Explanatory Model of Antecedents and Outcomes of Health and Safety Climate in the South African Construction Industry

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PLAGIARISM DECLARATION

I, Chao Feramo Nkhungulu, declare that, except where noted, the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the University of Cape Town. All references used are acknowledged in accordance with the American Psychological Association referencing format.

Signature:.. **Date:.......................................**

Chao Feramo Nkhungulu

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"I look at an ant, and I see myself: a native African endowed
by nature with strength much greater than my size so I might cope…"

uMama Miriam Makeba

Chao – Ine, Chiwalo jikha!
Ake! Ake! Kia Kaha E!

ACRONYMS AND ABBREVIATIONS

ACSNI	Advisory Committee on Safety of Nuclear Installations
AVE	average variance explained
CB	citizenship behaviour
CFA	confirmatory factor analysis
CIDB	Construction Industry Development Board
DoL	Department of Labour
DV	dependent variable
EFA	exploratory factor analysis
EU	European Union
FEMA	Federated Employers' Mutual Assistance
FIFA	Federation of International Football Associations
H&S	health and safety
HSCO	health and safety communication
HSE	health and safety executive
HRM	human resource management
HSIR	health and safety individual responsibility
HSMO	health and safety motivation
HSPF	health and safety performance
HSPFA	health and safety performance Active
IAEA	International Atomic Energy Agency
IES	Inspection and Enforcement Services
INJU	injuries
IREP	incident reporting

KMO	Kaiser-Meyer Olkin
MBASA	Master Builders Association South Africa
MCAR	missing completely at random
MGCO	management commitment
MSYS	management systems
MVA	missing value analysis
HSAB	H&S avoidance behaviour
OC	organisational culture
OECD	Organisation for Economic Cooperation and Development
OHS	occupational health and safety
PLS	partial least squares
PAF	principal axis factor
PCA	principal component analysis
PPE	personal protective equipment
SADC	Southern African Development Community
SD	standard deviation
SEM	structural equation modelling
SHSLE	supervisory health and safety expectations
SPSS	Statistical Package for Social Sciences
SSA	sub-Saharan Africa
StatsSA	Statistics South Africa
TMO	temporal multipurpose organisations
TRNG	training
TSC	total safety culture
UCT	University of Cape Town

UK	United Kingdom
WDNG	work environment danger
WLHS	workload health and safety

ABSTRACT

Workplace injuries and fatalities are a major cause of concern for government and organisations in South Africa. The cost incurred by government as compensation for injuries that occur in the workplace has increased steadily over the past 10 years. This has raised the need for alternative approaches to dealing with causes of workplace injuries and fatalities. The loss of employees due to workplace fatalities and the cost of medical care have both direct and indirect cost implications for organisations. The cost of hiring replacement labour while the injured employee is on leave, the cost of training a new employee, paying for medical care for the original employee, and reduced productivity due to lack of experience of the incoming replacement are financially draining and detrimental to the functions of organisations.

The primary objective of the study being reported here was to develop an explanatory model of the health and safety (H&S) climate in the local construction industry. A secondary objective was to provide a theoretical and practical framework for the study of the health and safety climate in the South African construction industry. A literature review, observations and structured interviews informed the development of a survey questionnaire. The survey was completed by construction workers who were members of the Master Builders Association South Africa (MBASA) in the Western Cape. On-site observations and structured interviews by the researcher informed the development of a pen-and-paper survey, which was completed by construction workers at selected building sites from organisations who were members of MBASA. A pilot study was conducted for refinement of the survey measurement tool. Hypotheses were tested using regression analysis techniques.

Partial least squares path analysis was used to test the structure of the proposed model. In total, 1 200 surveys were administered, and a total of 851 participants completed the survey.

This study provided empirical evidence of the link between antecedents of the health and safety climate and health and safety performance. Overall, the proposed health and safety model showed significant predictive ability for health and safety incident reporting (R^2 = .464, p = <.001), health and safety motivation (R^2 = .450, p = <.001) and health and safety performance (R^2 = .508, p = <.001). Path analysis found a predictive ability of health and safety performance to injuries (R^2 = .028, p = <.001). The findings provided evidence-based support for the variables of top management's commitment to health and safety and health and safety communications and the predictive ability of these on positive health and safety behaviour. Predicting injuries in the construction industry can help to reduce the high costs of compensation and make employees in the sector safer. Insights gained from this study will contribute to the field of occupational health psychology in particular at both academic and practical level.

Keywords: safety climate, construction industry, health and safety performance, health and safety behaviour

CHAPTER ONE

HEALTH AND SAFETY IN ORGANISATIONS

1.1 INTRODUCTION

Occupational accidents in the construction industry are a major concern for workers, communities, organisations and governments (Ramutloa, 2008a; Takala, 2002). The magnitude of the problem is reflected in the high number of fatal and disabling accidents, which are underreported (Hamalainen, Takala, & Saarela, 2005). According to Haupt and Smallwood (2005), occupational injury and fatality statistics available for South Africa are generally higher than international rates. The current study set out to develop, test and validate a health and safety (H&S) climate model for the South African construction industry by investigating organisational, situational and individual factors that can help predict H&S performance. It is believed that the developed explanatory model of H&S climate will be used to design and develop interventions that can help reduce accidents and fatalities in the South African construction industry.

In 2007, an investigation found that 53% of the 105 construction sites inspected were non-compliant with safety legislation (Hamlyn, 2007). Nevertheless, Van Niftrik, Reijnierse, Bogaard and Lumens (2003) found that occupational health and safety (OHS) issues are not prioritised by organisations in the South African construction industry, despite the costs that are associated with the lack of H&S adherence in the industry sector.

Underreporting of occupational and injury incidents has been noted to underestimate substantially the true magnitude of the incidence of injuries and fatalities in the construction industry (Dong et al., 2011). Workplace fatality and injury data for the sub-Saharan Africa (SSA) region is scarce. Currently, data is based on reporting from Zimbabwe (Takala, 2002) and reports from Ethiopia and Botswana (Hamalainen et al., 2005). For the rest of the continent, available data from Morocco and Kenya (Mbakanya, Onyoyo, Lwako, & Omonde, 1999) indicates the endemic nature of the problems of poor recording and limited availability of data on occupational injuries and fatalities. Even with poor reporting, global occupational injury and fatality records show that established market economies record significantly lower rates than developing countries (Construction Industry Development Board [CIDB], 2009). In short, there is a lack of empirical data, but a persistent sense that there are many accidents and fatalities, with a considerable cost to organisations and governments in terms of medical and human resources.

The lack of empirical data on workplace and injuries creates a paucity of evidence from studies on H&S in this sector (Hamalainen et al., 2005). Current workplace injury and fatality data for the South African labour force, and the construction industry in particular, is obtainable from the Department of Labour (DoL), which provides data on nationwide incidents and fatalities. Private associations and organisations also collect workplace and injury and fatality data, but such data is not widely distributed and therefore not available for research use. Statistics from the DoL offer an indication of the prevalence of workplace injuries and fatalities, but do not give data that is accurate enough to be able to develop interventions that can address the problem in the industry sector.

In a study of five industries that were categorised as having an above average risk for employee injuries, Probst and Estrada (2010) found that there was an average of 2.48 underreported accidents for every accident that was reported. According to Hoonakker and Van Duivenbooden (2010), it is important to have accurate reported fatality and incident data to enable organisations to monitor H&S in the organisation and identify suitable interventions to reduce such events. Further evidence of underreporting injuries in the workplace was found by Psarros, Skjong and Eide (2010), who analysed maritime data in Norway over 10 years and found a disparity of almost 10 cases of injury between two organisations reporting data in this sector. Further evidence of workplace incident underreporting was found by Oleinick and Zaidman (2010), who reported an undercount of between 10% and 16% of workplace incidents.

The construction industry is an important contributor to the South African economy, employing approximately 1 012 000 employees in the formal and informal sectors in June 2012 (CIDB Quarterly Monitor October 2012). This figure represents 8% of the total workforce in South Africa (CIDB Quarterly Monitor October, 2012). This represents a significant contribution to employment in a nation with high unemployment levels. The construction industry is often cited as an indicator of the state of the national economy (James, Rust, & Kingma, 2012), and can be influential in the performance of the country's economy. The construction industry has a global reputation as a high-risk industry sector (Swuste, Frijters, & Guldenmund, 2012). Suraj, Duff and Peckitt (2001) developed a model that reported the complexities of factors and relationships that contribute to H&S at construction sites. The model developed by Suraj et al., (2001) identified causes of accidents on construction sites which included: Increased pressure on work teams; failure to supply safety equipment; allocation of resources; peer pressure to engage in dangerous work practice; employees failure to use standard procedures (p.340 -341). The model identifies various factors at multiple levels of the construction project that contribute to accidents.

The modelling of causal processes of accidents and injuries in the construction industry has been described as “less mature, with previous research confined to the collection, analysis and interpretation of data derived from regulatory accident reporting schemes” (Haslam, Hide, Gibb, Gyi, Pavitt, Atkinson & Duff, 2005, p. 402). This study reported a scenario where data collected is fraught with problems of underreporting, and poor reporting processes. Haslam et al., (2005) further reported limited investigations of a full range of contributory managerial, site and individual factors that contribute to injuries on construction sites (p. 402). The reported challenges were attributed to factors such as the poor risk management procedures; shortcomings with protection equipment and other workplace issues (Haslam, et al., 2005). In a study that investigated multi-causal accident causation in the construction industry Manu, Ankrah, Proverbs and Suresh, (2012) reported construction project features (CPF) that identified the extent of the contribution of CPF’s to accident causation. The study reported causal interactions between proximal factors (e.g. time-pressure; fragmentation of workforce; working at height) and CPF’s (such as nature of project; method of construction; site restriction; project duration; procurement systems; design complexity; level of construction and subcontracting) and how these can be used to manage H&s risks on construction sites. In a study that investigated the link between production processes, teams and H&S, Mitropoulos and Cupido, (2009), reported that the strategies focused on production error prevention influenced the reduction of accidents. The South African construction industry is no different in terms of accident occurrence on construction sites (CIDB, 2009), an examination of factors that can reduce accidents will benefit the industry sector.

The organisational structures that exist in this sector cause H&S management processes to be implemented poorly (Seo, Torabi, Blair, & Ellis, 2004). The fragmented nature of the building and construction industry has led to fragmented H&S policies and procedures being implemented at the different contractor and subcontractor levels, rendering them ineffective and leading to the continued high rate of incidents and fatalities (Lingard & Holmes, 2001; Seo et al., 2005; Spangenberg, 2010).

Although the construction industry in South Africa was the focus of attention leading up to the hosting of the 2010 FIFA soccer world cup, a series of accidents in 2008 attracted widespread negative reporting in the media (Emuze & Smallwood, 2012). The current study presents an opportunity for the development of models that identify factors that can assist in the promotion of H&S and a reduction of injuries. To the researcher's knowledge, no such models have previously been developed in the local South African context.

There is evidence of the various effects of workers' safety in the construction industry arising from fatalities and injuries (Haupt & Smallwood; 2005 Hinze, 2006) as well as worker health (Fourie & Schönteich, 2002). The effect of accidents on productivity, cost structures in the workplace, work schedules and the quality of life for workers has been identified (James et al., 2012). The direct and indirect costs of these accidents are an important financial consideration for an organisation and the society in which it is located.

The general cost of occupational accidents for society is well documented (Ramutloa, 2008a, 2011, 2012a; Smallwood, 1999). Ngai and Tang (1999) identified costs that are associated with loss of production by an injured worker. Some of the easily identifiable and quantifiable costs include medical fees, legal fees and opportunity costs for family members who have to care for the injured worker.

According to Ramutloa (2008b), during the period 2002–2003 there were an estimated 25 000 accidents reported in the construction industry, which averaged 70 accidents per day. In the same period, 150 workers were killed while working in this industry. The moral implications, though hard to quantify, and the economic costs of these incidents and fatalities which result in disruption to work processes, are beyond the compensation scope for the poor state of H&S in this sector.

During the period 2002–2003, the DoL's compensation fund paid R204 million for injuries in the construction sector (Ramutloa, 2008b). For the period 2001–2003, the compensation fund paid R2 335 527 for death and illness benefits. During 2005, the construction industry received claims amounting to R168 million from the DoL. In 2006, the compensation fund paid R201 million in workplace injury and fatality claims to the construction industry, representing 9.1% of the total compensation fund pay-outs to all industries for the period. Although a 3.8% reduction in the total number of accidents was observed during the period 2005–2006, the fatality incident rates during the same period for the construction industry was still high at 130 over 11 months.

A steep increase in the number of workplace injury and fatality claims between the period 2008 to 2011 were observed when the DoL compensation fund paid R2 175 679 138 in 2008; this amount escalated by 5.09 % for the period of 2009 to 2010 when R2 286 410 189 was paid. The period 2010 to 2011 reported an exponential increase in workplace injury and fatality compensation pay-outs of R2 708 203 689, representing an 18.45% jump from the previous period (Ramutloa, 2012b). These increments in workplace injury and fatality compensation pay-outs represent a total increase of 24.48% over a period of four years. The rising compensation costs are worrying not only for the DoL but also for employer organisations that have to deal with costs associated with the loss of experienced skilled workers and the recruitment of new employees, when workers experience injuries that render them absent from work, or even fatalities. The cost of hiring replacement labour and training of new staff has an effect on productivity and work output for construction projects (James, Rust, & Kingman, 2012; Mearns, Hope, Ford, & Tetrick, 2010).

The escalating human and economic costs associated with occupational injuries and fatalities have been the focus of DoL efforts to reduce the high incidence of workplace accidents (Ramutloa, 2011, 2012b). The DoL rates the construction industry amongst the high-risk sectors that receive compensation from the DoL's compensation fund for workplace injuries and fatalities. According to Ramutloa (2012a), there has been an alarming increase in compensation payments to service providers over the past five years.

According to Mearns et al. (2010), studies conducted on several continents have found that the low level of a standardised work environment in the construction sector creates a work culture that is averse to rules and procedures. Further reporting of low emphasis on decision-making, planning and executing safety in the construction sector have been recorded (Lingard & Rowlinson, 1998). The challenges of H&S in the construction industry are often attributed to the dynamic nature of the industry sector. Each product has its own unique design, planning, environmental context and different labour intensity, which all contribute to a unique final product. The geographic and structural distances of each project result in a gap between H&S as perceived by the main contractor organisation and the subcontractors that are working on each site. The problem of escalating injuries and fatalities in the construction sector requires empirical investigation to identify which organisational and individual factors can predict H&S performance and reduce the incidence of costly accidents.

Response:

Major comment 1:
The conceptual model has been revised and is presented on page 4 of the schedule of corrections. This model clarifies the antecedents and outcomes of H&S climate with an explanation presented on pages 2 - 3 of this schedule. The revision is on pages 8 – 11 of the thesis. The revised section is presented below:

According to Zohar (2008), assessing safety climate using shared perceptions about safety policies, procedures and practices in an organisation requires that a distinction be made between formal policies and procedures and the practices and the enactment of these by management (p.376). This view implies that perceptions about safety climate will relate to how policy is interpreted rather than how it is formulated by the different levels of employees. This means that for safety at construction sites, the site manager might expect workers to ignore formulated policies due to project deadline pressures ignoring the regulated requirement. This is consistent with an earlier study (Zohar & Luria, 2005) which reported the role of individual line management who ignored safety rules in favour of production speed. Taking this into consideration, safety climate in this study was considered to include variables such as management commitment, supervision, safety systems, work pressure, competence (training) identified in a meta-analysis on safety climate (Flin, Mearns, O'Connor & Bryden, 2000). Although the major themes identified in the Flin et al., (2000) study were reported as common variables, they acknowledged that variation may arise in respect to what is emphasised depending on the industry sector (Flin et al., 2000). In a multi-level study of the Australian construction industry, Lingard, Cooke and Blismas, (2010) reported safety climate as the shared perceptions that inform employees behaviour. These perceptions are based on expectations that are determined by how behaviour is rewarded or supported in the organisation (Lingard et al., 2010). In a Hong Kong construction site study that investigated worker perceptions (of their teams, management, supervisors and safety personnel), Siu, Phillips and Leung (2004) reported significant correlations between safety climate variables (management, supervisor, colleagues and the individual worker) with communication (.66) and job satisfaction (.43); with 17% of workers self-reported injuries that did not require medical attention in the past six months. Siu et al., (2004) study reported significant findings that established a causal link between worker perceptions of safety climate variables and self-reported injuries.

The current study conceptualised organisational level variables of H&S climate as management commitment, supervisory leadership and H&S management systems. H&S management systems included variables such as H&S communication and H&S training. Other variables used in this study assessed individual aspects of safety climate. Individual factors included H&S motivation, and H&S incident reporting. This study set out to measure worker perceptions of safety climate at the individual level that was aggregated to the entire workforce. Although previous studies such as Lingard et al., (2010) and Zohar and Luria (2005) have investigated group level safety climate models (in countries where the phenomena has been previously studied), this study focused on establishing the construct in the local context and examining the relationships between safety climate and injuries in the South African construction industry. In this regard, the conceptualised H&S climate relationships are illustrated in Figure 1.

A previous study identified a set of safety climate indicators such as training, workload, management attitudes, individual attitudes, local work practices and supervision (IAEA, 1991). Similarly, the British Advisory Committee on human factors in nuclear safety identified senior management commitment, communication pressure for production, and training amongst others as indicators of safety climate. Flin et al., (2000 p. 179) reported that there was “very limited evidence for or against a common set of core features of safety climate”. Flin et al., (2000) suggested that a basic set of features were emerging from literature on the construct and that a base taxonomy of safety climate attributes could be extracted from the scales and items being used to measure the construct. In this regard, a set of emergent themes were proposed based on a meta-analysis of literature which included management, supervision, safety systems, work pressure, competence and risk. With this in mind, the researcher for this study selected themes commonly identified in the reviewed literature to investigate the construct of safety climate in the South African work environment. The researcher was not able to identify any studies that investigated safety climate in the South African environment. Seeing that no known studies have investigated H&S climate emergent themes in South Africa, this creates an opportunity for the current study to generate knowledge in this field.

Considering that safety climate provides a snapshot of the state of safety providing an indicator of the safety climate of an organisation (Flin et al., 2000, p178), the researcher for this study considered safety climate variables from different sources to determine variables to include in the proposed model illustrated in Figure 1.

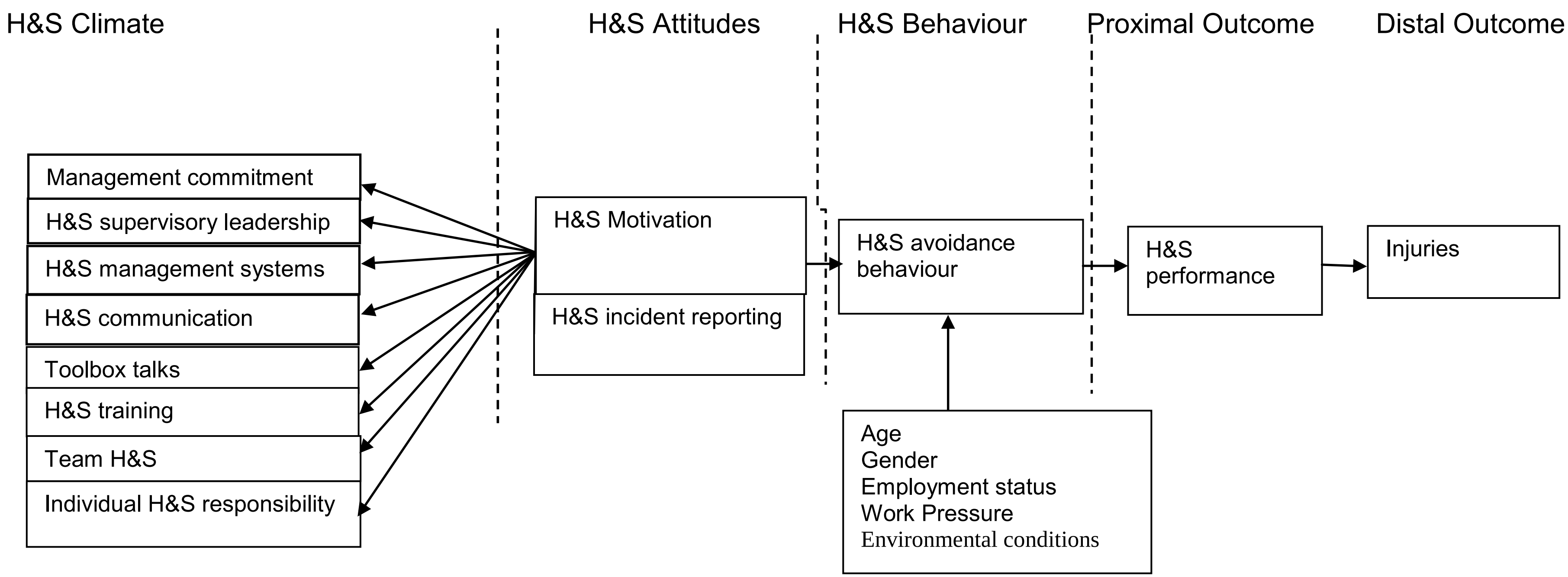

Figure 1. Proposed model of H&S climate.

