.386**
Q72	0.201	**0.474**
Q75	0.136	**0.561**
Factor Correlation Matrix		
Factor	**1**	**2**
1	1.000	
2	0.598	1.000

TABLE 5

DESCRIPTIVE STATISTICS

	Factor 1	Factor 2	Factor 3
N	425	425	425
Mean	3.97016807	3.91932773	2.61433155
Std. Error	0.02994655	0.03155137	0.03451435
Std. Deviation	0.617364	0.65044824	0.71153148
Variance	0.3811383	0.42308291	0.50627705
Skewness	-2.2061024	-1.92544	0.29849889
Kurtosis	8.04888049	6.37621341	0.17303709
Coeff Variation	15.5500721	16.5959135	27.216574
Alpha Coefficient	0.9562	0.8366	-

TABLE 6

KMO AND BARTLETT'S TEST FOR THE PROPOSED 3 FACTOR MODEL

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.903
Bartlett's Test of Sphericity	Approx. Chi-square	6465.379
	df	1378
	Sig.	.000

TABLE 7

KMO AND BARTLETT'S TEST FOR THE PROPOSED 2 FACTOR MODEL

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.935
Bartlett's Test of Sphericity	Approx. Chi-square	4926.906
	df	741
	Sig.	.000

TABLE 8

GOODNESS OF FIT ANALYSIS

Fit Indices	Model 1	Model 2
Goodness of Fit Index (GFI)	0.6767	0.7122
GFI Adjusted for Degrees of Freedom (AGFI)	0.6506	0.6798
Square Root Mean Residual (SRMR)	0.0824	0.0644
Chi-square	2749.2965	1611.8901
Chi-square DF	1324	701
Chi-square / df ration	2.076	2.299
Pr > Chi-square	<.0001	<.0001
RMSEA Estimate	0.0714	0.0785
RMSEA 90% Lower Confidence Limit	0.0677	0.0734
RMSEA 90% Upper Confidence Limit	0.0752	0.0835
Bentler's Comparative Fit Index (CFI)	0.7406	0.7850
Bentler & Bonett's (1980) Non-normed Fixed Index (NNFI)	0.7300	0.7727
Bentler & Bonett's (1980) (NFI)	0.6000	0.6762

TABLE 10

FINAL ITEMS PER FACTOR

Internal Locus of Control		External Locus of Control
Factor 1: Perceived Behaviour	**Factor 2: Safety Attitude**	**Factor 3: External Locus of Control**
Q1	Q21	Q4
Q2	Q24	Q12
Q5	Q27	Q26
Q6	Q28	Q32
Q8	Q30	Q36
Q10	Q33	Q44
Q15	Q40	Q45
Q16	Q42	Q58
Q17	Q43	Q64
Q19	Q46	Q66
Q23	Q47	Q69
Q25	Q49	Q70
Q53	Q51	
Q68	Q52	
Q71	Q55	
Q73	Q57	
Q77	Q59	
	Q60	
	Q61	
	Q62	
	Q72	
	Q75	

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APPENDIX A: LETTER OF CONSENT FOR DATA USAGE

Faculty: Economic and Management Sciences, University of Pretoria

Researcher: Maritza Windbacher
Contact Details: 082 567 6774, E-Mail: Maritza@rb-solutions.co.za

RE: CONSENT TO PARTICIPATE IN THE RESEARCH PROJECT

The intent of this letter is to explain the purpose and procedure of this study. It is also a consent agreement between the researcher and the respondent (You). It protects your rights as a person participating in the research with the following title:

Determining the Construct validity of the Safety Survey Instrument

The purpose of this study is to determine whether the Safety Survey Instrument measures the dimensions it set out to measure and if it is a valid measurement of employee's safety risk profile. Your willingness to participate in this research study is greatly appreciated.

Your will be given a survey with 80 questions. The questions will be about different feelings and hypothetical situations. Although the survey is relatively easy to complete, please answer it as truthfully as you can. The survey will take approximately 45 min to complete.