The current study set out to determine if the organisational variables would predict H&S performance, which in turn would predict the incidence of injuries. The study proposed that H&S prediction in the South African construction industry requires an integration of organisational, individual and contextual variables to determine the reduction of H&S incidents.

1.2 THE IMPORTANCE OF H&S IN ORGANISATIONS

Having identified the high levels of injuries and fatalities in the construction industry in South Africa, the importance of identifying organisational and individual factors that can help reduce the occurrence of such incidents is highlighted. The challenge for construction industry sector organisations is to identify factors that can assist in addressing this problem and the important question of influencing H&S in this sector. Health and safety considerations have to consider the dynamic and mobile nature of work and of workers in this sector, and ensure that differences that arise in H&S perceptions due to this fragmentation are reflected in proposed interventions. This will enable organisations to address H&S issues in a holistic manner in an industry that offers challenges in work environment and team composition consistency.

1.2.1 Benefits of health and safety interventions in the workplace

The benefits of effective H&S management for organisations are reduced injury and fatality rates, which are associated with human resource outcomes such as reduced absenteeism and reduced healthcare costs (Mearns et al., 2010). Reduced health claims, inpatient and outpatient hospital costs, absenteeism and life insurance costs have been reported as benefits of H&S interventions (Forrester, Weaver, Brown, Phillips, & Hilyer, 1996). The emphasis on the economic benefits of H&S

management and interventions is warranted given the escalating compensation costs that arise from workplace injuries and illnesses. The reduction of workplace incidents becomes an organisation's human resource strategic decision in order to reduce associated direct and indirect costs. In the South African workplace, the commitment to reducing injuries and fatalities in the workplace resulted in 2002 in the Department of Labour’s signed accord on occupational health (Ramutloa, 2009), which reinforced the collaborative effort between government and businesses. This accord also promotes the training of both workers and managers in safe work practices and procedures (Ramutloa, 2009).

There is a need for H&S climate research in the South African context to investigate the phenomenon in a manner that will enable organisations to have empirical evidence to use for identifying and examining the implications of investing in H&S for employees, the organisation and broader community to reduce the negative effect of workplace injuries and fatalities. The current study drew on safety climate theory to investigate factors that affect H&S performance in the South African construction industry. In a region where resources are scarce, the cost of neglecting H&S in the workplace places an extra burden on governments and other organisations who are faced with escalating compensation and healthcare costs that can arise from workplace injuries and illness besides other pressing social health issues that are prevalent in the local environment (James et al., 2012). Figure 1 presented below illustrates the proposed model which is discussed in detail in Chapter Four. For this study, the theorised relationships under investigation are presented in the comprehensive conceptual model in Figure 1, where H&S climate is manifested in the organisational and individual factors that inform an employee's

H&S avoidance behaviour which determines the H&S performance of the organisation and reduces the incidence of injuries.

1.3 RESEARCH OBJECTIVES

Given the background discussed above the current study set out to describe factors identified in the H&S climate literature. The primary objective of this study was to develop an explanatory model of H&S climate in the South African construction industry. The study investigated organisational variables as predictors of individual H&S behaviour and proposed that individual behaviour will predict H&S performance of the organisation, which can determine the incidence of injuries in the workplace. This approach allowed a holistic examination of organisational, individual and contextual factors that can reliably predict H&S performance and injuries in the local construction industry.

A further objective of the study was to examine perceptions of construction workers in the South African context on H&S climate. The investigation of these factors was conducted using organisational variables of management commitment, H&S management systems in organisations and individual variables to determine perceptions of H&S climate in their work environments. Figure 1 presented below illustrates the proposed model which is discussed in detail in chapter four. For this study, the theorised relationships under investigation are presented in the comprehensive conceptual model in Figure 1 where H&S climate is manifested in the organisational and individual factors that inform an employee's H&S avoidance behaviour which determine the H&S performance of the organisation and reduce the incidence of injuries.

1.4 OUTLINE OF THE THESIS

The following logical framework explains the format of the dissertation. Chapter One introduced the study and highlighted its importance and scope. Chapter Two provides a review of the literature on the safety climate construct. Chapter Three presents the context of the local construction industry in South Africa. Chapter Four presents the proposed H&S climate explanatory model and the theory that informed the selection of variables to be included in the model. Chapter Five presents the research design and discusses the data collection methods, measurement tools and data analysis techniques used. Chapter Six presents the findings of the study. Chapter Seven presents a discussion of the findings, noting their contribution to knowledge in the study field, and the theoretical and practical recommendations emerging from this thesis.

CHAPTER TWO

SAFETY CLIMATE

2.1 INTRODUCTION

This chapter presents a review of literature on safety climate constructs. The review of literature was a precursor to the development of determinants of health and safety (H&S) behaviour and the dimensions of the safety climate explanatory model in the South African construction industry. The first section presents the evolution of the construct of safety climate, locating it in organisational culture discourse and linking the construct to other constructs in this field. The second section discusses the safety culture construct, a precursor of the safety climate construct, and presents models of the safety construct. The third section presents a definition and models of safety climate.

A search of peer-reviewed literature was undertaken to identify studies of safety climate. The review used an evolving process of using relevant keywords to search different online databases and platforms at the University of Cape Town (UCT). Data sources such as Elsevier, Emerald, EBSCO host, Psych Info, Sabinet and ProQuest were used as the main sources of articles for review. The review of literature in academic databases and platforms was focused on peer-reviewed articles that identified safety climate dimensions in various industries and country contexts. Keywords used were iterations of the following combinations: 'organisational culture', 'organisational climate', 'safety culture', 'safety climate', 'safety behaviour' and 'safety performance'. These keywords were combined with organisational and structural factors such as leadership, training, communication, work pressure, teamwork, motivation and management commitment. Outcomes from initial reviews of literature were used to refine the search further. The common themes that were identified through the review of literature were used in further searches of safety climate variables.

2.2 DEVELOPMENT OF THE SAFETY CLIMATE CONSTRUCT

To determine the origins of the safety climate construct, it is important to trace the roots of the construct. Safety climate has been reported to be embedded in the study of organisational culture, which was a precursor to the safety culture construct. This section presents a discussion of organisational culture as the conceptual precursor to safety culture and safety climate.

2.2.1 Organisational culture

Choudhry, Fang, and Mohamed (2007) noted that any discussion of safety culture without a reference to organisational culture (OC) is incomplete because such a discussion omits the origins of the construct. Several studies have linked the concept of safety culture to organisational culture (Cooper, 2000; Gadd & Collins, 2002; Guldenmund, 2000; Hale & Hoven, 1998; Mearns, Flin, Gordon, & Fleming 2001). Schein (1989, p. 6) defined organisational culture as "… deeper level of basic assumptions and beliefs that are shared by members of an organisation, that operate unconsciously, and that define in a basic taken for granted fashion an organisations view of itself and its environment …" Taking into consideration the common meanings that relate to organisational culture, Schein (1989) attributed the description of culture to factors such as observed behavioural regularities, the philosophy that guides the organisation and the rules of the game for getting along in the organisation. These assumptions and beliefs become ingrained in organisations' thinking, are taken for granted and become reliable problem-solving practices. While the above factors hold true for OC, Schein (2010) described the concept as an abstract construct; therefore, factors that exist in the social and organisational context are powerful and influence the actions of the members of the group in these contexts. OC is described as consisting of shared values, symbols, beliefs and actions, which guide individual decisions and behaviour, and influence how workers act unconsciously, which impacts on the organisation's wellbeing and success. Hartnell, Ou and Kinicki (2011) reported that the implications of OC on performance are influenced by factors that also include competing values such as work speed in organisations. According to Black (2003), the different accidents that occur in the workplace indicate that the importance of safety is informed by commonly held interpretations and shared experiences among the workforce, within the organisations and also within the specific industry sector. Such interpretations and experiences guide the work operation’s efficacy in reducing incidents.

Over the years, the construct of OC has been described and defined with varying aspects all rooted in the definition provided by Schein (1989). In a study of public sector organisations, Parker and Bradley (2000) presented an argument for the role of OC in influencing worker actions and behaviour. These authors reported a strong case for the influence of a particular culture on worker behaviour. Organisational culture is reflected at the psychological level and in the dynamic reciprocal relationships between members. These relationships inform the perceptions of and attitudes towards the implementation of organisational goals. The behavioural aspect of culture is reflected in the goal-directed behaviour of employees in response to existing organisation systems and subsystems that direct and support desired employee behaviour (Schein, 1992, 2010). Situational factors are represented in an organisation by rules and procedures that manage and maintain work systems that are designed to enhance goal-directed behaviour. An earlier study by Reason (1998, p. 293) found that OC does not emerge ready-made in organisations, but it is a "gradual process of adapting to local conditions, previous events and character of leadership and mood of the workforce".

Table 2.1

Definitions of Organisational Culture 1982–1995

Author	Definition
Schein, 1992	deeper level of basic assumptions and beliefs that are shared by members of an organisation, that operate unconsciously, and that define in a basic taken for granted fashion an organisation's view of itself and its environment
Choudhry et al., 2007	socially transmitted behaviour patterns, arts, beliefs and other products of human work
Cooper, 2000	shared beliefs, attitudes and values regarding organisational goals, functions and procedures

Note: selected definitions of organisational culture.

Organisational culture has been defined as the "perceptions that employees have and how these perceptions create patterns of beliefs, values and expectations" (Gibson, Ivancevich, & Donnelly, 1997). The concept of organisational culture has several definitions but has been described as behaviour patterns and beliefs that are shared by employees in the work place and influence their behaviour towards H&S (Choudhry et al., 2007). Organisational culture is a multidimensional construct defined as “a pattern of shared basic assumptions that a group has learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems.” (Schein, 1992, p.12). Organisational culture is reported to manifest at three levels: (a) cultural artifacts which refer to worker behavioral patterns, visual items as well as technological aspects of the organization; (b) values which are present in the environment and are tested by organisation member consensus; and (c) basic assumptions, including mental models and shared meanings. Organisational culture is reported to influence group norms, espoused values and climate (Schein, 1992).

2.2.2 Organisational climate

The construct of organisational climate is also referred to as 'corporate climate', and is derived from the OC construct. Organisational climate is considered as the process by which the culture of an organisation can be quantified. Organisational climate is described as employees' direct or indirect perceptions of the work environment properties, which influence their work behaviour. The original definition of organisational climate by Schein (1992) referred to the more variable aspects of organisational practice that influence behaviour of employees. According to Denison (1996, p. 624), organisational climate is a "… portrayal of organisational environments which are rooted in the organisation's value system". Further clarification of the definition is provided when climate is explained as being "often considered largely limited to those aspects of the social environment that are consciously perceived by the organisation members" (Denison, 1996).

Glendon and Stanton (2000) reported an overlap between organisational culture and organisational climate, where the former is in reference to organisational levels as per Schein (1992), and then later is seen as a more superficial concept.

Organisational climate is considered as a multidimensional construct that encompasses a range of individual evaluations of the work environment (Neal et al., 2000, p.100). Workers develop perceptions of organisational climate as they attribute meaning to the organisational context based on the significance of the environment (Neal et al., 2000). Organisational climate has been reported to exert a strong impact on worker motivation to achieve work outcomes and influences knowledge and skills by increasing participation in activities such as training. Safety climate is reported as a specific form of organisational climate that describes individual perceptions of the value of safety in the work environment (Cooper, 2000; Neal et al., 2000). The most popular measurement method for organisational climate has been the use of questionnaires to measure employee perceptions at a particular time. Taking this into consideration, organisational climate is considered as relatively temporary, subject to direct control, and largely limited to those aspects of the work environment that are consciously perceived by the workers in relation to health and safety.

Work environment factors have been reported (Cotton & Hart, 2003) as dimensions that include supportive leadership, role clarity, participative decision-making, co-worker interaction, appraisal and feedback, employee development, goal alignment, work demands, workgroup morale and workgroup distress, with further items developed, which included factors such as climate for customer service and safety climate (Neal, Griffin, & Hart, 2000). A problem with the dimensions of the organisational climate construct was that different organisational aspects emerged with each study that investigated the concept. The emergent dimensions were dependent on the approaches taken by the researchers, thus resulting in a wide range of scales exhibiting different item configurations (Wilderom, Glunk, & Maslowski, 2000).

Other studies have described organisational climate as a subset of OC because organisational climate is reflected and manifested in employees' assumptions about the organisations (Gadd & Collins, 2002; West, Smith, Lu Feng, & Lawthorn, 1998). The concept of organisational climate is perceived as a variable that is easy to change, whereas organisational culture is more stable and sturdy (Gadd & Collins, 2002; Glendon & Stanton, 2000). According to the above studies, the organisational culture concept is reported to be present in an organisation and it informs the emergence of the safety culture construct.

2.2.3 Safety culture

Definitions of safety culture have been consistent with the 'parent' construct of organisational culture where employee perceptions regarding safety were described as products of individual and group values, attitudes, perceptions, competencies and patterns of behaviour, which determine the commitment to and the style and proficiency of an organisation's H&S management, indicating a safety culture (Choudhry et al., 2007; Guldenmund, 2000). According to Guldenmund (2000), and Ostrom, Wilhelmsen and Kaplan (1993), the construct of safety culture has been developed over a long period, from the early 1930s to the current definitions. Ostrom et al. (p. 163) defined safety culture as "an organisation's beliefs, and attitudes manifested in actions, policies and procedures that impact on the organisation’s safety performance". Other studies (Gadd & Collins, 2002; Guldenmund, 2000) defined safety culture as the outcome of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to safety management in an organisation. The report on the Chernobyl disaster (International Atomic Energy Agency [IAEA], 1986) promotes and publicises the official use of safety culture to explain organisational errors that were responsible for the Chernobyl accident. Studies following that refer to either a positive or negative safety culture as being characterised by the shared perceptions of safety in an organisation, and state that these perceptions are reinforced through organisation, individual and group interactions (Choudhry et al., 2007; Parker, Lawrie, & Hudson, 2006; Pidgeon, 1991; Reason, 1997).

These organisational dimensions were found to interact in terms of safety in the organisation, and to inform the safety culture that is established in the workplace. Safety culture is also described as the embodiment of a set of principles that define what an organisation considers important in terms of safety (Glendon, Clarke, & McKenna 2006). The concept of safety culture is considered essential for the construction industry, considering the notorious reputation of poor safety in the sector. The organisation's safety culture is reported (Choudhry et al., 2007) to influence the way in which leadership will allocate resources, and it also determines how effective safety management resources, policies, procedures and practices are implemented and manifested in the workplace. Safety culture therefore represents the underlying perceptions, attitudes and actions of workers at different organisation levels (Choudhry et al., 2007).

From the definitions cited above, the researcher observed that definitions of safety culture are viewed from three different levels of organisational structural processes and individual behaviour. The different definitions of safety culture presented above suggest that norms in the organisation will translate into safety behaviour, creating both formal and informal accepted actions of safety behaviour. The concept of safety culture has received considerable attention, and represents an important widening of theoretical perspectives in research regarding injury prevention. Several studies have identified aspects of organisations' systems to contextualise the concept of safety culture (Grote & Kunzler, 2000; Mohamed, 2000; Thompson, Hilton, & Witt, 1998). Glendon and Stanton (1998) used Schein's (1992) three-level model, which identifies aspects of core underlying assumptions, namely espoused beliefs and values, behaviours and artefacts to determine safety culture in organisations. Similar models developed by Guldenmund (2000) and Furnam and Gunter (1993) explored Schein's (1992) model, but did not account for the dynamic nature of safety culture. The most important and generally accepted definitions of safety culture are presented in Table 2.2.

In previous studies (Guldenmund, 2000), the distinction between safety culture and safety climate as two separate concepts is not explicit, and the constructs are sometimes used interchangeably. The use of 'safety culture' and 'safety climate' synonymously and interchangeably has led to confusion and misunderstanding amongst both safety practitioners and researchers (Schneider, 1990). Pidgeon (1995) pointed out that the search for 'safety culture' has been reduced to the measurement of individual attitudes and practices within a hazardous work context that more closely matches the concept of 'safety climate'. A debate on the nature, validity and applicability of the concepts still persists. Although no consensus has been reached on the cause, content or consequences of safety culture (Guldenmund, 2000), safety culture is considered to represent a proactive approach to safety in organisations. From the review of literature above, it can be deduced that 'safety culture' tends to focus on the deeper and less readily accessible core values and assumptions of the organisation regarding safety and human resources (Mearns & Flin, 1999). Whereas 'safety climate' refers to the perceptions of organisational and individual factors that are, variable and which can be influenced by both internal organisational events and external factors.

Table 2.2

Definitions of Safety Culture

Author	Definition
Guldenmund, 2000	Safety culture concerns the underlying beliefs and convictions of those attitudes, that is, the prevailing values of the social group. Safety climate refers to the attitudes towards safety within an organisation
Reason, 1997	The engine that continues to propel the system towards the goal of maximum safety, regardless of the leadership's personality or current commercial concerns.
Cooper, 2000	Product of multiple goal-oriented interactions between people (psychological), jobs (behavioural) and the organisation (situational)
Mohamed, 2004	Safety culture is concerned with the ability to manage safety at the organisational level in a top-down manner including measureable aspects such as management commitment, communication, policies and procedures
Moghaddam, 1998	… having strong links to social norms in the organisation … a normative system that prescribes how one should behave in given contexts
Cox, Tomas, Cheyne and Oliver, 1998	The emergence of safety culture becomes a reflection of the structure and operation of the established H&S systems that reflect the organisation's values and beliefs towards H&S
Turner, Pidgeon, Blockley and Toft, 1989	The set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimising the exposure of employees, managers, customers, and members of the public to conditions considered dangerous or injurious
International Nuclear Safety Advisory Group (1991)	That assembly of characteristics and attitudes in organisations and individuals that establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance
Cullen, 1990	Corporate atmosphere in which safety is understood to be and is accepted as the number one priority
Confederation of British Industry [CBI] (1991)	The ideas and beliefs that all members of the organisation share about risk, accidents and ill health
UK Health and Safety Commission (1993)	The product of individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to and the style and proficiency of an organisation's safety programmes

The above definitions, though measuring one concept, adopt differing approaches to measure the construct. The CBI (1991) and the UK H&S Commission (1993) measured safety culture as a measure of employee perceptions focusing on values, beliefs, and attitudes. The described definitions indicate an emerging consideration of safety culture as a construct that emerged with a specific focus on safety management at organisational level, i.e. establishing systems and structures for managing workers' safety practices. Several models of safety culture have emerged over the years. These models have all been based on the organisational culture model underpinnings as discussed above. Based on the above definitions, the study reported proposed an investigation of H&S that includes the three aspects identified in the definitions above. The following section presents a discussion of models relevant to this study.

2.3 MODELS OF SAFETY CULTURE

Particular aspects of organisations' safety management systems have been identified to contextualise the concept of safety culture (Grote & Kunzler, 2000; Mohamed, 2000; Reason, 1993; Thompson et al., 1998). Over the last three decades, theories and models used in research have gradually become more sophisticated and better able to predict safety behaviour and inform the planning of safety education and interventions in organisations (Cooper, 2000; Stroebe & Stroebe, 1995). The models presented below were selected to illustrate this.

2.3.1 Reciprocal determinism model

Bandura's model of reciprocal determinism (1977) has been adapted by several researchers (Cooper, 2000; Glendon & Litherland, 2001), to identify and describe variables that best explain the concept of safety culture. The popularity of Bandura's model has been ascribed to its ability to investigate health at three levels of person, situation and behaviour. The reciprocal model contains three elements, which encompass subjective internal psychological factors, observable safety-related behaviours and objective situational features. These elements are used to investigate safety in organisations because of the potential to provide organisations with a common frame of reference for the different aspects that interact to create an environment for safety culture.

The reciprocal model provides an integrative way of thinking about the many processes that impact on safety culture and offers a triangulated set of measurement instruments that can be used to measure safety at multiple levels, enabling an organisation to establish relationships of safety variables in the organisation. The model considers context and external factors as influential in determining an organisation's safety culture. The inclusion of context and external observable factors offers additional perspectives for investigating safety, and is particularly relevant for the construction industry where the work context and external factors will vary for each project, thus affecting the types of safety issues the workers will experience.