The data collected from the survey will be used to compile a report to Management to improve the Safety Conditions on the Mine and to suggest immediate training interventions.

The information obtained from the survey **will not at any given time** be used against you or endanger your job.

Please sign below if you are willing to participate in this research study.

Name:____

*Signature:*______________________________ *Date:* ________________

Thank you for your participation, time and commitment to contribute to this study.

April 2008

Faculty: Economic and Management Sciences
University of Pretoria
Pretoria
0001

Dear Sir / Madam

RE: **LETTER OF CONSENT: PROPOSED RESEARCH AT AQUARIUS KROONDAL PLATINUM MINE FOR FURTHER EDUCATION AND TRAINING**

Aquarius Kroondal Platinum Mine herewith consents to the proposed research, as partial completion of Maritza Windbacher's studies at the University of Pretoria. Aquarius Kroondal Platinum Mine acknowledges that the proposed research relates to her Masters Degree in Human Resource Management and will consist of a Survey Questionnaire that will be completed on a voluntary basis by staff members. Aquarius Kroondal Platinum Mine grants authorization for the use of the above information for this purpose, with the full understanding that this will not be to the detriment of the Mine.

Should any additional information be required in this regard, please do not hesitate to contact Mr Rudi Rudolph at the following numbers:

- Office: (014) 536 4504
- Cell: 083 455 1609

I hope this information will suffice.

Yours sincerely

Rudi Rudolph
General Manager
Aquarius Kroondal Mine

APPENDIX B: SAFETY SURVEY INSTRUMENT

EMPLOYEE SAFETY SURVEY

The purpose of this survey is to check your attitude and opinion of safety issues - your answers to this survey will be treated as confidential.

Please read each statement carefully. You need to mark **only** one block next to each statement with an **X** with what you either strongly disagree (1), disagree (2), are neutral (3), agree (4) or strongly agree (5) with. Be honest in your answers and be sure to answer all 80 questions - do not skip any items.

Please contact the administrator if there is anything you do not understand or need help with.

There are **80** questions in this survey.

	Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1	I have read and understand the instructions and I will answer each statement the best I can					
2	I believe I understand all the legal and safety issues that are part of my job responsibilities					
3	It is important to me to have a good time no matter what or how much it costs					
4	I believe getting injured or hurt is because of bad luck, fate, destiny or chance					
5	I believe that most accidents that happen at work can be avoided					
6	I believe I reach and complete all legal and safety requirements of my job everyday					
7	I feel quite strongly about what is right and what is wrong					
8	I believe safety is just as important as production					
9	I try to keep away from situations where someone else tells me what to do					
10	I believe that the quality of my work is important to the overall success of the business					
11	I believe production targets can be overlooked or ignored for safety matters					
12	To a big extent my life is controlled and determined by accidental happenings or activities					
13	I become nervous when thinking about things that may or can happen at work					
14	I often find myself experiencing new and exciting feelings even if they are dangerous					
15	I believe I can handle most situations					
16	I believe that obeying and following work standards and procedures will keep up safety regulations					
17	I believe accidents can be avoided if regulations and rules are followed					
18	I choose to take risks in life					
19	I will always follow and stick to company rules and regulations					
20	I feel comfortable in being able to handle the work pressure and stress related to my job					

	Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
21	I believe that standard operating procedures in my company are practical and easy to use in the workplace					
22	I would not try something dangerous just for the fun of it					
23	I do not let my troubles control my mood					
24	I am careful and try to avoid dangerous situations					
25	I believe that following safety procedures will support production					
26	There is no chance of protecting myself from bad luck					
27	I believe that my company does a lot in terms of safety matters					
28	I believe that I can control my anger					
29	I have too much on my mind and find it hard to sleep at night					
30	I believe my company holds safety as importantly as production					
31	I believe that in some jobs accidents cannot be avoided because of the danger level of the job					
32	I believe that when accidents happen, it is generally because of bad luck					
33	I believe that everybody sees safe working practices as important					
34	I enjoy doing things that gets attention from other people					
35	When I get upset, I find it difficult to get over it					
36	I believe my company has double standards when it comes to safety - they say one thing and then do another					
37	People like me enjoy getting involved in activities with other adventurous people					
38	I believe that everyone working with me worry about safety matters					
39	I have been tempted to break some rules if I felt they were a bit harsh or strict					
40	I believe our company places safety first before anything else					
41	People are involved in accidents because they are not concentrating on what they are doing					
42	I believe all levels of management lead by example (do what they say) when it comes to safety					
43	I believe our company follow and meet safety laws and regulations; i.e. the MHS Act					

	Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
44	Bad luck leads to most people getting injured or hurt at work					
45	I believe it is not possible to prevent accidents at work					
46	I believe we (the company) live and have the right attitude towards safety					
47	I believe that on-the-job injuries or accidents can be avoided by following procedures and sticking to regulations					
48	Most people will never be involved in work related accidents or injuries					
49	I believe executives (top management) are serious about safety					
50	Little things upset me greatly					
51	I see myself as being someone who thinks things through before doing something					
52	I believe that my manager is serious about safety					
53	I do not loose my temper easily					
54	I am tense because of work related stress					
55	I believe supervisors in my company are serious about safety					
56	I tend to worry about getting injured or hurt at work					
57	I believe that I am serious about safety					
58	I believe that the chances of accidents happening are mostly because of bad luck					
59	I believe general workers are serious about safety					
60	I take personal responsibility for adhering to safety rules and practices					
61	I like to get a good idea of what the safety rules and regulations are before working in an area					
62	I believe that people like myself will try to stay out of trouble					
63	I have too much to deal with which leaves me feeling worn out					
64	It is largely a matter of chance or luck whether I get injured or am involved in an accident					
65	When I am angry, I become physically aggressive					
66	I believe in not planning too far ahead because many things turn out to be a case of good or bad luck					

	Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
67	I believe that production always comes first regardless of safety rules					
68	I am an energetic person who will be able to handle everyday problems easily					
69	I believe it is not possible to avoid accidents all the time					
70	I believe that whether or not I get into an accident or become injured depends on my luck					
71	I try not to put myself in situations where I could be hurt by someone else's mistakes					
72	It is important to me to work according to specific set standards					
73	I prefer to avoid situations where I might be at risk of getting injured or hurt					
74	I am someone who will try to make fewer mistakes than others					
75	There are many situations where I double check my work before I feel comfortable to continue					
76	I try to avoid having other people ask me to redo my work due to bad quality control					
77	I always try to improve my skills and abilities					
78	Some problems are so small that it is not necessary to take action to make them right					
79	I believe that most accidents happen because people are overworked					
80	People are not interested in making sure that back up plans are in place for safety reasons					

Demographic details

Finally, we would like you to share some basic biographical information with us, so that we can study trends within the group.

Please place a cross next to the relevant box below. Cross only **one** box per question.

1. What is your hierarchical level in the organisation?

	Junior management level / Supervisory level		Technician / Qualified Tradesman		Other
	Team Leader		Assistant / Attendant		

2. Your Job Title?

3. Your Job Grade?

	Cat 3 - 8		B4 – B6		C1 – C2
	B1 – B3		B7		Other

4. Your years of working experience?

	Less than 1 year		1 - 2 years		2 - 5 years
	5 - 10 years		More than 10 years		

5. What is your gender?

	Male
	Female

6. What is your race?

	Asian		Coloured
	Black		White

7. What is your age group?

	Younger than 20		21 - 30		31 - 40
	41 - 50		Over 50		

8. What is your highest qualification?

	ABET 1 - 3		NQF 2		NQF 4
	ABET 4 / NQF 1		NQF 3		No Qualification

9. How many hours per day do you spend underground?

	0 hours p/d		4 - 6 hours p/d
	1 - 3 hours p/d		More than 6 hours p/d

Thank you for taking the time to complete this questionnaire.

Please return your completed questionnaire.