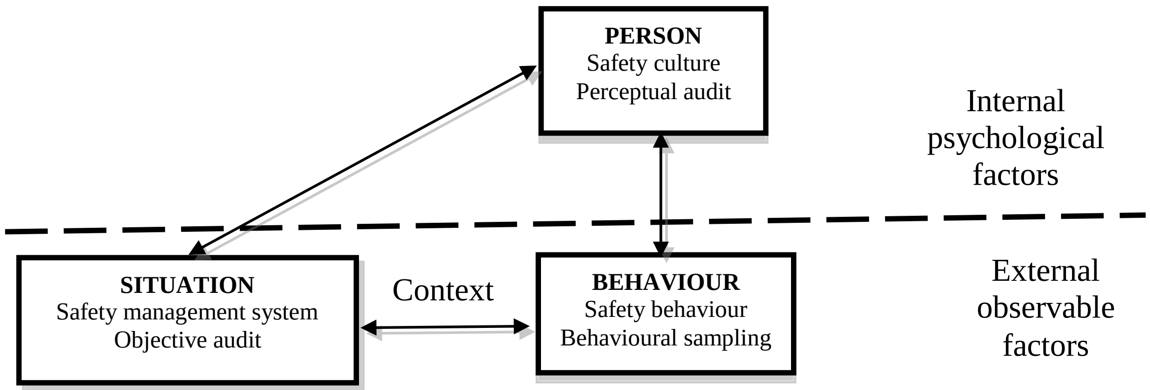

Figure 2.1: Reciprocal Safety Culture Model (Cooper, 2000)

This model supports a multi-dimensional approach to investigating safety culture in organisations considering the variables in the model, which address a framework of H&S systems including worker perceptions, behaviour and organisational structural factors.

2.3.2 Pathogen model

Consistent with Bandura's reciprocal model (1977) in recognising that personal, situational and behavioural factors are antecedents of unsafe behaviour, Reason's (1993) pathogen model identifies three levels of personal, situational and behavioural factors that are responsible for accident causation at these levels in an organisation. Reason's model recognises that the strength of each variable may differ, and that it may take time for one element to exert its effects on the other two elements, but all three contribute to safety behaviour of the workforce. The model recognises that employees can display behaviours learnt from observing co-workers, and that environmental factors may influence safety behaviour negatively or positively depending on the factors that prevail in the organisation. The model acknowledges that the strength of these factors may differ depending on each given situation.

The models discussed above offer a dynamic approach to the measurement of safety in organisations because they address both organisational and individual factors, and take into consideration situational factors which recognise the reciprocal influence of the different factors on each other. This approach offers dynamism suitable to the study of H&S in the construction industry, a sector that has a flexible and mobile workforce, especially with contextual and external conditions, such as weather, being a factor in safety behaviour.

2.3.3 Glendon and Stanton's organisational culture approach

To identify safety culture factors in organisations, Glendon and Stanton (1998) used Schein's (1992) three-level organisational model. The organisational culture approach to H&S recognises aspects of the organisation that affect workplace safety, highlighting features that are shared with existing organisational processes, systems and norms. Safety culture is considered to exist at different levels, referring to the "specific set of norms, beliefs, roles, attitudes and practices within an organisation which is concerned with minimising exposure of workers, managers, customers, suppliers and members of the general public to situations considered dangerous or injurious" (Turner, 1991, p. 241). Three levels of organisational factors that influence H&S are distinguished as the core assumptions, beliefs and values that the workers hold about safety requirements and expectations in their workplace. The norms and artefacts that are either explicit or implicit in the workplace are well communicated.

2.3.4 Total safety culture

The total safety culture (TSC) model (Geller, 1994), which encompasses 'the safety triad', which recognises the dynamic and interactive relationships between organisational policy, structures present in the environment and in employees' behaviour, is consistent with the reciprocal safety model. Geller advocated for 10 principles or values that form the basis of TSC. The TSC approach is reported as encouraging collective responsibility for safety, which is pursued on a daily basis, identifying unsafe conditions and behaviours, and intervening appropriately (Glendon et al., 2006). TSC rewards safe work practices and positive feedback from peers and managers, creating an environment of consistent care for safe work practices. The total safety culture model (Geller, 1994) identifies individual characteristics of knowledge, skills, motivation, communication and environmental housekeeping as key to TSC.

Other models developed by Guldenmund (1998) and Furnam and Gunter (1993) explored Schein's (1992) model, but do not account for the dynamic nature of safety culture by including interactions at the three identified levels. Glendon et al. (2006) used the three-level approach by identifying statements, inspection reports and safety posters representing artefacts, which are the outer layers of a safety culture. The middle layer includes explicit and conscious values and attitudes to policies, procedures and job descriptions. Finally, the third layer is the core layer, which comprises implicit basic assumptions about safety, which can be observed from values about safety held by employees (Glendon et al., 2006). This model enhances the observation of safety to include organisational, individual and situational factors, but extends this further to examine individuals' attitudes and values. This model enables the study of safety to go beyond observed and implemented organisational aspects to include workers' perceptions, adding extra insight into the phenomenon of workplace safety.

Safety culture models such as the organisational safety model (Cooper, 1998) assign meaning to selected constructs such as management commitment, leadership, training, H&S systems and key internal environmental factors including perceptions and attitudes of group members. Neal and Griffin's (1997) model of health and safety performance distinguishes between performance components, determinants of performance and performance antecedents. The International Atomic Energy Agency (1988) model identifies managerial systems and structure as necessary for the effective management of safety culture. The models above are presented here to illustrate the emergence of common features of safety models in the literature. The common theme amongst the models presented is the measurement of safety using organisational factors, structural processes and individual actions.

2.4 SAFETY CLIMATE

Several studies contextualised safety culture, defining the construct in terms of employees having a shared set of safety values and beliefs (Cooper, 2000; Gadd & Collins, 2002; Rundmo, 2000). The definition developed by the Advisory Committee on the Safety of Nuclear Installations (ACSNI) (1993) described the construct of safety culture as an outcome of individual and group values, attitudes, perceptions, competencies and patterns of employee behaviours that determine their commitment to their work and efficiency of their organisation's health and safety management. This description provided both a link to the OC construct and a sound basis from which the closely related construct of safety climate has been derived (Gadd & Collins, 2002). Safety climate has been described as a subset of organisational climate (Cooper, 2000; Denison, 1996; Zohar, 1980).

The study of safety climate as an empirical construct emanates from the seminal study of a manufacturing work environment conducted by Zohar (1980). Safety climate is defined by Zohar (1980 p. 96) as "Shared perceptions of employees in regard to fundamental properties of policies, procedures and practices. Safety climate emphasises how employees perceive the importance of H&S in their organisation." The definition of safety climate presented above implies that employee perceptions are dependent on cues that are evident in the work environment, which then inform their actions and behaviour towards safety (Choudhry et al., 2007). Workers develop perceptions and expectations of the desired behaviour and the expected outcomes from that behaviour, and react accordingly, creating a safety climate that is either positive or negative. The definitions are closely aligned to the reciprocal (Bandura, 1977), pathogen (Reason, 1993) and Glendon et al. (2006) models, which considered different organisational, individual and situational aspects of the work environment that influenced workers' safety behaviour.

Other definitions of 'safety climate' describe the construct as a manifestation of the underlying safety behaviours of employees and their attitudes to safety issues in the workplace (Mearns et al., 2001). In a comprehensive periodic review of safety literature, Gadd and Collins (2002) define safety climate in terms of current surface features of safety culture, which were reported to be obtained and understood from employees' attitudes and perceptions.

Although the construct of safety climate emerged in 1980, studies of workplace accidents and psychological climate have a long history. Some early studies were conducted in the 1940s and 1950s, and investigated psychological safety climate and accident proneness (Keenan & Kerr, 1951; Kerr, 1957; Mintz & Blum, 1949). Earlier studies (Schneider & Bartlett, 1970) found employees' perceptions as having a significant psychological role that informs the frame of reference for guiding safe work behaviour.

Safety climate has generated a number of studies in different industries over time (Flin, Mearns, O'Connor, & Bryden, 2000; Guldenmund, 2000; Zohar, 1980, 2000; Zohar & Luria, 2005). The difference in the definition of safety climate has been attributed to the different industry sectors investigated, resulting in different variables used to measure the construct in different industry settings, giving rise to a diverse range of variables being identified in each study (Zohar, 2010). Guldenmund (2000) offers a detailed review of safety climate causal models for the period 1980–

1997, which provides 17 different definitions of safety climate, including shared employee perceptions of how H&S management is being operationalised in the workplace at a particular moment in time. Guldenmund (2000) observed confusion on the discourse of safety culture and H&S climate constructs, and indicated that the use of the H&S climate and safety culture construct be investigated using an integrated framework. Flin et al., (2001) reported that construct ambiguity has led to the failure by various studies to replicate safety climate dimensions due to individual studies confounding levels of measurement. The observed difficulties in obtaining shared definitions of the construct as well as the lack of a generic taxonomy of construct variables renders the study of safety climate a challenge. This is especially so in view of the diverse range of risks and hazards that difference industries and work environments may encounter. The challenge is enhanced for the construction industry with inherent environmental risks and also an industry where workers can report on varying levels of contractor grouping making the establishment of such a safety climate problematic (Lingard, et al., 2010).

The current study drew on previous literature reviews (Colla, Bracken, Kinney, & Weeks, 2005; Guldenmund, 2000; Yule, 2003) which proposed that H&S climate perceptions be assessed at three levels: the level of organisations' measuring assumptions; the middle layer, which refers to issues of policy, legislation and safety management systems; and lastly the assessment of H&S climate at the individual level, measuring H&S behaviour and performance. The study set out to establish relationships between H&S climate assessment measures and H&S performance and injuries. The decision to measure H&S climate was based on previous studies that found the construct to be reliable for the measurement of safety performance in organisations (Guldenmund, 2000).

Previous studies of safety climate found the construct to be an indicator of the state of safety culture in an organisation (Glendon & Stanton, 2000; Silva, Lima, & Baptista, 2004; Zohar, 2000), while some studies found safety climate to be a reflection of actual safety culture (Arboleda, Morrow, Crum, & Shelley, 2003; Lee & Harrison, 2000; O'Toole, 2002; Vredenburgh, 2002). Other studies have defined and described the safety climate concept and provided characteristics of the construct (Choudhry et al., 2007; Clarke, 2006). Safety climate includes perceptual processes, which are used to interpret H&S information in the workplace (Glendon et al., 2006). Neal and Griffin (2004) argued that the definition of safety climate should be in terms of perceptions of the work environment. Griffin and Neal (2000) identified first-order factors that relate to safety climate perceptions as management values, H&S communication, and H&S practices. From the above discussion, we can conclude that safety climate represents a specific type of organisational climate, which describes the perceptions of employees, giving an indication of how they perceive safety in their work environment. The fact that safety climate can vary according to the specific industry and work environment, has resulted in a diverse range of safety issues in different dimensions being investigated to suit each work environment and the risks and hazards involved (Glendon & Stanton, 2000; Guldenmund, 2000). The issue of different organisational climate aspects emerged as important in each study (Wilderom et al., 2000, p. 194).

The multiplicity of hazards and risks that influences employees' H&S behaviour in different work environments and industries has resulted in theory and research paradigms that have defined and developed safety climate measures for the particular industry under investigation (Zohar, 2010); however, previous studies have not been able to develop a generic comprehensive theory on safety climate with accompanying measurement tools that have a unanimous preference among researchers (Zohar, 2010). The challenge is for researchers to develop and validate scales that are relevant to the different sectors to further generate industry-specific interventions (Zohar, 2010).

The increased interest in the study of safety climate has generated fresh perspectives on the construct. Several studies have defined safety climate and identified conceptual themes that inform the construct (Cooper, 2000; Flin, Mearns, O'Connor, & Bryden, 2000; Zohar, 1980). Zohar (2010) argues that a combination of characteristics that encourage a coherent safety system, which leads to high safety performance in an organisation, has been identified, but no common generic safety dimensions have been investigated for particular sectors to account for the context-specific nature of H&S in organisations. The commonly identified dimensions of safety climate have been:

- management commitment;
- priority of safety matters in meetings;
- rank and status of safety officers in an organisation;
- safety training;
- open communication;
- frequent safety inspections;
- good housekeeping;
- a high usage level of personal protection equipment; and
- a stable workforce.

The dimensions have varied between industries and countries (Zohar, 2010).

According to Zhang, Wiegmann, Von Thaden, Sharma and Mitchell (2002), safety climate refers to shared perceptions of employees about the safety of their work environment, and provides a background against which day-to-day tasks are performed in a safe manner. These shared perceptions derive from several factors, including management decision-making, organisational H&S norms and expectations, and H&S practices, policies and procedures, which together serve to communicate organisational commitment to H&S. Several studies have investigated safety climate and generated a number of definitions, as presented in Table 2.3.

Table 2.3

Definitions of Safety Climate

Author	Definition
Zhang et al., 2002	Safety climate is the temporal state measure of safety culture, subject to commonalities among individual perceptions of the organisation. It is situation-based, refers to the perceived state of H&S at a particular place at a particular time, is relatively unstable, and subject to change depending on the features of the current environment or prevailing conditions
Zohar, 1980	Shared perceptions of employees about fundamental properties of policies, procedures and practices. Safety climate emphasises how employees perceive the importance of H&S in their organisation
Neal and Griffin, 2004	Perceptions of the policies, procedures and practices related to H&S
Gadd and Collins, 2002	Attitudes within an organisation seen as an indicator of safety culture as perceived by employees at a given point in time
Donald and Canter, 1994	The extent to which all workers share attitudes towards H&S enables retention of control and responsibility for accident prevention
Cox, Cheyne and Alexander, 1998; Flin et al., 2000;	A multi-layered construct, which has a mediating role in the relationship between organisational variables and H&S performance
Glendon et al., 2006	Safety climate comprises perceptual processes, which are used to interpret H&S information in the workplace
Mohamed, 2004	Bottom-up approach, which includes workers' constructive involvement, proactive reporting, individual attitudes, group behaviour, and working relationships with supervisors
Denison, 1996	Safety climate is often considered as relatively temporary, subject to direct control, and largely limited to those aspects of the social environment that are consciously perceived by organisational members

The definitions presented in Table 2.3 show common features of employees' perceptions of organisational, structural and individual variables, and report the shared attitudes towards H&S held by workers indicating that safety climate refers to the more visible and measurable current state and short-term aspects of safety in an organisation, whereas safety culture implies established long-term aspects of safety. The given definitions of safety climate imply that safety climate is not stable and that it can fluctuate depending on employees' perceptions of organisational or structural factors, organisational changes and incidents that affect employees' perceptions of safety in their work environment (Brown, Willis, & Prussia, 2000; Cheyne, Cox, Oliver, & Tomas et al., 1999).

2.4.1 Safety climate models

Research on workplace H&S can be traced back to Keenan and Kerr (1951), Mintz and Blum (1949) and Schneider (1975). The study of H&S in the workplace has evolved to a situation where researchers focus on different aspects of H&S as indicated by Guldenmund (2000), as discussed above. Through this evolution, Zohar (2003) proposed that safety climate be investigated and described in terms of two factors:

- strength of safety climate (weak to strong) referring to the internal consistency with which climate perceptions are held; and
- the level of safety climate (low to high), referring to the relative position of the climate average on a given scale.

For example, high safety climate relates to supportive policies concerning H&S. Such a climate may be weak or strong, depending on the extent of agreement among employees. This will have important implications for the effect of safety climate on safety behaviour. Landy and Conte (2004) argued that organisations are characterised by internal safety climates, which can range from strong emphasis on safety to a disregard of H&S practices, i.e. weak safety climate.

An organisation's commitment to safety through strategy, systems and structures is considered to influence the safety attitudes of top management, supervisors and employees (Cooper, 2000; Gadd & Collins, 2002). These properties of safety climate are closely linked to Bandura's reciprocal model approach to safety (Bandura, 1989), which highlights the effect of context and external factors on safety perceptions and behaviour. The ACSNI (1993) definition of safety climates highlights the interaction between organisational, individual, situational and contextual factors; therefore, ensuring that safety is addressed in a holistic manner in the organisation. The strength or weakness of this interaction is determined by the workers as they engage and interact with safety demands and with the work environment.

According to Zohar (2003b), safety climate can be investigated at two hierarchical levels: organisational and subunit or group level. At the organisational level, H&S processes that take place at several levels simultaneously and processes at different levels are linked to each other. H&S policies and procedures that are established at the organisational level are, for example, implemented or executed by unit managers throughout the organisational hierarchy (Zohar, 2003b). Top managers are concerned with policy making and establishing procedures to facilitate policy implementation, while supervisors at operational levels execute the policies and procedures. This differentiation in development and implementation of safety policy creates a potential for discrepancy between formal and executed policy, including a reflexive discrepancy whereby top managers do not implement their own formal policies (Zohar, 2003b). This approach is closely linked to both Reason's (1993) pathogen model and the model proposed by Glendon et al. (2006), which identified three different levels of safety behaviour, and the comprehensive definition, which emphasises the different roles of organisational structures, established to manage safety in organisations.

Hoffman, Jacobs and Landy (1995) identified three levels of an organisation that have an impact on employee safety behaviour:

- the individual level, which includes employees' attitudes, behaviour and knowledge.
- the micro organisational level, which includes management attitudes, presence of accountability mechanisms, self-regulation of the organisation, and the presence of joint labour–management groups such as H&S committees; and
- the macro organisational level, which includes H&S communication, channels (Landy & Conte, 2004).

Hofmann and Morgeson (1999) reported that organisations that have open and supportive relationships between leaders and employees have positive H&S behaviour established amongst workers in the organisation.

Previous studies on safety behaviour identified organisational, individual and situational factors that promote safety behaviour (Cooper, 2000; Glendon et al., 2006). Different approaches have been used by different researchers to identify factors that affect worker safety behaviour (Cooper, 2000; Guldenmund, 2000). The summary of safety climate studies reported in Table 2.4 shows that different industry investigations using cross-sectional surveys resulted in the emergence of various factor dimensions on the construct.

Cooper (2000) developed a safety climate model which identifies dominant themes that contribute to an understanding and analysis of the safety climate. This model emphasises both individual and contextual factors that affect H&S behaviour. Similar to other studies on safety climate, Cooper (2000) established that management commitment, communication, training and supervisory leadership were among the important influences on H&S behaviour. This approach is an acknowledgement of the different factors that interact to enable the workers to conduct their tasks safely.

Other studies have examined the role that employees' perceptions play in adherence to safety behaviour (Mearns, Whitaker, & Flin, 2003; Varon & Mattila, 2000; Zohar, 2000) and how this link can result in fewer injuries (Barling, Kelloway, & Loughlin, 2002; Dedobbeleer & Beland, 1991; Mearns et al., 2003; Zohar, 2000). Organisations with a strong safety climate tend to have fewer employee injuries, especially when the workplace has well-developed and effective safety programmes (Gillen, Baltz, Gassel, Kirsch, & Vaccaro, 2002). The presence of safety programmes is reported to convey positive messages to employees regarding management's commitment to safety, encouraging employees to engage in safe work behaviours.

Machin and DeSouza (2004) investigated safety amongst taxi drivers, using a model that considered individual factors, the work environment, organisational factors and behaviour and wellbeing outcomes, similar to models by Bandura (1989), Reason (1993) and Glendon et al. (2006). See Figure 2.2 below.

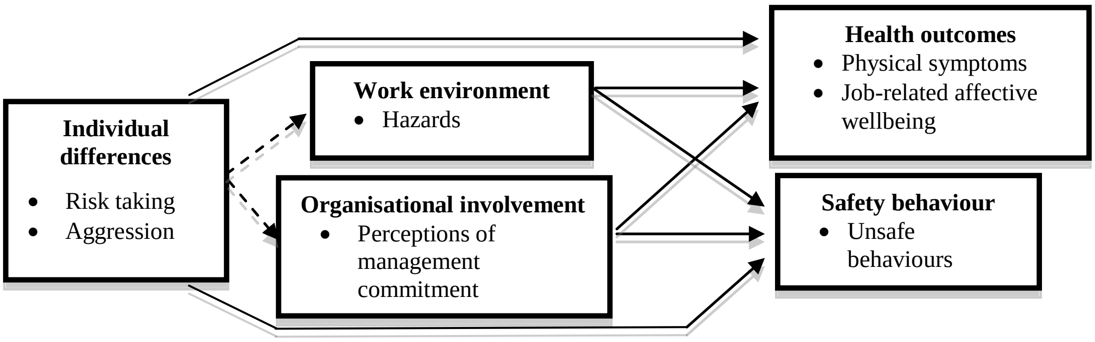

Figure 2.2: Proposed Model of Factors Influencing Taxi Driver Health Outcomes and H&S Behaviour. Source: Machin and De Souza (2004)

Replication studies that investigated safety climate, using previous scales validated in different samples and industries, reported that similar constructs emerged with little confirmation of original factors (Johnson, 2007; Neal et al., 2000; Zohar & Luria, 2005). The construct of safety climate has generated definitional consensus among different researchers (Cooper, 2000; Cooper & Phillips, 2004; Gadd & Collins, 2002); however, differences persist concerning the dimensions that inform this concept depending on the researcher and the industry sector being examined (Johnson, 2007). The debate on the dimensions of safety climate has resulted in differing opinions on the uni-dimensionality or multi-dimensionality of the construct (Cooper & Phillips, 2004; Neal et al., 2000; Zohar & Luria, 2005). The debate is further complicated by the different degrees of success of replication studies that have investigated the construct. The emergence of factor structures that are different from the original studies led to the conclusion by Cooper and Phillips (2004) that the factor structure for this construct was important, but that each study's factor structure should be considered as a unique structure for the specific sample under observation. Despite the differing factor structures and dimensions, common themes have emerged that provide a shared structure of generic organisational and individual variables that inform this construct (Cooper, 2000; Gadd & Collins, 2002).

Niskanen (1994) sampled workers and their supervisors engaged in road construction using generic work-specific items. Niskanen's study produced four factors that were labelled *changes in job demands*, *attitudes to H&S in the organisation*, *value of work*, and *H&S as part of productive work*. Glendon and Litherland (2000) studied road construction and road maintenance workers to produce a six-factor structure: communication and support, adequacy of procedures, work pressure, personal protective equipment, relationships, and H&S rules. A comparison of two organisations was conducted by Coyle, Sleeman and Adams (1995) to replicate a safety climate factor structure. This study reported a seven-factor structure at the first organisation and a three-factor structure at the second organisation. Of the factors under study, only two (work environment and personal authority) were present in both.

In a study of off-shore oil workers, Mearns, Flin, Gordon and Fleming (1998) reported a nine-factor solution with factors labelled *speaking up*, *violations*, *supervisors*, *rules and regulations*, *site management*, *work pressure*, *work clarity*, *communication*, *risk*, and *H&S measures*. In other studies conducted in the manufacturing sector, Williamson, Feyer, Cairns and Biancotti (1997) and Zohar (2000) measured samples taken from manufacturing organisations. Williamson et al. (1997) used 27 items extracted from previous questionnaires to produce a five-factor solution comprising *personal motivation for safe behaviour*, *positive H&S practice*, *risk justification*, *fatalism*, and *optimism*.

In a study of patient safety climate, Armstrong, Lachinger and Wong (2009) replicated factor structures consistent with safety climate dimensions, and found consistent factor patterns. Brown and Holmes (1986) attempted to replicate safety climate factors developed by Zohar (1980), using a sample of manufacturing workers, but failed to reproduce the previous eight-factor solution, producing instead a three-factor solution: management concern, management activity, and risk perception. Brown and Holmes's (1986) study proposed that national cultural differences may have been responsible for the differences in factor structure since the research was based on a North American sample while Zohar's research used an Israeli sample. Dedobbeleer and Beland (1991) replicated Brown and Holmes's (1986) survey, in an attempt to negate the effect of national cultural differences by using another North American sample. This study replicated the three-three factor structure of Brown and Holmes's (1986) study, but also recommended a two-factor model, with *management commitment* and *worker involvement* as the two factors, and suggested that different statistical procedures may provide support for a third factor. In another study, Zohar (2002) reported a two-factor structure, with *management action* and *worker expectation* as the two factors.

Studies conducted in the transport contexts resulted in a variety of safety climate factors that appear to have minimal overlap. Diaz, Cabrera and Isla (1997), in a study of airport ground staff, used 69 safety climate and attitude items that resulted in five safety climate factors of *H&S policy*, *productivity and H&S*, *group attitudes*, *prevention strategies* and *H&S level*. In another study, McDonald, Corrigan, Daly and Cromie (2000) investigated safety climate across four aircraft maintenance organisations using 36 items of the 69-item scale developed by Diaz et al. (1997), that were described as either H&S attitude or safety climate items. Qualitative and quantitative data collection methods were used to analyse salient features of safety management systems, and reported similar findings among the four organisations where safety attitudes and compliance with task procedures were consistent. McDonald et al. (2000) found differences between occupational groups in the organisations, which implied that the workers in the different organisations had differing ideas of what each organisation's safety culture was.

In a sample of rail workers, Clarke (1999) sampled railroad drivers, supervisors and senior management using 25 items derived from accident reports and interviews with senior management. The results showed that five factors emerged, which were labelled *unsafe conditions*, *managerial decisions*, *working conditions*, *local management*, and *line functions*. The findings from previous studies in the transport sector have since led to a measurement tool for transport that has shared scales that can be adapted for the industry sector.

In a study that investigated the role of supervisors in creating safe workplaces, Zohar (2000) used 23 items specific to supervisory leadership generated from themes gathered at interviews. The study found two factors, viz. *supervisory expectation* and *supervisory action*, that can be used to assess the relevant priority of H&S safety perceptions in an organisation. The two factors offer an opportunity to examine both aspects of what the operational leader expects of workers, and to assess how the supervisor acts when work demands put pressure on workers to neglect safe work behaviour to get the job done. Lee and Harrison (2000), recommended the use of H&S performance indicator measures for assessing worker H&S behaviour, suggesting that consistent factor structures and dimensions can be obtained using these measures.

The above discussion shows that the studies cited have examined safety climate using dimensions that combine organisational, situational and individual factors. According to Fuller (1999), the inclusion of organisational, situational and human factors in the work environment can improve efficiency and productivity and reduce workplace risks to H&S. Process factors such as workplace hazards and technology, environmental factors such as work and shift patterns, and employees' previous experience, training and communication have been identified as contributors to a safety environment, and thus were included in this study. The reviewed studies were conducted in different industry sectors and they presented different safety climate variables tailored to the risks and hazards of the particular sector. Common factors observed in the reviewed studies included *top management commitment*, *supervisory leadership*, and *training and communication*. The common trend for these studies was to combine the commonly used factors with minimal industry-specific scales utilised.

For this study, safety climate was operationalised as shared perceptions of employees in regard to fundamental properties of (a) policies and procedures of the formal structures that govern and determine H&S performance (leadership and H&S management systems); (b) and practices and individual factors that influence worker H&S behaviour (H&S motivation, incident reporting.

The emphasis of safety climate is on workers' perceptions of the policies, processes and procedures that determine how workers are expected to conduct their work tasks in line with established organisational safety requirements (Zohar, 1980). It further takes into consideration the definition by Mohamed (2004), which describes safety climate as a "bottom-up approach which includes workers' constructive involvement, proactive reporting, individual attitude, group behaviour, and working relationship with supervisors". The choice of this definition was informed by the current study's objective of investigating organisational, situational and individual dimensions of safety behaviour in the construction sector.

2.4.2 Measurement of safety climate

Although many tools have been developed, and the safety climate construct is well established, there still exists a scarcity of industry-specific safety climate measures that can be used with contextual factors of the specific industry sector (Zohar, 2010). The challenge of developing generic measurement tools that can be applied to similar work environments remains elusive. The review of literature above demonstrates that the perceived safety climate of the organisation has a direct influence on the allocation of resources towards safety initiatives and on the effectiveness of the strategies that are implemented in the organisation (Choudhry et al., 2007).

Since the establishment of the construct of safety climate, studies have designed psychometric measures that have established valid factor structure measurement instruments for safety (Coyle et al., 1995; Garavan & O'Brien, 2001; Zohar, 1980). These studies have been conducted in a diverse range of industries such as oil exploration, manufacturing, mining and agriculture. This diverse range of industries experiences a variety of safety hazards and risks, dependent on the industry sector, which informs the specific measurement tool that is developed and used.

Designing psychometric measurement instruments and ascertaining their underlying factor structures for a specific industry sector remain a challenge due to the context-specific nature of H&S, even in organisations that are in the same industry sector. This is especially true of the construction industry, where each project experiences unique environment hazards and risks. Table 2.4 presents recent studies that have investigated the safety climate in different countries and industries, and indicates the emergent dimensions and psychometric properties of the different scales, which differ even though they measure similar constructs. Although studies indicate variable names that are similar, different items are used to measure the same dimension (Zohar, 2010). The challenge for a study of safety climate remains to develop a standard generic measurement tool for each sector that can be used with little adaptation to suit the local context of the workplace.

Table 2.4

Global Safety Climate Studies

Author & Year	Participants and response rate in parentheses	Safety climate dimensions	Country	Factor structure Intercorrelations in parentheses	
Snyder, Krauss, Chen, Finlinson and Huang, 2008	253 unionised blue-collar workers (59%)	Situation constraints (SC1) Safety control (SC2) Safety climate (SC) Workplace injuries (WI)	USA	.93 .82 .94	SC1 & WI (r = .24); SC2 & WI (r = -.06 P>.05)
Neal et al., 2000	525 (56%) hospital workers	General climate GC) Safety climate (SC) Safety knowledge (SK) Safety motivation (SM) Safety compliance (SC2) Safety participation (SP)	Australia	.94 (35) .93(16) .90(4) .93(4) .94(4)	CFA confirmed 7 factor dimensions GC & SC (r = .52 ;) SK & SC (r. = 20;) SM, GC, SK & SC (r = .21; r = .40; r = .65); SC2, GC, SK, SM & SC (r = .23; r = .42; r = .68; r = .75); SP, GC, SK, SM, SC2 & SC (= r.19; r = .47; r.55; r = .53; r = .54).
Parker et al., 2006	26 in-depth interviews with oilrig senior staff		USA	n/a	n/a

Author & Year	Participants and response rate in parentheses	Safety climate dimensions	Country	Factor structure Intercorrelations in parentheses	
Clarke, 2003	185 car-manufacturing workers (71%)	Work environment (WE) Job communication (JC) Assessment of safety (AS) Safety climate (SC) Safety behaviour (SB) Accident history (AH)	UK	-(6) .78(7) -(11) -(20) .86(9) -	EFA confirmed 5 factors. JC & WE(r = .43);
Cheyne, Oliver, Tomás and Cox, 2002	708 manufacturing workers (66%)	Safety management (SM) Communication(C) Individual responsibility (IR) Safety standards (SS) Involvement (I) Work environment (WE) Workplace hazards (WH)	USA France Argentina	.89 .79 .58 .62 .69 .66 - -	7 factors confirmed with CFA

Safety activities
(SA)

Author & Year	Participants and response rate in parentheses	Safety climate dimensions	Country	Factor structure Intercorrelations in parentheses	
Mearns et al., 2001	722 oil & gas industry (33%)	Job communication (JC) Safety behaviour (SB) Safety hazards (SH) Safety satisfaction (SS) Safety attitudes (SA) Accident history (AH) Your job (YJ)	UK	-(-) -(12) -(18) -(20) -(52) -(8) -(18)	PCA varimax rotation. Six out of 14 correlations were significant but with weak correlations
DeArmond, Smith, Wilson, Chen and Cigularov, 2011	Study 1:150 plumbers, fitters, pipe fitters (14.3%) Study 2:182 (29.6%)	Safety compliance (SC2) Safety participation (SP) Injuries	USA	.70 (10) .88(10)	CFA confirmed two-factor model – SEM
Ismail, Doodstdar and Harun, 2012	275	Management (M) Personal (P) HRM incentive HRMI) Relationship (R) Resources (R2)	Australia China Finland Jordan Malaysia the Netherlands Singapore Spain Thailand		EFA conformed 5 factors –

			USA	

Author & Year	Participants and response rate in parentheses	Safety climate dimensions	Country	Factor structure Intercorrelations in parentheses	
Cavazza and Serpe, 2009	345 blue-collar workers	Unsafe behaviour Company safety concern Senior managers' safety concern Supervisor attitude Workgroup safety involvement Work pressure Safety communication	Italy	.66(3) .84(-) .80(-) .68(-) .34(-) .74(-) .53(-)	EFA confirmed 7 factors
Sui, Phillips Leung, 2004	374 construction workers	Safety attitudes (SA) Communication (C) Psychological distress (PD) Job satisfaction (JS) Safety performance (SP)	Hong Kong	.93(33) .84(7) .93(13) .81(2) -(3)	CFA confirmed five separate factors C & SA (r = .66); PD, C & SA (r = .23; r = .19); JS, C, PD & SA (r = .43; r = .50; r.21);
Brondino, Silva and Pasini, 2012	991 blue-collar workers (83%)	Organisation safety climate (OSC) Supervisory	Italy	.93(12) .95(10)	Two factors confirmed

	safety climate (SSC)	.95(12)	
	Co-worker safety climate (CSC)	.84(8)	
	Safety performance		

Note: All studies were cross-sectional survey studies unless specified otherwise; PAF (principal-axis factor analysis); CFA (confirmatory factor analysis). There was no consistency of items in the different studies with the same variable names.

Although many studies have investigated the construct of safety climate, only a few theoretical models have been developed. According to Zohar (2010), the development and testing of safety climate theoretical models designed for specific industries represent the next challenge for research in this field. For the safety climate construct to be well established, the continued development of theoretical models is encouraged (Zohar, 2010).

2.4.2.1 Examining safety climate and H&S performance

Even though studies identified in the review of literature above have examined the safety climate phenomenon in a diverse range of industries, few studies have examined the relationship between safety climate perceptions and actual safety performance in the South African context. Safety performance as an outcome variable is an indicator that is considered important in determining interventions that can be implemented in organisations. Zohar (2010) proposed that studies be conducted that investigate links between safety climate variables and safety performance in different industry sector organisations. This focus represents an important area of study, as interventions developed can reduce costs associated with absenteeism from injuries and fatalities.

2.4.2.2 Links between safety climate and organisational climate

Previous studies that have explored links between organisational climate and safety climate were able to identify reliable and valid factors that can be used to measure the safety climate of the organisation (Neal et al., 2000; Silva et al., 2004; Zhang et al., 2002). Considering the fact that safety climate constitutes an interconnection of safety hazards, aspects of management control, and employees' perceptions of the effectiveness of safety policy, procedure and practice, it is essential to investigate these relationships in line with the proposed development and testing of theoretical models of safety climate (Flin et al., 2000; Williamson et al., 1997).

A few problems regarding measuring the safety climate construct have been raised. It is reported (Zohar, 2010) that studies that are often cited have conceptualised safety climate at the individual level, focusing on safety practice and behaviour. The focus on individual level factors does not include an overall assessment of safety in relation to other factors in the organisation that have an effect on employees' behaviour. The multiplicity of safety climate antecedents and dimensions has caused the measurement of safety climate to vary across industries. Another problem with measuring safety climate has been the suggestion of consistency of organisational procedures and practice (Zohar, 2010). In reality, such procedures are inconsistently implemented, and employees' perceptions of how well the practice is aligned to procedure remain a challenge for measuring this construct. Zohar (2010) suggested adopting a level of analysis perspective to be able to measure the differences between the identified organisational levels.

The Keli Centre (2002) reported problems with measuring safety climate as a factor that has influenced the levels of promoting a positive safety climate in organisations. The Keli Centre (2002) used the climate safety tool (CST) developed by Health and Safety Executive (HSE) (1993) to identify factors that influence H&S. Time constraints and limited resources were found to be restraints to effective study and communication of findings by organisations. Problems with safety climate surveys are similar to that of other self-report tools, but are further complicated by reported low literacy levels in the construction industry.

2.5 SAFETY CLIMATE RESEARCH IN DEVELOPING COUNTRIES

Currently, there is limited research activity in the area of occupational health psychology (OHP) in developing countries, and none has been reported in Africa so far. Europe and North America are currently the main centres of the majority of OHP studies (Leka & Houdmont, 2010). This trend extends to safety climate studies, creating a dearth of research activity from developing countries, especially in Africa. The aim of the current study was to contribute to the development of a measurement tool for the construction sector in the South African context. The study set out to examine H&S dimensions that influence employees' H&S behaviour at construction sites, thus providing a greater understanding of their inter-dependence which, in turn, facilitates H&S performance improvement in this sector.

2.6 CONCLUSION

H&S climate has been investigated predominantly in developed countries with minimal studies in developing countries; therefore it is anticipated that there might be differences in education, cultural background or any other demographic variable that might introduce correlation between the variables. The selection of variables for investigation has been reported as problematic in the above review, because different studies have investigated the similar concepts but used diverse attributes and dimensions to measure safety climate. The sample under investigation can influence the scale properties and outcome of the study due to different factor structures.

Despite the established field of study on safety climate, no studies have been conducted on this construct in the Southern African region and South Africa in particular, leaving a gap for this study and future studies to generate knowledge in this area.

This chapter presented a review of literature and established the historical origins of the safety climate construct as a field of empirical study. The chapter presented the evolution of the safety climate construct, locating the construct in the organisational culture and safety culture discourse. Models of safety culture and safety climate, and the characteristics of these constructs, were discussed. The following chapter discusses H&S in the South African construction industry.

CHAPTER THREE

RESEARCH CONTEXT

3.1 INTRODUCTION

Having presented a review of relevant literature on the safety climate construct in the previous chapter, this section provides a description of the local construction sector and the factors that influence H&S in the South African context.

> This (construction) is one industry that continues to give our department headaches. Though I am impressed by the good working relations between management and unions, I still believe supervisors should be more hands-on in preventing unnecessary injuries, while worker representatives should assume the role of being the eyes and ears of the department since it is impossible for our inspectors to be everywhere at the same time" (Mdladlana, 2008).

It was considered important to establish the context within which the current study was conducted. Having established that there were no studies that have investigated safety climate in the South African workplace, the context within which the study was conducted was a consideration in establishing relationships between variables identified in previous studies. According to Johns (2006), context has an effect on the occurrence and meaning of behaviour in organisations and can affect relations between variables in organisational research. Johns (2006, p. 386) defines context as "situational opportunities and constraints that affect the occurrence and meaning of organizational behaviour as well as functional relationships between variables". This consideration is particularly important for the study of safety climate in South

Africa as previous studies were conducted in contexts where social and economic conditions are different. Johns (2006) reported that the influence of work situations context and personal characteristics on responses can influence analysis and findings of the study. Similarly, Cappelli and Sherer (1991, p. 56) described context as "the surroundings associated with phenomena which help to illuminate that phenomena". This view indicates that context has implicit factors that are not easily observed but can influence the variables under study, thus it is important to record the context of the phenomenon under investigation.

The construction industry is globally considered to be one of the most hazardous industries (Derr, Forst, Chen, & Conroy, 2001; Dong, Vaughan, Sullivan, & European Agency for Safety and Health at Work [EASHW], 2001; Lingard & Rowlinson, 1997; Lowery & Glazner, 2000; Snashall, 2005). In a study of the Australian construction industry, Lingard et al., (2010) provides detailed statistics for the industry, which place the sector as the third most dangerous industry in Australia. The construction industry in South Africa is probably no different as the sector reports similar injury and fatality trends, although higher statistics are on record in comparison to global trends. The high prevalence of fatalities and injuries in the construction industry has led to a continued focus by the Department of Labour (DoL) on this sector's H&S practices (2008; Ramutloa, 2004).

The construction industry is distinct from other sectors because of the nature of the work, the contextual factors that each building project encounters, and the composition of work teams, which often consist of multiple subcontractors. The nature of the building industry is such that no two projects are the same; the environmental factors at each site are unique (Dubois & Gadde, 2002; Rowlinson, 2004). H&S issues and human resources required to complete a project are always changing, depending on the project (Dubois & Gadde, 2002). The construction sector as a project completion product-oriented industry involves work activity that has to change the work location for each project.

The change of locations means that no two building sites will experience a template format of H&S challenges to be addressed by an organisation. This factor, in addition to constant changes to work teams on building projects, creates challenges for construction organisations to implement H&S strategies and contingency measures. The nature of construction work involves multiple organisations and multiple teams working towards the completion of a single project. The multiplicity of contractors and subcontractors has been reported to result in uncertainty about safety roles on a construction site (Toole (2002). The lack of clarity on the responsibilities of different role players on a construction site has led to regulations narrating the duties of employers in relation to hazards in the workplace (Toole, 2002).

These factors present a challenge for the sector to establish H&S procedures that are consistent for the organisations and different role players on each project (Rowlinson, 2004). Goetzel et al. (2002) reported the cost of work injuries for the United States of America's economy, and highlights the sky-rocketing healthcare costs for organisations. The British economy experienced escalating costs in workplace injuries and illnesses between 1996 and 2001, with reported amounts of between 14.5 and 18 billion British pounds (Health and Safety Executive [HSE], 2000). The incidence of injuries and work-related illness resulted in 299 000 reported injuries and 34 million workdays lost during 2007 (HSE, 2008). The European Union

(EU) reports that annually 10 million workers suffer work-related injuries (Walters, 2004).

The construction industry is a complex industry sector with multiple sources of complexity that include:

- The resources that are required to complete a building project;
- The environment within which the project has to be carried out;
- The different levels of expertise that are required for the completion of the project; and The different workflow interactions that are expected and required for the completion of the project (Dubois & Gadde, 2002).

The first source of uncertainty refers to inherent components of the operation of work at the individual level. This form of complexity originates from resources or the work environment (Dubois & Gadde, 2002 p. 622). Four causes of complexity are identified:

- management is not familiar with the resources and the environment within which they are operating;
- there are ambiguities in terms of the activities that are to take place on the site, which are not well specified;
- the resources are not uniformly distributed, resulting in a lack of materials; and
- the work environment is unpredictable and cannot be controlled or avoided.

The second source of uncertainty is the operational interdependence that is inherent in construction projects (Dubois & Gadde, 2002, p. 624). This interdependence involves:

- interaction between different construction companies on one project;

- interdependence of these companies on the sequence of activities that contribute to the completion of a building project; and
- the rigidity of the sequence of operations, especially in situations where there is an overlap on elements of work interdependence.

The organisation of work in this environment poses a further challenge for construction companies to implement and coordinate consistent and effective H&S management systems among construction workers. The challenges of implementing construction safety interventions are common knowledge (Rowlinson, 2004). The challenges experienced in the global construction industry are also common in the South African construction sector.

3.2 THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

The South African construction industry is similar in nature to the industry worldwide and in the number of workplace fatalities and injuries reported (CIDB, 2009Haupt, 2004).

As a developing country, the contribution of the construction industry to the physical development of the South Africa's infrastructure is not contested (Haupt, 2004). The South African construction industry experiences similar challenges as the rest of the world in the prevalence of injuries and fatalities and associated costs (Haupt, 2004). Construction is an inherently accident-prone work activity due to the type of equipment used and the physical nature and intensity of the work (Mohamed, 2004), poses unique H&S challenges due to the nature of the environment within which the sector operates. For developing countries, construction sites are reported to be "ten times more dangerous than in developed countries" (Agumba & Haupt, 2009). For developing countries, the construction sector is dominated by small or medium sized sub-contracting organisations that have limited resources to effectively implement H&S regulations and programmes (Kheni, Gibb & Dainty, 2007). The following contextual factors are relevant for a discussion of OHS in the South African construction industry:

- the 2010 Soccer World Cup hosted by South Africa saw a huge increase in construction activity throughout the country, in conjunction with increased accidents and fatalities in a sector that has a poor occupational health and safety reputation;
- Escalating compensation fund costs for the construction industry in South Africa;
- Increasing casualisation of labour which has resulted in altering the working practices so that regular workers are re-employed on a casual or short-term basis;
- The impact of the fragmentation of labour on H&S activities on construction sites.
- The absence of credible data on accidents and fatalities, which could inform the development of OHS interventions (Haupt & Smallwood, 2005; Mohamed, 2004);
- widespread non-compliance with national and international building legislation by South African construction companies (Ramutloa, 2008a, 2009, 2011; Hamlyn, 2007), as illustrated by 115 construction site inspections by the DoL, where only 55 contractors (47.8%) were found to be fully compliant; and
- failure of the South African construction industry "to develop into a mature, technically-advanced, late twentieth-century industry" (Ball, 1988, p. 23).

In 2007, the DoL had set a target of achieving at least 70% compliance levels for the sector, but no records could be obtained of the current levels of compliance (Ramutloa, 2009).

3.2.1 The nature of construction work

The structure of work on construction projects has been in existence for over two centuries, and still uses fragmented work teams characterised by contractors and subcontractors at different levels. The sector has not evolved in keeping with other industry sectors and is regarded as ineffective (Groak, 1993). The fragmentation of the construction industry has a negative effect on productivity (Dubois & Gadde, 2002; Fang, Chen, & Wong, 2006.) The industry is also slow to change (Woodhuysen & Abley, 2004). The different construction project stakeholders and participants, who are experts in their own field but collaborating to complete a building project, render implementation of H&S programmes difficult (Toole, 2002). Each area of expertise has specific H&S challenges that cannot be addressed with a generic H&S programme. This lack of standardisation leads to an environment where each group believes they understand their H&S needs best, which poses a problem for the implementation of H&S initiatives that are generalizable to all groups on one project. A further contributing factor is the constitution of work groups for each building project, with diverse subcontractor groupings.

Workers on construction sites are expected to exercise a high degree of autonomy because the work environment is most often geographically removed from the operational centre. The building project is constantly changing with project progress, creating further challenges for workers who have to make decisions based on current work, contextual and environmental factors. As a result, workers at a construction site are often expected to rely on their own judgement to ensure that work progresses in line with a constantly changing work environment and work demands (Rowlinson, 2004). This form of autonomy leads to situations where workers believe they know how best to conduct their work and operate independently

(Rowlinson, 2004). The absence of a common standard and understanding among role players at construction sites leads to challenges when implementing H&S programmes, as it becomes problematic to identify H&S indicators that are common to the different groupings of professionals and work teams on a project.

According to the DoL, construction organisations subcontract to a diverse range of subcontractors on a single project. These subcontractors may not have proper H&S procedures for each site where they operate, and there may sometimes be a lack of supervision of workers on the building site leading to H&S incidents (Ramutloa, 2008). Such occurrences have been cited as the source of accidents and fatalities on construction sites. The worrying trend in the escalating costs of occupational injuries and incidents has resulted in several conferences and forums being convened to address the problem (Ramutloa, 2012a).

Similar to global trends of high costs associated with construction industry incidents and fatalities, Ngai and Tang (1999) identified costs such as loss of production by the injured worker, medical fees, legal fees, and opportunity costs for family members who have to care for the injured worker. Research conducted in the South African construction industry has confirmed that accidents negatively affect productivity, cost structures, work schedules, and the quality of work (Smallwood, 1999). While accidents on a construction site are often associated with resultant damage to equipment and injuries to or ill health of the employee, other accidents are fatal (Smallwood, 1999). The direct and indirect costs of such accidents are an important financial consideration for an organisation and the society in which is the organisation is located (Ngai & Tang, 1999).

Construction project teams are temporal multipurpose organisations (TMO), creating an environment where a group of organisations and experts come together to form a coalition with one project completion goal (Rowlinson, 2004). The consistent formation of TMOs for different projects does not allow for a track record of established H&S systems for the teams, which requires high levels of integration to ensure that operational systems, which include H&S, are implemented safely. The level of integration in the construction industry requires that employers in the sector should be prepared to be able to improve on mechanisms for managing subcontractors to ensure that H&S is maintained (Rowlinson, 2004).

In a study of absence and early retirement in the construction industry, Brenner and Ahern (2000) found that injury was the most frequent reason for absence, followed by infectious disease and musculoskeletal disorders. Hannerz, Spangenberg, Tüchsen and Albertsen (2005) found that workers engaged in the construction of the Great Belt Fixed Link (1988–1998) had twice the risk for disability retirement in comparison with economically active men in general. However, little is known of the effect of different types of construction worker injury on the risk of short- and long-term work absence, in terms of general construction work (Van Duivenbooden, Frings-Dresen, & Ringen, 2005).

The South African construction industry is no different to the global sector in terms of fragmentation of reporting structures on project sites and H&S performance. Decisions are made at different stages of the project cycle that affect other stages of the project. The different responsibilities during these stages pose a challenge for acquiring skilled competent personnel to address H&S requirements, and affect communication between the different subcontracting teams on a building project (CIDB, 2009). The South African construction industry faces similar challenges to the global industry sector, with more than 53% of building sites inspected by a government inspection team not legally compliant with H&S legislation (Hamlyn, 2007). The construction industry has been described as being in a state of "H&S chaos" (CIDB, 2009). Table 3.1 presents a snapshot of H&S fatalities in the local construction industry in comparison to regional and global data. The data positions the South African construction industry as a high-incidence sector recording fatalities above four regions recorded in the report (CIDB, 2009).

Table 3.1

Comparisons of H&S Fatalities in South Africa and Other Regions

Region	Fatalities/100 000	Accidents/100 000
Singapore	98	7 452
Former socialist economies	129	9 864
Latin America & Caribbean	172	13 192
Middle Eastern Crescent	186	14 218
South Africa	**192**	**14 626**
Sub-Saharan Africa	210	16 012
Other Asian islands excluding China & India	215	16 464

Source: CIDB (2009).

Determining who is responsible for H&S on a construction project has always been a challenge because of the structural organisation of work on a project site. The fragmentation of roles that are distributed to all participants on a site creates a multiplicity of contractors and subcontractors, each responsible for one aspect of the project, thus making the monitoring of H&S a challenge (CIDB, 2009). This fragmentation creates further challenges to educate and motivate various stakeholders regarding the importance of their role and the benefits of well-managed, safe projects.

3.2.2 National construction industry H&S

The local construction industry has been reported (CIDB, 2009) as having the third highest number of fatalities when compared to other industries such as transport and fishing. Non-compliance with H&S regulations in this sector was highlighted by the Department of Labour's national construction blitz (Hamlyn, 2007), which reported the Western Cape to have the highest number of contraventions (see Table 3.2 below). According to Abudayyeh, Fredericks, Butt and Shaar (2006), most incidents and injuries on construction sites are directly linked to workers not complying with established H&S procedures.

Table 3.2

National Construction Blitz Inspection Report: August 2007

	1	2	3	4	5	6
Eastern Cape	136	24 (3.16%)	102 (12.30%)	0	106	14
Free State	155	271 (35.70%)	84 (10.13%)	2	77	5
Gauteng North	57	21 (2.77%)	35 (4.22%)	8	40	2
Gauteng South	247	80 (10.54%)	167 (20.14%)	25	172	163
KwaZulu-Natal	240	126 (16.60%)	100 (12.06%)	7	100	3
Limpopo	75	7 (0.92%)	68 (8.20%)	5	57	12
Mpumalanga	237	152 (20.03%)	85 (10.25%)	9	50	40
North-West	56	22 (2.90%)	32 (3.86%)	5	27	23
Northern Cape	105	19 (2.50%)	86 (10.37%)	9	71	13
Western Cape	**107 7.5%**	**37 (4.87%)**	**70 (8.44%)**	**16**	**315**	**4**
Total	**1415**	**759 (100%)**	**829 (100%)**	**86**	**1015**	**287**

Note: 1 = Total work places inspected; 2 = Compliant; 3 = Non-compliant; 4 = Improvements; 5 = Contraventions; 6 = Prohibitions.
Source: CIDB (2009).

Examples of recent incident of accidents and fatalities in the construction industry include:

1. In 2008, the DoL served prohibition notices against two Pretoria-based construction companies due to failure to abide by proper H&S standards (Ramutloa, 2008a).
2. DoL labour inspectors shut down scores of construction sites in KwaZulu-Natal and issued compliance notices to many employers in various other provinces

in what has turned out to be an alarming plunge in labour law compliance in a sector that leads in workplace fatality rates (Ramutloa, 2008a).

3. In the Eastern Cape, disregard of workplace safety measures continues to prove a trend as DoL inspectors embark on surprise inspections in the construction sector around the country (Hamlyn, 2007).
4. The DoL's ongoing focus on the construction industry has seen a further nine contravention orders issued to an Eastern Cape construction company and three of its subcontractors (Ramutloa, 2008b).
5. The Western Cape construction industry reported a higher than national average of contraventions between 2005 and 2007. During an inspection blitz in the province in 2007, inspectors found a number of H&S violations which led to varying sanctions and resulted in two prohibition orders (Ramutloa, 2009).

3.2.3 South African regional construction H&S claims data

The CIDB safety report (2009) identified client internal factors that influence contractors' H&S performance. The identified factors are consistent with literature on safety climate, namely *management commitment*, *communication and feedback*, *supervisory environment*, *supportive environment*, *H&S rules and procedures*, *training and competence levels*, *workers' involvement and personal risk perception*, and *work pressure*. The role of the client on the H&S processes for building projects was considered important in view of the high reported rate of non-compliance with legal H&S requirements (Hamlyn, 2007). The H&S fatalities and H&S claims of the Western Cape construction industry is reported as the highest in the country, as shown in Table 3.3. This further highlights the need for interventions that can help reduce the high number of incidents and fatalities.

Table 3.3

Regional Construction Fatalities and H&S Claims

	2006		2007	
Province	**Number of claims**	**Number of fatalities**	**Number of claims**	**Number of fatalities**
Gauteng	4 257	32	5 143	30
KwaZulu-Natal	1 207	13	1 311	10
Eastern Cape	943	7 (9.46%)	929	7
Boland	1 577	12	1 629	6
Western Cape	**827**	**3 (4.05%)**	**814**	**1**
Kimberly and Northern Cape	28	0 (0.00%)	43	0
Free State	345	7 (9.46%)	362	6
SA	**9 184**	**74 (100%)**	**10 231**	**60**

Source: FEMA (CIDB, 2009)

Construction sector: Historical influence

South Africa with the legacy of apartheid is different from developed Western countries in terms of workers' beliefs, perceptions and attitudes to H&S. South Africa has a diversity of cultures and a work environment affected by labour migration and strong trade unions – all these issues require further investigation to identify any underlying factors that may influence H&S behaviour. This is an important contextual factor that research needs to take into consideration when investigating safety phenomena in a context where studies have not been conducted before (Jones, 2006). Workers in different industrial contexts and different countries may vary in their perceptions of and attitudes to H&S (Lin et al., 2008). Different attitudes have been found to derive influence from social economic and cultural factors that inform the hazards or risks that workers experience in specific work contexts. For example, Brown and Holmes (1986) and Dedobbeleer and Beland (1991) used North American work samples to study safety climate and were unable to reproduce Zohar's (1980) safety climate study. They cited different work contexts as the reason for the varying research outcomes.

These findings highlight and strengthen the need for industry and context-specific studies of safety climate that are conducted in different contexts to allow for sample variation and validation of scales in these contexts. The South African construction industry represents a different context with a different population and work experiences that differ from the studies of safety climate that have been conducted in other countries, therefore presents an opportunity to investigate the phenomenon further. There are few reported studies in the South African context that have investigated H&S climate and an injury, this study presents an opportunity to examine this construct in South Africa.

Despite concerted government efforts, the construction industry remains a sector with high injury and fatality rates that cost government and employer organisations large sums of money for medical care and compensation. The continued spate of accidents (Ramutloa, 2008a), the disregard for workplace safety measures, and the continued H&S negligence in most provinces (Ramutloa, 2008, 2009, 2010; Mothiba, 2010; Ramutloa, 2004) demand a collaborative effort by individuals, organisations and government to address the issue. The costs of compensation for this sector have seen a steep 24% rise in the past five years, signalling an escalation of the problem, and therefore warranting further investigation for solutions to be raised.

The problems of the construction sector as a high-risk work environment have been well identified (Agumba & Haupt, 2009). Individual workers, the employing organisation, trade unions and government should endeavour to find evidence-based mechanisms that would elevate the H&S performance of this industry sector from random compliance to avoid DoL inspections to an approach which integrates H&S into the culture and climate of the organisation.

This chapter provided the context for the investigation of H&S in the construction industry. The next chapter presents the proposed explanatory H&S climate model. The proposed model was informed by a review of safety climate literature, construction site observation notes, and structured interview notes.

CHAPTER FOUR

PROPOSED HEALTH AND SAFETY CLIMATE EXPLANATORY MODEL

4.1 INTRODUCTION

This chapter presents the proposed safety climate explanatory model, identifying the components of organisational and individual antecedents and outcomes of safety climate that comprise the model. Literature on safety climate was used to gain an understanding of factors that inform H&S performance. The theoretical approach used to develop the proposed model was based on safety climate approaches to understanding H&S behaviour. The developed model is consistent with earlier theories of safety behaviour discussed in Chapter Two. Findings from structured interviews and a review of relevant literature were used to identify relevant independent variables, and these were used to guide the development of the model. The chapter also discusses demographic variables used in the study.

This study used the taxonomy suggested by Neal and Griffin (2004) as a general guideline for conceptualising the H&S climate model for the South African construction industry. The review of the literature in Chapter Two informed the selection of common themes which apply to safety climate constructs from the literature. These constructs were selected for inclusion after consideration of the variables that have been investigated in previous studies in different industry sectors. Previous studies have identified management commitment as the primary theme, appearing in 13 out of the 18 safety climate scales (Flin et al., 2000). A secondary theme was worker attitude to H&S and risk. Similar results were reported in another review of 15 partially overlapping measurement scales (Guldenmund, 2000). Moreover, concerns of procedural features of the H&S system (e.g. training, compliance and communication) are included in these common safety climate dimensions. The identified dimensions are discussed in the following sections.

The development of an H&S climate model for the South African construction industry was based on both qualitative research, using secondary documentary empirical evidence, and primary qualitative data collection, using observations and structured interviews. The review of literature presented in Chapter Two indicates that the identification of leading and lagging H&S indicators has a positive effect on organisational H&S performance. In view of previous studies that investigated and validated safety climate constructs in work environments different to the construction industry, the proposed model offers a unique contribution to empirical validation of these constructs in a specific industry sector in the South African construction industry (Zohar, 2010).

The proposed H&S climate conceptual model proposes that a positive H&S climate should be able to increase workers' H&S knowledge through communication, toolbox talks (see 4.1.2.5), and training, and that the provision of resources (management commitment) to support these activities will be reflected in supervisory expectations (Zohar, 2000). Having created a positive environment for H&S, it is suggested that the proposed explanatory H&S climate model will be strongly related to H&S incident reporting and H&S motivation, because the individual nature of these variables will generate positive perceptions of H&S and workers would be motivated to report incidents and improve H&S performance (Clarke, 2006). In the proposed

H&S climate conceptual model, each variable in the safety climate cluster is distally related to H&S performance and H&S avoidance behaviour and injuries. The current study proposes that H&S avoidance behaviour will be negatively related to injuries (Christian, Bradley, Wallace, & Burke, 2009).

The conceptualised model is presented in Figure 4.1 below. Included in this model are the following variables: top management commitment, supervisory leadership, safety management systems, toolbox talks, H&S training, H&S communication, H&S motivation, incident reporting, individual responsibility, H&S performance, H&S avoidance behaviour, workload pressure, work environment danger, and injuries. Proposed H&S variables were grouped into five main categories, namely leadership, processes, norms, individual factors, and contextual factors. The conceptualised model positions H&S climate as being manifested in independent variables that inform workers' H&S avoidance behaviours, which in turn inform H&S performance and leads to reduced injuries. The influences of work pressure, environment dangers and incident reporting, together with other demographic variables, are assessed.

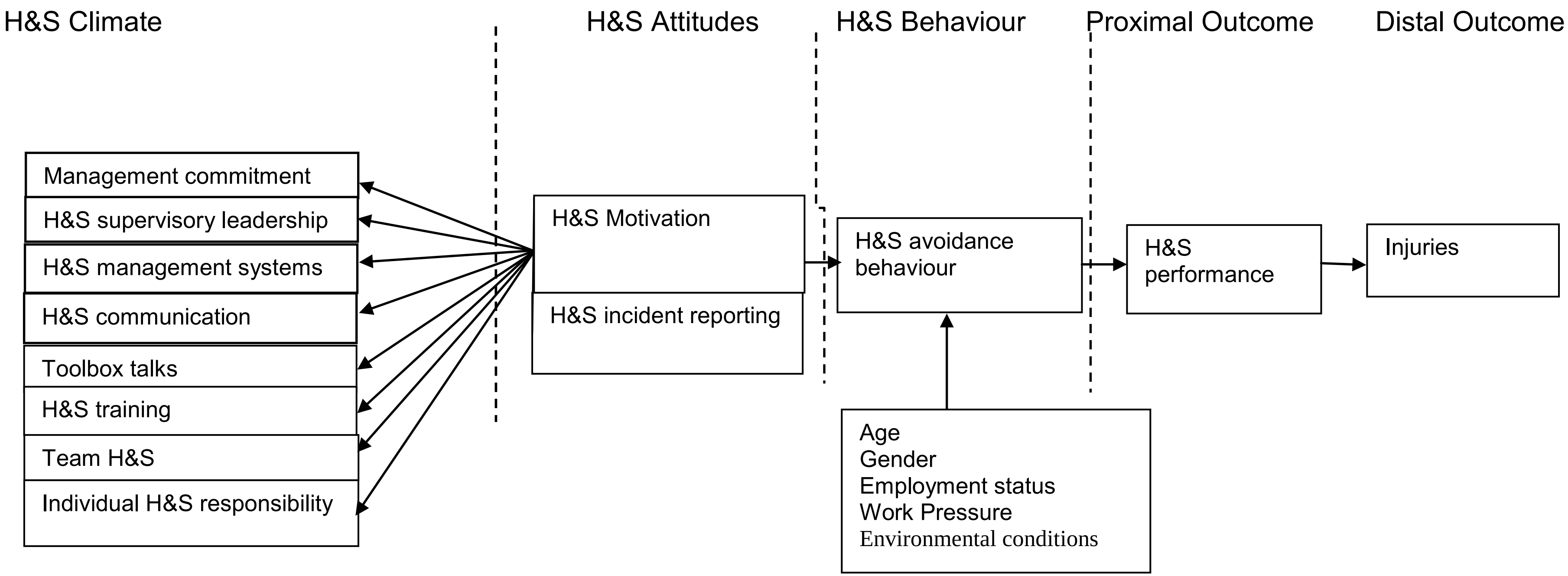

Figure 1. Proposed model of H&S climate.

4.2 SELECTION OF H&S CLIMATE VARIABLES

The review of literature presented in Chapter Two identified gaps in research on the H&S climate and the need for research that develops industry-specific measurement tools (Zohar, 2010). This observation creates a need for research that investigates the antecedents of an H&S climate in the local environment, and the construction industry in particular. Although studies have been conducted on dimensions of H&S climate in different work contexts, none of these studies sought to predict the influence of these constructs on injuries in the South African construction industry.

Since more needs to be known about H&S climate in the local construction industry, the current study examined H&S climate dimensions and the antecedents that inform H&S motivation and incident reporting among construction workers, and the ways in which these individual factors influence H&S performance and injuries. The identified dimensions offer an opportunity to develop and test an explanatory H&S climate model that identifies interrelations amongst organisational and individual dimensions that inform H&S behaviour and test the influence of H&S performance on injuries. Zohar (2010) suggests that further studies should develop and test industry-specific measurement tools that would form a basis for knowledge development. This will ensure that interventions can be designed to address specific issues experienced in the different work environments in consideration of the context-specific nature of H&S issues.

The identification of common safety climate conceptual themes of management commitment, supervisory leadership, safety management systems and individual variables, and the development of shared measurement tools for the construct, have evolved over the years to a point where reliable measurement tools for the concepts exist (Flin et al., 2000; Guldenmund, 2000; Zohar, 2010). Safety climate can be measured by examining workers' attitudes towards H&S and the way they perceive hazards that exist in their workplace. Previous studies have reported that employees' attitudes are one of the most important measures of safety climate because these measures are often influenced by other features of the working environment (Pidgeon & O'Leary, 2000).

Guldenmund (2000) identified additional factors that determine safety climate and contribute to the presence of a positive safety climate in an organisation as the following: risk management, H&S processes, procedures, attitudes to hazards, compliance with H&S rules, work pressure, risk management and training. When workers share common attitudes and values in terms of the importance of H&S in the organisation, a positive safety climate is considered to exist in the organisation (Choudhry et al., 2007; Gadd & Collins, 2002).

The common themes of safety climate variables identified from the studies considered in the literature review in Chapter Two informed the development of an explanatory H&S climate model for the construction industry in the South African environment. The selection of the proposed H&S dimensions was based on the following considerations:

1. The identified dimensions are consistent with previous empirical studies conducted in various industry sectors in countries and work environments that were different in terms of economic and social contexts.
2. The identified dimensions reflect essential elements of a good safety climate as per literature review and data from structured interviews.

3. The dimensions incorporate three basic ideas reported in previous studies: norms and rules for handling hazards, attitudes, and prioritisation of H&S practices.
4. The identified dimensions cover three levels of an organisation (organisation processes, individual responsibility, and work environment context) which have been recognised as the basis for safety culture and safety climate in organisations, as presented in Chapter Two.

The investigation of the combination of identified dimensions for the current study has not been done previously in the construction industry in South Africa. In a study of construction managers, Gillen, Kools, McCall, Sum and Moulden (2004) identified three important dimensions considered necessary prerequisites for a positive safety climate:

- Firstly, top management commitment and support for H&S practices were identified as contributors to having supervisory leadership that was involved, proactive, principled, innovative and not afraid to take a firm stand on H&S issues.
- Secondly, H&S training and continuous education help to keep management and employee skills up to date.
- Lastly, changes in workplace contextual factors regarding H&S, such as the organisation's setting of H&S goals, decentralise management and empower the workers (Gillen et al., 2004).

Willingness to report accidents and incidents was positively associated with employees' perceptions of top management (Mearns et al., 2001). The construction industry H&S climate dimensions cannot easily be aligned to the identified organisational levels due to the multiplicity of role players on a construction project.

For example, Lingard et al., (2011) presented a model that investigated contractors and subcontractors at Australian construction sites, with levels different from those identified in other safety climate studies. Similarly, Agumba and Haupt (2009), investigating H&S in the South African construction sector reported on the implications of multiple small and medium enterprises (sub-contractors) and the challenges these organisations face in providing resources for H&S on construction projects. For this industry sector safety climate will be manifested at different levels dependent on the resources that the different stakeholders can allocate to H&S.

This conceptual selection of antecedent variables in the field of H&S climate considers that no common definition or description of these variables have been established or measured in a systematic manner. Studies have used different combinations of variables depending on the industry sector and researcher as indicated in Table 2.5. The proposed conceptual model aims to establish a common underlying framework of variables which future studies of H&S climate can use to examine the construct and make inferences about H&S climate in conjunction with contextual variables suitable for each project.

4.2.1 Antecedents of H&S performance

The proposed organisational, individual and contextual variables of the H&S climate are distinct variables which measure different concepts. The selected H&S climate dimensions were informed by the literature reviewed in Chapter Two, which identified dominant themes in the field of safety climate. Inferences were made from the wider safety climate literature about the antecedents of H&S performance. The following section presents variables that were identified and selected for inclusion in the proposed explanatory model. Having reviewed safety climate literature, this study developed certain propositions.

4.2.1.1 Top management's commitment to H&S

Top management's commitment to H&S refers to senior managers, at strategic and executive levels in an organisation, who set the tone and tempo for organisational H&S climate (Flin et al., 2000). Previous studies reported the role of top management commitment and behaviour towards H&S in organisations (Gadd & Collins, 2002; Zohar, 2002). Top management is a key aspect of the establishment of a positive safety climate and H&S management system in an organisation (Gadd & Collins, 2002). According to Thompson et al. (1998), top managements in organisations support H&S by strategic H&S policy formulation, establishing H&S procedures and setting production goals that enable workers to perform their tasks in a safe manner. In contexts where job performance has direct H&S implications, top management commitment has been reported to have a mediation role by ensuring that H&S are prioritised (Zohar, 2000; Zohar & Luria, 2003).

In a study of restaurant workers, Huang et al. (2012b) found that perceptions of management's commitment to safety had a significant predictive ability concerning worker safety. An earlier study of the effect of top management commitment on H&S (Simmard & Marchand, 1994) noted that, in work environments where top management was involved and participated in H&S initiatives, the reduction of lost time and accidents was evident, especially where formal programmes were implemented. Vredenburgh (2002) found that closer and higher-quality relationships between top management and employees increased top management’s commitment to the workers' welfare, and these relationships manifest in both formal and informal interactions that highlighted the importance of H&S in the organisation.

For H&S policy and interventions to be effective, top management commitment and actions towards H&S were identified as key areas for organisations (Dedobbeleer & Beland, 1991; Gadd & Collins, 2002; Zohar, 2002, 2003b). Two factors were identified as influential in determining perceptions of safety in an organisation (Fugas, Melia, & Silva, 2011). The first factor was the perception of what management expectations were regarding H&S, and the second comprised the actions of management in regard to observing H&S, which referred to how H&S was perceived by leadership in the organisation (Fugas et al., 2011). In a study of train drivers, Clarke (1999) found that, although supervisors and senior managers shared a perception of the importance of H&S, the main influence on employees' H&S commitment was determined by how senior management H&S actions were perceived by the workers. In a study of building sites in the UK, Marsh, Hau, Bella and Grayson (1998) found that where successful H&S interventions that targeted behaviour were implemented at building sites across the UK, these were strongly influenced by top management who provided resources and set guidelines for required behaviours on site.

Several other studies have investigated top management's commitment to H&S as an antecedent of safety climate and as a significant factor in determining worker H&S performance (Cullen, 2001a; Griffin & Neal, 2000; Grosch, Gershon, Murphy, & DeJoy 1999). The most commonly identified forms of top management commitment were those of providing resources for training and giving feedback on H&S incidents. The success of H&S initiatives, production pressures, employee H&S behaviour interventions, H&S communication, fairness, and the ways in which these interact with workers' compliance with H&S regulations, have been linked to top management showing commitment to H&S in the organisation through provision of resources and time for H&S training (Cheyne et al., 1998; Dedobbeleer & Beland, 1991). Management commitment and actions towards H&S were identified as key areas for the success of an organisation's H&S strategy (Cox et al., 1998).

Setting of H&S policy and organisation production goals are the main areas where top management can influence the prioritisation of H&S in an organisation (Griffin & Neal, 2000). Through these processes, top management is able to outline the goals of the organisation and align H&S policy and procedures to ensure that work processes are conducted in line with the organisation's H&S policy. Supervisors and line managers form the link between top management and the operational floor, ensuring that compliance with H&S is achieved by workers. Well-formulated H&S policies have little impact when top management is geographically removed from the operational employees directly involved with H&S policy implementation (Robson et al., 2007).

In a study of two sites of the same construction company, Collinson (1999) found that one site had a more positive safety climate while the other site had evidence of accident concealment. The study found that a negative impact on H&S behaviour emerged in cases where senior management was separated from line management and workers hierarchically and geographically. Results indicated that employees' perceptions of top management's attitudes and behaviours towards H&S, production and issues such as planning and discipline, provided the most meaningful and useful measurement of an organisation's safety climate.

The role of managers and supervisors has been highlighted (Zohar, 2003), and it has been established that tension exists between top management's production goals and administrative demands, and the need to implement work processes that comply with the organisation's H&S policy (Flin et al., 2000). These demands result in managers and supervisors reducing their involvement and visibility in H&S in the workplace, thus compromising compliance with H&S requirements. In view of the finding that top management commitment has an impact on H&S behaviour in the organisation, the variable was included as a leading organisational antecedent for H&S, informing individual H&S behaviour in organisations. It is proposed that positive correlations will be observed between employees' perceptions of top management commitment and the individual variables of H&S motivation and H&S incident reporting.

> ***Proposition 1:*** Top management's commitment to H&S will predict employees' H&S motivation.

> ***Proposition 1.1:*** Top management's commitment to H&S will predict employees' individual H&S responsibility.

> ***Proposition 1.2:*** Top management commitment will predict employees' H&S incident reporting.

4.2.1.2 Supervisory H&S leadership expectations

The role of the operational line manager has been reported as influential in incident and accident prevention and in the promotion of H&S behaviour amongst employees (Mearns et al., 1999; Zohar, 2003a). Two primary attributes of effective H&S supervision were found by Zohar (2002) as important for employees' H&S compliance: (a) performance-based monitoring, and (b) timely communication of consequences. Zohar (2003) indicates that supervisors should monitor work through observations as part of their performance assessment to ensure effective H&S

implementation and management. An effective supervisor would observe whether work on a difficult task is performed properly, including the use of protective gear, and express approval or disapproval immediately (Zohar, 2003a). The integration of H&S performance monitoring at the supervisory level influences H&S behaviour of operational staff. Zohar suggested efficient communication mechanisms for H&S information in organisations to ensure that workers are provided with timely and relevant H&S information to facilitate or reinforce H&S behaviour.

Other studies have confirmed the role of supervision in promoting H&S behaviour in organisations (Mulenga, Bagraim, & Smallwood, 2011; Zohar, 2003a). The perceptions that workers hold of supervisory H&S actions or expectations inform employees' H&S behaviour. Employees' H&S behaviour is influenced by their immediate supervisor's expectations and actions (Zohar, 2003a). An investigation of supervisors' involvement assessing their direct participation in H&S found that participative supervisors were able to reduce lost time and accident and incidence rates through active monitoring and communication of H&S guidelines to the workforce (Simard & Marchand, 1994). Effective supervisory observation of work, especially in hazardous work environments, would include issuing of personal protective equipment (PPE) and initiating disciplinary procedures if violations are evident.

In a study of container terminal operators, Lu and Yang (2010) found that the kind of safety leadership that is provided influences the safety behaviour of workers, resulting in an effective safety management system. The actions that a supervisor takes when H&S rules are violated indicates to workers the importance attached to H&S by the supervisor and sends clear messages of what is expected in terms of compliance (Zohar, 2003a). The support that an effective supervisor receives from top management if disciplinary action is taken against a non-compliant worker reinforces the importance attached to H&S by the organisations' leadership (Zohar, 2003a). Supervisors are perceived as the link between senior management and the workforce, monitoring compliance to H&S rules and providing feedback to workers concerning the required H&S measures. Where supervisory H&S leadership is ineffective, the work environment is associated with poor H&S and regular breaching of H&S requirements (Zohar, 2002).

The assessment of employees' H&S perceptions at the operational level is required because supervisors are directly responsible for interpreting and implementing formal H&S procedures and policies (Zohar, 2003a). The discretionary power inherent in supervisory roles was deemed a necessary and sufficient condition for creating group-level variation, resulting in corresponding safety climate differences (Zohar, 2003a). Supervisors in a formalised organisation, where procedures are highly specific, many and rigid, were considered to enjoy little discretion within narrow policy boundaries (Collinson, 1999). Although the role of supervisors is well documented, there is a dearth of research in the South African work environment on the perceived role of supervisors on H&S performance, given the evidence that supervisors influence H&S behaviour and performance in organisations.

The role of a supervisor in influencing workers' H&S behaviour has been highlighted in several studies (Mearns et al., 2010; Zohar & Luria, 2003). Managers on site are reported to have a greater influence on H&S than top management. Supervisor expectations can be manifested through H&S performance monitoring, such as direct observation and work sampling. Such actions by the supervisor allow for employee clarification of expected H&S behaviours (Zohar, 2002). H&S become the responsibility of line supervisors rather than of H&S personnel or appointed co-workers who cannot monitor the work as effectively as supervisors at the operational level can (Zohar, 2002).

Supervisors' expectations are expressed through employees' behaviour observations, written communication of H&S policy statements, statements concerning H&S roles and responsibilities, performance standards, findings from risk assessments, and risk control information and practice. The discretionary power inherent in supervisory roles is a necessary and sufficient condition to create group-level variation, which results in safety climate differences. Supervisory expectations have been reported to be influenced by the organisation's structures and culture (Hopkins, 2005). Where structures are highly formalised, there are specific procedures that supervisors need to comply with, which do not allow for any discretion for H&S processes that do not fall within the designated procedures. Other factors, such as contextual hazards, supervisory expert power and physical distance from headquarters, can influence the safety climate in an organisation (Hopkins, 2005).

Zohar and Luria (2005) identified attributes that influenced the coherence of supervisory H&S leadership. The first was the extent to which H&S procedures implied a hierarchy of H&S roles over H&S issues, establishing a prioritisation pattern determined by supervisors. Employees observe the supervisor's actions and learn H&S priority facets based on espoused behaviour., The supervisor’s behaviour indicates the assigned priority of H&S. Firstly, through visible behaviour, employees recognise factors that senior managers regard as important, and adapt their H&S behaviour to align with observed factors. Secondly, supervisors show their commitment to H&S by taking regular H&S tours. Given that subordinates are expected to put greater emphasis on H&S performance, supervisory H&S expectations and actions are expected to influence employees' H&S behaviour. Based on the above literature this study proposes that:

> ***Proposition 2:*** High levels of supervisory H&S leadership will predict high levels of H&S motivation amongst construction workers.
>
> ***Proposition 2.1:*** High levels of supervisory H&S leadership will predict high levels of individual H&S responsibility amongst construction workers.
>
> ***Proposition 2.2:*** High levels of supervisory H&S leadership will predict high levels of employee H&S incident reporting amongst construction workers.

4.2.1.3 H&S management systems

H&S management systems comprise the framework within which an organisation's H&S policy and regulations are interpreted. Formalised procedures, processes and practices for H&S (Flin et al., 2000), the way risk and danger are perceived, and the priority attached to these perceptions contribute to determining day-to-day H&S practice (Evans, Glendon, & Creed, 2007; Merritt & Helmreich, 1996). These can include written safety policies, incident and accident records and reports, organisational safety records such as manuals and checklists, and all formal structures such as appointed safety officers (Cheng, Ryan, & Kelly, 2012; Rowlinson, 2004). H&S management systems represent a framework that shifts from prescriptive regulation of H&S to the establishment of H&S procedures and processes that self-regulate OHS in the workplace (Rowlinson, 2004).

Fang et al. (2006) proposed that organisations with effective H&S management systems are likely to improve H&S compliance among its employees. H&S management systems are important in ensuring that organisational members share the same ideas and beliefs about risks, accidents and ill health. H&S procedures are instituted by upper-level managers and implemented by lower-level managers (Guest, Peccei, & Thomas, 1994). These distinctive attributes of H&S in the workplace inform workers' perceptions of the H&S safety climate.

The role of H&S management systems in defining H&S for an organisation is outlined by Cooper (2000), who described policies as the framework which defines strategic goals and the means of goal attainment for H&S in an organisation. Formal policy is explicit, relating to overt statements and formal procedures. Enforced policy or enacted practices are tacit, derived from observing senior, middle and lower management’s patterns of action (Zohar, 2002). An alternative view is offered by Guldenmund (2000), who reported that perceptions about H&S policy should refer to policies in use or enacted policies, and not formal policies because enacted policies inform the probable consequences of H&S behaviour.

Health and safety procedures are described as the mechanisms that provide tactical guidelines for H&S action to achieve the goals that are formulated based on H&S policies that the organisation has devised (Cooper, 2000). The actual application of policy and procedures is the practice of H&S by both managers and workers across the organisation's hierarchy (Cooper, 2000). This approach establishes a system for managing H&S in an organisation, thereby influencing employees' behaviour at the different levels of the organisation. H&S policy establishes a framework for organisational expectations of H&S from the workers, and includes the provision of resources and staff to ensure that policy is adhered to by the different role players who are responsible for H&S performance.

The role of dedicated H&S structures and personnel in organisations has been studied and reported as critical in ensuring a safe work environment (Gadd & Collins, 2002; Neal & Griffin, 2004). The effectiveness and credibility of H&S committees and H&S officers are influenced by top management structures that determine H&S functions. The presence and status of H&S officers in an organisation are a reflection of top management's commitment to H&S (Griffin & Neal, 2000). Cooper (2000) suggested that the status of H&S officers is a reflection of management's commitment to H&S. If a senior manager does not see the importance of H&S it is unlikely that the H&S officer will be given management-level status, thus not creating a perception of the value of the contribution of this role to H&S and/organisation goals. The effectiveness of H&S committees is also likely to be influenced by management commitment. The notion of H&S management also represents a shift from prescriptive regulation of H&S to the establishment of H&S systems to self-regulate occupational H&S in the organisation (Rowlinson, 2004). An organisation's commitment to H&S through strategy, systems, structures and other factors is what shapes the attitudes of managers, supervisors and employees.

Establishing a safety climate in an organisation requires implementing, maintaining and monitoring H&S management systems to ensure that management commitment and employee H&S behaviour remain consistent (Landy & Conte, 2004). H&S procedures refer to the framework that guide rules and regulations that are put in place to ensure that H&S practice in the organisation is in line with H&S strategy and policy (Cooper, 2000), thus creating a system of H&S management. Expected H&S activities are the outcome of H&S policy and procedures. Practice executes policy and procedures through outlined protocols to foster H&S practice and behaviour. H&S activities are designed to ensure that workers are compliant with organisational H&S requirements. The existence of formalised H&S management systems does not guarantee or reflect the safety climate of that organisation (Guldenmund, 2000), but establishes a framework which can be used to implement the policies, procedures and practice of H&S in an organisation, thus establishing a system that can be measured and evaluated to determine the H&S climate of the organisation.

> ***Proposition 3:*** The presence of H&S management systems in an organisation will predict employees' H&S motivation amongst construction workers.
>
> ***Proposition 3.1:*** The presence of H&S management systems in an organisation will predict individual H&S responsibility.
>
> ***Proposition 3.2:*** The presence of H&S management systems will predict employees' H&S incident reporting.

4.2.1.4 H&S communication

Effective communication, which leads to collective goals, has been identified as a critical indicator of the existence of a positive safety climate in an organisation (Clarke, 2006; Mohamed, 2004). Clarke (2006) suggested that organisations with effective communication regarding H&S issues are likely to improve H&S compliance among their employees due to frequent and consistent information sharing processes. Lee and Harrison (2000) reported a positive correlation between H&S communication and work teams' positive attitudes to H&S. Other studies reported on the role of effective communication in making employees feel valued and fostering trust and respect between management and employees (Gadd & Collins, 2002). In a study of construction workers in the United Kingdom, Conchie and Donald (2009) reported the mediation role of safety specific trust in a relation between transformational leadership (safety specific) and employee citizenship behaviours. The findings from this study showed that where leadership initiatives are used for safety improvement, these should be combined with safety specific trust promoting initiatives. Conchie and Donald (2009) recommended a broader approach to basing safety enhancement on leadership and management of the implementation of processes beyond the provision of resources for H&S. Conchie, Donald, and Taylor (2006) highlighted the influence of trust on H&S in organisations and provided insight into the different types of trust in an organisation and how these impact H&S through processes at the operational level such as communication, procedures and practices. This study does not use trust to examine the role of communication on H&S behaviour but measures the different forms of communication mechanisms in an organisation and how these influence H&S behaviour and H&S performance to reduce injuries. The current study selected variables for inclusion that have been reported as major themes in the investigation of safety climate (Cooper, 2000; Gadd & Collins, 2002; Guldenmund, 2000). This decision was in consideration of the absence of safety climate research in South Africa and the need to examine the previously identified major themes.

Forms of effective H&S communication identified by Lee and Harrison (2000) are:

- visible H&S behaviour (for example use of PPE or working in a safe manner);
- face-to-face H&S briefings;
- written communications through bulletin boards and e-mail; and

- H&S policies and procedures.

Lee and Harrison (2000) reported that team briefing on H&S correlated positively with positive attitudes to H&S. Improved H&S supervision can be achieved through weekly personal feedback sessions concerning relative frequencies of H&S-related monitoring and rewarding interactions with subordinates (Zohar, 2002).

H&S communication that occurs through face-to-face discussions between managers and employees allows for personal contributions, and helps employees feel involved in H&S processes and decisions. These discussions can take place during H&S tours or planned H&S meetings or briefings (Cooper, 2000; Gadd & Collins, 2002). These forms of H&S communication enable all stakeholders to place H&S high on the organisation's agenda by ensuring a common understanding of H&S requirements and expectations.

The establishment of open and non-judgemental H&S communication is critical to employees' ability to identify the true cause of unsafe behaviour (Gadd & Collins, 2002). Several studies have noted the importance of effective H&S communication as a contributing factor to H&S in an organisation (Lee & Harrison, 2000). An effective information-sharing system is considered important for the sharing of H&S policies, H&S procedures, H&S instructions and feedback between management and workers. A positive safety climate is one which is informed, just, flexible and based upon problem solving rather than indiscriminate blame apportionment (Neely & Wilhelmson, 2006). Open H&S communication, which leads to collective goals, was identified as a critical indicator of the existence of safety climate in an organisation.

Previous studies (Glendon et al., 2006; Zohar, 2002) found that increasing H&S communication between supervisors and their managers, and between supervisors and their subordinates, leads to a positive safety climate in an organisation. In an organisation where open and supportive H&S communication and relationships between leaders and group members were absent, the occurrence of accidents was attributed to environmental factors such as equipment failure, rather than individual unsafe behaviour (Glendon et al., 2006). In an environment where there are no open and supportive relationships between supervisors and workers, the responsibility for incidents was attributed to factors beyond individual responsibility, e.g. equipment failure. This results in poor H&S performance because the organisation does not identify the root causes of poor H&S performance.

According to Zacharatos and Barling (2004), encouraging H&S communication, sharing ideas, and promoting greater concern regarding H&S among workers reduced status differences, and encouraged trust among workers. Glendon et al. (2006) identified effective H&S communication as a key characteristic of a positive safety climate and an important process in H&S management systems. Effective H&S communication, founded on employees' shared beliefs of the importance of H&S, mutual trust, and confidence in the effectiveness of preventive measures, was found to be a contributing factor to a positive safety climate.

Proposition 4: The presence of effective H&S communication in organisations will predict employees' H&S motivation amongst workers.

Proposition 4.1: The presence of effective H&S communication will predict employees' individual H&S responsibility amongst construction workers.

Proposition 4.2: The presence of effective H&S communication will predict employees' H&S incident reporting amongst construction workers.

4.2.1.5 Toolbox talks

Another aspect of a construction site H&S management system identified during the qualitative data collection stage was the toolbox talk forum. These were scheduled formal meetings between immediate line managers and workers held on construction sites. Toolbox talks have been defined as "a meeting held between the workgroup and the immediate supervisor in their place of work" (Quemard, 2004, p. 10). From site observations and interviews conducted by the researcher, toolbox talks emerged as a valuable forum for communicating H&S information. The value of the toolbox talk forum resides in the ability to address H&S issues experienced at the particular stage of the building project. Regular toolbox talks represent one forum where supervisors and workers discuss H&S issues relevant to the current hazards and risks being experienced, and where workers are reminded of safe ways of working in compliance with organisational goals and regulations.

At one construction site visited by the researcher, the toolbox talk forum was called 'Jika meeting', which was a local vernacular that translates to 'turnaround', in reference to the H&S strategy that the organisation had implemented in order to reverse the negative H&S record that the organisation had experienced in the past. The preferred term is in consideration of the visited site's preference to ensure that workers embrace H&S and turn around the high number of injuries and negative H&S behaviour.

The relevance of toolbox talks was highlighted in a study of construction workers in Australia (Trethewy, Atkinson & Falls, 2003), where sharing of training was reported to be relevant for contractors who did not speak English as all training and guidance material was in English. The toolbox talks were useful for these workers, because when the contractor had difficulty reading the language, a person of their own language orientation could explain and discuss H&S issues and improve awareness and hazard identification (Trethewy et al., 2003).

The weekly toolbox talks discuss the project targets for the week. This meeting reviews the previous week's work, identifying any delays in the project and causes such as rained out days or stopping work due to H&S incidents. Where cases lacking H&S compliance were identified these were discussed identifying the cause of the incident and informing workers how they can best react or respond to further hazards. In the discussion, current hazards relevant to the stage of construction would be identified and expectations of H&S compliance would be reinforced.

Toolbox talks are relevant to the construction industry in view of the changing risks and hazards at different stages of building projects (Trethewy et al., 2003). Toolbox talks enabling employees to have an opportunity to suggest safer ways of work have been identified elsewhere (Trethewy et al., 2003) as important forums that enhance H&S in organisations. Overall, toolbox talks constitute an important part of H&S management systems, together with informal briefings, verbal face-to-face meetings, H&S forums, and notice or bulletin boards that highlight H&S issues (Cooper, 2000; Glendon et al., 2006).

For this study, toolbox talks were considered particularly important because of the diversity of languages and nationalities that were observed at the sites visited by the researcher. At these sites, two types of toolbox talks were evident. One was a weekly toolbox talk that lasted approximately 30 minutes, and the other a brief daily meeting lasting five to 15 minutes, with minutes taken during the meetings. Toolbox talks were interactive, with workers identifying any challenges they were experiencing that might affect H&S compliance. In the toolbox talk sessions attended by the researcher, the talks were brief sessions at the beginning of each workday, lasting between five and 15 minutes. These meetings focused on the experiences of the workers and line managers on the site the previous day and the expectations for H&S performance for the new day. The daily toolbox talks were designed to address immediate incidents in the workplace that could not be deferred to the weekly meeting (Boud, Rooney, & Solomon, 2009). Similar to the weekly meetings, these were interactive and enabled workers and leadership to address issues that were affecting workers in the immediate work context, and were considered useful by interviewed workers. The focus of toolbox talks was on identifying both successes and areas of improvement (Boud et al., 2009).

> ***Proposition 5:*** Convening regular toolbox talks will predict employees' H&S motivation amongst construction workers.
>
> ***Proposition 5.1:*** Convening regular toolbox talks will predict employees' individual H&S responsibility amongst construction workers.
>
> ***Proposition 5.2:*** Convening regular toolbox talks will predict employees' H&S incident reporting amongst construction workers.

4.2.1.6 H&S training

Health and safety training refers to the process of equipping employees with appropriate knowledge and skills to be able to identify and address workplace hazards and risks (Glendon et al., 2006). According to Glendon et al. (2006), H&S training is important to establish and maintain a positive safety climate, and to ensure that risk control mechanisms are effectively implemented. The current study draws from Bandura’s (1989) research, which concluded that self-efficacy was an important factor in individual behaviour. This implies that the conviction that employees have concerning their capabilities to execute the desired H&S behaviours lead to the appropriate behaviour. This suggests that workers who have skills, competencies and knowledge of dealing with the risks and hazards in their work environment would be able to perform their tasks in a safe manner.

For employees to be active participants in H&S programmes there is a need to equip workers with the necessary skills and cognitive ability to enable them to recognise, identify and address workplace risks and hazards (Trethewy et al., 2003). According to Vredenburgh (2002), the ability to recognise hazards and unsafe acts, and to understand the consequences of these, represents the difference between safe employees and those who frequently get hurt. Dryer (2000) identified gaps in the H&S knowledge of senior management who received minimal H&S training. Operational workers and supervisors who received regular H&S training were found to be better informed (Dreyer, 2000). Other studies have established the importance of H&S training in creating a safe work environment, because training creates awareness of the organisations' expectations and behavioural requirements to be compliant with H&S requirements (Griffin & Neal, 2000).

In a report on the management of H&S by managers, Dryer (2000) found that procedures for ensuring work competence were flawed. In some organisations, managers appeared to receive little H&S training. Dryer (2000) suggested that the lack of H&S training at business and management schools, as well as the absence of H&S in management texts, compromised H&S awareness. Workers' H&S performance has been associated with competence, accurate hazard perception (task training and learning from experience), and motivation based on internalised H&S values (Dryer, 2000). Guastello (1993) found a reduction in the occurrence of accidents at a shipping yard when work groups were provided with H&S information and feedback about H&S levels. The study established that the provision of information was successful in changing employees' H&S behaviour.

The type of training offered in dangerous industries is often reported to be inadequate, and does not consider the context-specific hazards and risks (Adie et al., 2005). This was evident in their study of offshore divers who were offered generic training and induction (Adie et al., 2005). The training provided to the workers was not relevant to the type of hazards they experienced, and as a result it did not have an effect on the employees' H&S behaviour (Adie et al., 2005). In a study of construction managers, Gillen et al. (2004) found strong positive correlations between the safety culture of an organisation and H&S training.

Media campaigns, information leaflets and films have been identified as common training methods used to inform employees about hazards and risks in their workplace. From the above literature, it is inferred that training for H&S is important to instil knowledge of hazards in employees, and educate them about ways in which to address H&S issues in their work environment. Employees' systematic acquisition of skills, rules, concepts and attitudes can result in improved H&S performance. The current study therefore proposes that:

> ***Proposition 6:*** The provision of H&S training for construction workers will predict employees' H&S motivation.
>
> ***Proposition 6.2:*** The provision of H&S training for construction workers will predict employees' H&S incident reporting.

The following section presents a discussion of the individual variables selected for inclusion in the proposed conceptual model. The inclusion of the variables is based on the assumption that, if H&S climate variables influence worker H&S behaviour, as presented in Chapter Two, it is expected that individual predictors of H&S (H&S motivation, individual H&S responsibility and H&S incident reporting) would have a positive relationship with H&S performance and reduce the incidence of injuries as a distal outcome.

4.2.1.7 H&S motivation

Motivation is considered important to generate a workforce that is constantly aware of safe work practices, and to ensure that an organisation implements interventions that target and address appropriate employee H&S needs. The theory of motivation which outlines Maslow's hierarchy of needs (1954), describes five aspects of motivation. Motivation principles have been used to investigate safety motivation in the study of H&S. Neal and Griffin (2006 p. 947) defined safety motivation as "an individual's willingness to exert effort to enact safety behaviours and the valence associated with these behaviours". They further suggested that workers should be motivated to comply with H&S requirements and that they should be able to participate in H&S activities when a perception of the existence of H&S climate is held. In a longitudinal study, Probst and Brubaker (2001) found that H&S motivation had a lagged effect on safety compliance in that workers who were motivated were reported to behave in a safe manner in the work context. Neal and Griffin (2002, 2006) identified H&S motivation as a determinant of safety performance, and highlighted the role of motivation in determining safety compliance and participation.

The Oxford dictionary defines motivation as a "reason or reasons for acting or behaving in a particular way" (http://www.oxforddictionaries.com/definition/english/motivation). The current study describes H&S motivation as a process that is important in promoting H&S behaviour. This approach is consistent with Landy and Conte (2004) who defined motivation as an inner force that encourages workers to behave and act in a manner that will accomplish individual and organisational goals. Employee motivation in the workplace is important for organisations so they have to implement structures and systems that will influence employees' behaviour. In the case of H&S, workers' motivation enables them to comply with H&S requirements such as wearing PPE or performing H&S inspections and reporting H&S incidents, activities that create a safe work environment (Flin et al., 2000). Motivation to behave in a safe manner has been reported as an important consideration in employee's H&S behaviour in the workplace (Flin et al., 2000; Glendon et al., 2006).

For organisations to achieve a positive H&S climate, the organisational antecedents that influence H&S performance need to be perceived positively by the workers. Strategies to encourage employees towards H&S motivation were reported by Vecchio-Sadus and Griffiths (2004) as management commitment through resource allocation, high visibility and participation and consultative forums. The use of physical artefacts such as media posters, newsletters, visual and audio prompts together with slogans and a mission statement that promotes H&S are considered physical reminders that generate and reinforce H&S motivation for employees' H&S behaviour (Vecchio-Sadus & Griffiths, 2004). Based on the above literature the current study proposed that:

> ***Proposition 7:*** Construction workers' H&S motivation will predict employees' H&S avoidance behaviour.

4.2.1.8 *Individual H&S responsibility*

Individual responsibility has been identified as an important aspect of H&S performance, and was reported (Neal & Griffin, 2002) to mediate the relationship between H&S activities and personal involvement, and between workplace activities and workplace hazards. A previous focus of H&S behaviour was on measures that adopted an engineering approach to H&S with minimal consideration for the workers in the work process (Weiss, Fielding & Baum, 1991).

The role of each worker's responsibility for his or her own H&S has been reported as an important contributor to ownership of H&S behaviour by employees (Glendon et al., 2006). Zohar (2002) reported that careless H&S behaviour prevails during job activities for which risk is unjustifiably played down, which contradicts a commonly held assumption that self-preservation prevails in H&S activities. Some studies have found that employees hold perceptions about the risks they face, evaluate the risk, and then adjust their attitude and behaviour based on this appraisal (Flin et al., 2000; Rundmo, 2000). The nature and type of industry also influenced the assessment and appreciation of risk involved (Zohar, 2002).

To address H&S responsibility, some initiatives have focused on the individual level, with interventions that were targeted at preventing accidents at the job design level to ensure that the employee does not engage in unsafe behaviour (Landy & Conte, 2004). Alternative approaches offer employees a choice to engage in H&S behaviour, with incentives offered for good H&S behaviour (Hoffman & Stetzer, 1996). Contextual factors, such as the attitudes and behaviour of supervisors and workmates (Zohar, 2003a), management and organisational commitment to H&S behaviour (Gadd & Collins, 2002; Guldenmund, 2000) have been identified as influential to H&S behaviour creating a positive safety climate when an individual has the option to behave in a safe manner.

The issue of personal H&S responsibility is viewed in conjunction with other organisational H&S initiative concerns (Grote, 2011). If the decision is to address process H&S, the risks and issues to be addressed are linked directly to the workers' tasks (Grote, 2011). Where personal individual H&S responsibility is the consideration, the issues relate to falling off a scaffold, being hit by falling objects (Grote, 2011) and injuries such as cuts, sprains or fractures, instances where the individual worker is expected to take personal responsibility for his or her H&S and wellbeing.

The current study assumes that employees desire to work in a safe manner, which motivates them to take responsibility for their own H&S beyond the organisation’s specific H&S policies or any legal requirements, and therefore the following is proposed:

> ***Proposition 8:*** Employees' perception of individual H&S responsibility helps predict H&S motivation.

4.2.1.9 H&S incident reporting

Identifying and reporting unsafe acts and conditions have been identified as indications of the emergence of a positive safety climate (Cullen, 2001b). Investigating and reporting 'near misses' were reported to lead to prevention of accidents and were included as symptoms of the safety climate of an organisation. In instances where H&S were linked to employee assessment it was found that this resulted in a 'blame culture', which resulted in workers being reluctant to report accidents, injuries or 'near misses'. Respondents in the Cullen (2001b) study admitted to concealing accidents and/or 'near misses' in order to safeguard their performance appraisals. Measuring near-miss occurrences provides useful lessons for the organisation, because the data collected is used to assess and monitor the frequency of incidents, and can be used to develop H&S interventions in the workplace. Cultivating an environment of 'no blame' and 'just work' is important for a safety climate, because penalising individuals for incidents can lead to non-reporting behaviour, which leads to a negative safety climate (Cullen, 2001a;). According to Cullen (2001b) if workers are not blamed when accidents happen in the workplace, they are more inclined to report H&S incidents. Further support for this point is provided by Cullen (2001b) who indicated in the Landbroke Grove Rail report that when workers were treated unfairly after reporting a H&S incident, they were most likely not to report the next H&S incident that happens. The report also reported that where workers had reported a H&S incident and been penalised, they admitted to not reporting further incidents.

In a study of a chemical processing organisation, Van der Schaaf and Kanse (2004) reported four main factors that were attributed to the failure of employees to report H&S incidents, namely:

- fear from disciplinary action, which represented a punitive reaction from management when incidents were reported;
- a perception by workers that the incident reporting processes were time-consuming and difficult;
- a perception that incident reporting is useless because management does nothing about it; and
- acceptance of risk by the workers, when incidents are perceived to be part of the job – commonly associated with a 'macho culture'.

Alexander, Cox and Cheyne (1995) reported that blaming employees for accidents or unsafe acts reinforced fear of disciplinary action leading to employees complying with H&S out of fear. Financial incentives to improve productivity or to reward zero accidents or no time lost have also been found to result in employees not reporting accidents and incidents (Collinson, 1999). The lack of reporting of H&S incidents results in poor H&S records because trends of H&S violations and performance are not recorded for appropriate interventions to be developed and implemented.

When H&S incidents and accidents occur but are not reported, there is an indication of poor communication (Mearns et al., 2001) for fear of reprisals from the supervisor. Employees' perception of a blame culture has a greater effect on employees' H&S behaviour than the H&S policy promoted by the organisation (Mearns et al., 2001). According to Mearns et al. (2001), characteristics of sustained injury reduction prevail in a work environment where top management exhibits a serious orientation to H&S and the organisation has a participatory system which is inclusive of all employees, which develops a mutually respective relationship between management and workers. The process of investigating reported ‘near misses’ can lead to prevention of accidents or incidents (Mearns et al., 2001).

Incident reporting and the tendency not to commit H&S violations were identified as key elements which support organisational H&S (Clarke, 2000). In an earlier study, Clarke (1999) found significant predictors of train drivers' intentions not to report incidents:

- Firstly, an accident was considered to be part of the day's work.
- Secondly, managers would take no notice of reported incidents.

- Lastly, an incident was considered routine and no action was taken even if it was reported.

A routinisation effect, whereby frequently occurring events were more likely not to be reported, and reluctance to report was based on anticipated lack of management response, was observed (Clarke, 2000). Zohar (2002) found that collection of performance H&S data and supervisory practice data required twice the amount of observation visits to each work team; therefore, reporting of incidents required the supervisor to keep records.

Cox and Cheyne (2000) suggested that direct observation of employees was one way of identifying the number and nature of minor accidents and near-miss occurrences. Keeping a record of these incidents makes a positive contribution to organisational learning, and leads to improvement in H&S and established systematic incident reporting, thus tracking trends of H&S incidents.

Where workers' perceptions of managers were negative, intention to report incidents were significantly lower compared to areas where positive perceptions prevailed. Mearns et al. (2001) found that employees' perceptions of top management's commitment to H&S were positively linked to willingness to report accidents and incidents. Pressure to report positively was reported as a drawback, together with social desirability biases (Cullen, 2001b). Investigation of near-miss occurrences was reported as a very useful measure of H&S performance, as well as enabling organisations to learn from such errors. Underreporting of accidents and incidents by employees to ensure that incentives are received has been acknowledged (Reason, 1997). Considering the above empirical findings, this study proposes that:

Proposition 9: High levels of H&S incident reporting will lead to high levels of H&S avoidance behaviour.

4.3 WORK PRESSURE

H&S behaviour is often in conflict with other competing organisation objectives, such as speed and productivity. Pressure to meet production targets or to increase production, which conflict with the implementation and effective monitoring of H&S, have been reported in different industry studies (Flin et al., 2000; Dickety, Collins, & Williamson, 2002). According to Glendon et al. (2006), work pace and work overload factors affect the balance between pressure for production and H&S requirements. Dickety et al. (2002), in a study of foundry workers, found that workers took risks in performing their work due to work pressure. Flin et al. (2000) found that work pace and workload pressure negatively affect the balance between pressure for production and the need to comply with H&S procedures. Factors such as production pressure and the potential rewards or punishment associated with H&S compliance or non-compliance are reported to have a moderating effect on this reciprocal relationship (Flin et al., 2000).

Priorities of H&S over production have been reported to have an indirect effect on risk behaviour, whilst acceptability of rule violations was found to be the strongest predictor of negative H&S behaviour (Rundmo, 2000). Other studies have indicated that, when work pressure increases, supervisors will set relatively lower priorities for H&S based on expectations from immediate superiors (McDonald et al., 2000; Dickety et al., 2002). Supervisory H&S effectiveness will influence subordinates' behaviour only if H&S are given priority above other competing demands by the supervisor (Zohar, 2002).

In organisations where work speed is emphasised over H&S, tension between the line manager and workers has been reported, because there is pressure on workers to produce more; therefore, H&S become a secondary consideration (Dickety et al., 2002; Zohar, 2002). In instances where H&S precautions entail associated costs, such as a slower pace, extra effort or personal discomfort, it has been reported that employees will neglect H&S (Zohar, 2002).

Incidents of H&S negligence by managers and workers under pressure to meet production goals have been reported in different industry sectors (Dickety et al., 2002). McDonald et al. (2000) found that workers cut corners due to work pressure, and that tension builds up between H&S and production goals, leading to negligence of H&S. Similar findings were found in the South African context during the observational sessions and from interviews with construction workers who would prioritise completion of tasks over H&S.

The supervisor's role in monitoring H&S behaviour can be compromised if such a supervisor experiences excessive workload pressure. A supervisor might not be able to monitor employees' H&S performance effectively because of a heavy workload. This is further compromised if the supervisor experiences tension between H&S and pressure to meet desired work outputs and targets (Cooper, 2000). Acceptability of H&S rule violations was found to be the strongest predictor of unsafe behaviour (Rundmo, 2000). H&S managers might expect workers to bend the company's H&S rules, with the exception of life-threatening situations, whenever production falls behind schedule, despite official claims to the contrary. If this is done consistently it promotes a low H&S environment within a company (Cooper, 2000; Dickety et al., 2002). Instances where pressure from management has led to disasters have been previously documented. Pate-Cornell (1993) reported on the cause of the Piper Alpha disaster and identified managerial pressure as one of the major causes of that disaster. In a separate large industrial disaster, Mason (2010) reported that managerial cost cutting initiatives were a contributory factor to the Gulf of Mexico oil spill disaster in April 2010. Supervisory leadership has been identified as an important source of H&S information (Zohar, 2003). Employees are reported to assess their supervisors H&S behaviour is supported by the company's top management. Congruence between supervisor H&S behaviour and top management support indicates a message not to engage in unsafe behaviour (Zohar & Luria, 2005).

Instances where pressure from management has led to disasters have been well documented. Pate-Cornell (1993) reported on the cause of the Piper Alpha disaster and identified managerial pressure as one of the major causes of that disaster. In another large industrial disaster, Mason (2010) reported managerial cost-cutting initiatives as a contributory factor to the Gulf of Mexico oil spill disaster in April 2010.

Dickety et al. (2002) found that many workers preferred to risk the consequences of working without protective equipment in order to complete as much work as possible and earn a higher wage. During the current research, workers at different sites were observed working without gloves, especially on tasks that required working in small spaces between other pieces of equipment. Flin et al. (2000) found that work pace and workload pressure had an effect on the balance between pressure for production and H&S policy and H&S behaviour.

> ***Proposition 10:*** Perceived H&S workload pressure leads to lower employees' H&S avoidance behaviour..

4.3.1 Work environment dangers

The work environment has been reported to be the source of workplace incidents that result in injuries or fatalities (Cooper, Liukkonen, & Cartwright, 1996). Environmental and workplace conditions such as dust, noise and hazardous equipment have been linked to workplace injuries and fatalities. For the construction industry, situational factors such as the weather, working at elevated heights, heavy machinery and equipment type have been reported as main causes of injuries. The work environment where construction projects take place comprises different locations, and can be dependent on weather elements that influence H&S on the building site.

The nature of construction work is a source of environmental factors that are specific to the particular phase of the project, which might involve working at elevated heights or below-ground excavation levels, each posing particular risks for H&S. For example, hazards at the excavation stage of the building project will vary from those at the roofing stage. It was assumed that employees would pay particular attention to risks and hazards that were directly relevant to their context and provide a true indication of perceived H&S behaviour (Fuller, 1999).

Proposition 11: Perceived H&S work environment danger will lead to higher employee H&S avoidance behaviour

4.4 H&S OUTCOMES

Based on the literature reviewed in Chapter Two and the discussion above, this study anticipates that the individual variables selected for inclusion in this study would play a significant role in predicting workers' H&S behaviour, and should be closely related to H&S performance and H&S avoidance behaviours. H&S outcomes have been the focus of numerous studies in the safety climate discourse, for example:

- safety performance (Brondino et al., 2012; Sui, Phillips, & Leung, 2004);
- unsafe behaviour (Cavazza & Serpe, 2009; Clarke, 2003; DeArmond et al., 2011);
- injuries (DeArmond et al., 2011).

These studies provided a basis from which the H&S outcomes for this study were derived.

4.5 H&S PERFORMANCE

In the review of literature conducted for this study and presented in Chapter Two, several factors have been identified as influencing safety performance in organisations. These factors have been grouped into common themes that relate to organisational factors, worker roles, management, work environment and technology (Tam, Zeng, & Deng, 2004).

H&S performance is a multi-dimensional concept that includes organisational processes that contribute to positive safety behaviours in workers engaging in H&S behaviour, thus reducing workplace incidents and fatalities (Cooper & Phillips, 2004; Glendon & Litherland, 2000). Previous studies (Glendon & Litherland, 2001; Zohar, 2000) that examined the effects of a safety climate on H&S performance have argued that a model of safety performance that was one-dimensional and focused on worker compliance was limited, and proposed models that included workers' safety initiatives.

Other studies presented expanded models that included safety initiatives by workers (Griffin & Neal, 2000; Neal et al., 2000). A two-dimensional model that distinguished between task and contextual performance was developed (Neal & Griffin, 2004), which included workers' adherence to safety procedures, working in a safe manner, helpful behaviour towards colleagues, and promoting safety in the workplace (Clarke, 2006). This model emphasised conscious individual behaviour, such as the use of PPE and taking safety precautions against hazards. This approach suggests that, when senior management, line managers and supervisors show commitment to H&S, workers will respond by taking on the responsibility of working in a safe manner and promoting H&S in the organisation. The perceptions that workers have of their senior management’s and supervisors' commitment to safety (Flin et al., 2000) contribute to workers' H&S motivation and responsibility for their own H&S. According to Neal and Griffin (2004), worker participation in H&S initiatives, H&S motivation, and knowledge of H&S were significant for H&S performance in the organisation.

The size of the organisation has been identified as one of the major influences on an organisation's H&S performance (Lin & Mills, 2001). The ability to perform better on H&S has been linked to the resources that large organisations can access to address H&S procedures, processes and practices in the organisation. The provided resources enable managers to implement H&S procedures and monitor these for efficiency, which ensures that the organisation experiences positive H&S performance (Choudhry et al., 2007). In large organisations, the capacity to establish H&S management systems allows for antecedents of an H&S climate to contribute to a positive safety climate (Choudhry et al., 2007). Such an environment should be supported by management attitudes, formal conditions, collective values, and individual attitudes, which interact and reinforce each other and influence H&S performance (Törner & Pousette, 2009).

Variables in large organisations which were reported as having the most influence on H&S performance have been investigated (Choudhry et al., 2007). The five important variables associated with construction site H&S performance were management talks on safety, provision of safety booklets, provision of H&S equipment, providing an H&S environment, and appointing a trained H&S representative on site (Choudhry et al., 2007). For small companies, the challenge is the lack of both financial resources and management's commitment to improve H&S performance. Two forms for measuring H&S performance are suggested: active or reactive. Active monitoring occurs before an accident, incident or ill health occurs. This can be done through audits, site inspections, plant and equipment checks, environmental monitoring and health surveillance (Vredenburgh, 2002). Reactive monitoring is done after an incident. It includes identification and reporting of accidents, injury or property damage, investigation of 'near misses' and cases of occupational ill health after an incident.

It is important to measure H&S performance in order to maintain and improve the safety climate in an organisation. According to Gadd and Collins (2002), little research has attempted to validate H&S performance results of the organisation with actual employee H&S performance (Fuller, 1999). Although limited empirical evidence exits that demonstrates a direct link between safety climate, the individual and H&S performance (Cooper & Phillips, 2004; Glendon & Litherland, 2000), some results reported a significant improvement in H&S performance in certain aspects of construction site H&S interventions (Lin & Mills, 2001; Zohar, 2010). Although there is common agreement that identical safety climate factors cannot emerge for all industries (Zohar, 2010), general factors have been identified, and future research should focus on factors that can be generalised to a specific industry and that will be able to predict performance for that sector (Lin & Mills, 2001; Zohar, 2010). According to Christian et al. (2009), safety climate is a predictor of safety performance behaviours (including individual responsibility and participation). Based on the literature reviewed, the current study adopted a two dimensional approach to safety performance (Neal & Griffin, 2004; Clarke, 2006) and assessed H&S performance as an outcome. The following was proposed:

Proposition 12: High levels of employee H&S avoidance behaviour will lead to higher H&S performance.

4.5.1 H&S avoidance behaviour

To investigate employees' H&S behaviour, the multidimensional model of H&S performance proposed by Neal and Griffin (1997), which distinguished between performance components, determinants of performance, and performance causes, was used as a foundation for the current study. The model has two dimensions of H&S compliance, which can be described as:

(a) employees adhering to organisational H&S procedures and policies and working in a safe manner; and

(b) H&S participation, which is described as helping co-workers, promoting H&S in the organisation and showing initiative with extra effort to improve H&S in the workplace.

The current study investigated the effect of individual motivation and incident reporting on employees' H&S behaviour in terms of self-reported adherence to organisation's safety requirements, which is the first dimension of the multidimensional model (Neal & Griffin, 1997).

Human errors have been the focus of H&S studies for a long period (Glendon et al., 2006; Reason, 1990). Four basic common human errors have been identified:

- Intended deliberate deviations from standard practice, errors where a worker makes a mistake or commits a direct violation of required H&S requirement.
- Mistakes which are knowledge-based, where the employee is not aware of the H&S requirement.
- Unconscious mental errors, which are skill-based, where the employee may not be aware at the time that an error is committed.
- Slips, which are task execution failures where the employee executes unintended actions.

Other studies suggest that H&S behaviour can be improved if emphasis is placed on aspects of H&S about which workers hold positive attitudes (Glendon et al., 2006). Identified H&S aspects include H&S goals that were found to affect H&S behaviour by focusing the attention and action of the worker on increasing motivation.

Other forms of H&S avoidance behaviours include extra role efforts by employees that promote the H&S goals of the organisation and contribute to the reduction of incidents (Riggio, 2009). Citizenship behaviours (CBs) are defined as discretionary behaviours that are not explicitly recognised by the formal reward system and that, in the aggregate, promote the effective functioning of the organisation (Riggio, 2009). According to Oguz (2010), CBs stimulate H&S

performance because they assist with establishing positive H&S practices and enhance coordination of efforts (Baker, Hunt, & Andrews, 2006).

A study conducted in the construction industry (Mohamed, 2004) found that employees' attitudes differed depending on whether the employee had personally experienced an accident or injury at work. Due to inherent dangers common to the industry, familiarity with the job and reduced danger awareness, coupled with tiredness or fatigue, were found to be significant causes of incidents and fatalities (Mohamed, 2004). According to Williamson et al. (1997), H&S interventions that focus on workers' H&S attitudes, together with supervisors' and top management's commitment, was deemed successful in ensuring positive worker H&S attitudes and behaviour. The measurement of H&S behaviour is often conducted utilising employee self-report methods (Glendon et al., 2006). In view of the review of relevant literature, it is proposed that:

Proposition 13: Low levels of H&S avoidance behaviour will predict low levels of workplace H&S performance

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4.5.2 Workplace injuries

Workplace injuries refer to physical harm that employees experience during the course of their work (DeArmond et al., 2011). Injuries from workplace accidents are a threat to every organisation and affect work processes and costs because of work interruption (DeArmond et al., 2011).

Injuries are an outcome of unsafe conditions, unsafe acts and chance variations (Zohar, 2010). Zohar identified three layers of causes of injuries:

- Organisational layer, which refers to the policies and procedures that are either formalised or espoused.
- Departmental layer, which refers to group-level priorities for competing demands at the operational level.
- The upper or surface layer, which refers to worker practices.

Although relationships between safety climate and injuries in the workplace have been investigated (Tomas et al., 1999), conclusions from reviews of research on the effects of attitude change interventions on behaviour and accidents or injuries have been pessimistic.

Previous studies have offered explanations for the occurrence of accidents in the construction industry (Haslam, et al., 2005). According to Haslam et al., the range of contributory factors to construction accidents range from the individual and team to include workplace factors such as scheduling and equipment (inclusive of work design and the safety culture in the organisation). The identified causes of accidents in the construction industry are not different from explanations offered for the occurrence of accidents in other workplaces range from random events that cannot be foreseen or prevented to individual employees' behaviour (Hovden, Albrechtsen, & Herrera, 2010). According to Hovden et al., (2010), changes in the work environment influenced by technology, work structures, work relationships and social pressures have impacted H&S management and resulted in participatory systems of dealing with H&S. Hovden et all proposed new approaches to H&S that consider the interaction between the individual workers, technology, strategic H&S management systems. The study advocates for flexible models that can be adapted and tailored to specific work contexts and local needs. In this regard, Hovden (2010) suggested a need to develop taxonomies of types of work relevant features of the socio-technical systems which can used to address accident prevention. Haslam et al., (2005) explained a wide range of contributory factors to accidents in the construction industry highlighting workers and work teams; workplace issues, faulty equipment, problems with suitability and conditions of materials and management deficiencies (page 401). The study developed a hierarchy of causal influences, which lists the important role of management and supervisors in managing risks and the reduction of accidents on construction sites. According to Haslam et al., (2005), it is important to benchmark H&S practices of the construction industry with other industries and for the sector to separate safety from bureaucratic processes. The study emphasises the importance of identifying and managing risks on construction sites.

The prioritisation of injury prevention strategies (Silverstein, 1998) is often motivated by the social and economic consequences for the organisation employing an injured worker. Organisations implementing injury prevention programmes and interventions focus on fatal and severe injuries, while minor incidents and ‘near misses’, which result in absence from work, are neglected (Silverstein, 1998). Fatal and severe injuries are the focus in occupational injury prevention strategies employed by organisations (Silverstein, 1998). A focus on the reduction of injury absence opens up the possibilities for new strategies in injury prevention that are not only focused on prevention but also on compensatory and return-to-work aspects (Silverstein, 1998), which are beneficial to organisations in the long term.

Injuries, fatalities and the ensuing absenteeism that arise from such incidents can be reduced either by preventing them from occurring (primary prevention), by reducing the initial effects through effective medical and social care (secondary prevention), as well as various return-to-work schemes (tertiary prevention) (Leka & Houdmont, 2010). According to Leka and Houdmont (2010, p. 91), primary interventions targeted the problem at the source, and are “designed with aspects of work design, organisation and management” For H&S issues this will relate to how the work is organised and structured, and also management processes that are in place in relation to H&S. When strategies are concerned with the primary prevention of injuries, then steps are taken to establish which types of injuries are occurring and try and design work and ensure that the injuries are eliminated or minimised. Leka and Houdmont (2010, p. 92) further describe secondary interventions as those that empower workers with cognitive ability to respond to problems that endanger their wellbeing. Secondary interventions for the construction industry can include communication and training that can empower the workers to respond to accidents in a positive way either though behaviour reaction or positive responses to accidents and fatalities. Tertiary interventions, which are aimed at workers who have already experienced injuries, would include the provision of first aid, medical care and treatment as remedial activities by the organisation (Leka & Houdmont, 2010, p. 92). When efforts to reduce injuries are targeted at the secondary intervention level, the strategies will involve influencing worker behaviour, and can include training and forums that increase knowledge of H&S procedures and practice (Zohar, 2010).

To address injuries at tertiary level is costly for organisations as this involves remedial measures which result in increased additional labour force and medical costs for the injured worker.

Proposition 14: Higher levels of H&S performance will lead to lower levels of workplace injuries..

Table 4.1

Global Safety Climate Studies

Author & Year	Participants and response rate in parentheses	Safety climate dimensions	Country	Factor structure	Intercorrelations in parentheses
Snyder, Kraus, Chen, Finlinson and Huang, 2008	253 unionised blue-collar workers (59%)	Situation constraints (SC1) Safety control (SC2) Safety climate (SC) Workplace injuries (WI)	USA	.93 .82 .94	SC1 & WI (r = .24) SC2 & WI (r = -.06 P>.05)
Neal et al., 2000	525 (56%) hospital workers	General climate (GC) Safety climate (SC) Safety knowledge (SK) Safety motivation (SM) Safety compliance (SC2) Safety participation (SP)	Australia	.94 (35) .93(16) .90(4) .93(4) .94(4)	CFA confirmed 7 factor dimensions GC & SC (r = .52;) SK & SC (r. = 20;) SM, GC, SK & SC (r = .21; r = .40; r = .65) SC2, GC, SK, SM & SC (r = .23; r = .42; r = .68; r = .75); SP, GC, SK, SM, SC2 & SC (= r.19; r = .47; r.55; r = .53; r = .54).
Parker et al., 2006	26 in-depth interviews oil rig senior staff		USA	n/a	n/a
Clarke, 2003	185 car manufacturing workers (71%)	Work environment (WE) Job communication (JC) Assessment of safety (AS) Safety climate (SC) Safety behaviour (SB) Accident history (AH)	UK	-(6) .78(7) -(11) -(20) .86(9) -	EFA confirmed 5 factors. JC & WE (r = .43)
Cheyne et al., 2002	708 manufacturing workers (66%)	Safety management (SM) Communication (C) Individual responsibility (IR) Safety standards (SS) Involvement (I) Work environment (WE) Workplace hazards (WH)	USA France Argentina	.89 .79 .58 .62 .69 .66	7 factors confirmed with CFA

		Safety activities (SA)		-	

Author & Year	Participants and response rate in parentheses	Safety climate dimensions	Country	Factor structure Intercorrelations in parentheses	
Mearns et al., 2001	722 oil & gas industry (33%)	Job communication (JC) Safety behaviour (SB) Safety hazards (SH) Safety satisfaction (SS) Safety attitudes (SA) Accident history (AH) Your job (YJ)	UK	-(-) -(12) -(18) -(20) -(52) -(8) -(18)	PCA varimax rotation. Six out of 14 correlations were significant but weak.
DeArmond et al., 2011	Study1: 150 plumbers, fitters, pipe fitters (14.3%) Study2:182 (29.6%)	Safety compliance (SC2) Safety participation (SP) Injuries	USA	.70 (10) .88(10)	CFA confirmed two-factor model
Ismail et al., 2012	275	Management (M) Personal (P) HRM incentive HRMI) Relationship (R) Resources (R2)	Australia China Finland Jordan Malaysia The Netherlands Singapore Spain Thailand USA		EFA confirmed 5 factors
Cavazza and Serpe, 2009	345 blue-collar workers	Unsafe behaviour Company safety concern Senior managers' safety concern Supervisor attitude	Italy	.66(3) .84(-) .80(-)	EFA confirmed 7 factors

Workgroup safety involvement	.68(-)
Work pressure	.34(-)
Safety communication	.74(-)
	.53(-)

Author & Year	Participants and response rate in parentheses	Safety climate dimensions	Country	Factor structure Intercorrelations in parentheses	
Sui et al., 2004	374 construction workers	Safety attitudes (SA) Communication (C) Psychological distress (PD) Job satisfaction (JS) Safety performance (SP)	Hong Kong	.93(33) .84(7) .93(13) .81(2) -(3)	CFA confirmed five separate factors C & SA (r = .66); PD, C & SA (r = .23; r = .19); JS, C, PD & SA (r = .43; r = .50; r.21);
Brondino et al., 2012	991 blue-collar workers (83%)	Organisation safety climate (OSC) Supervisory safety climate (SSC) Co-worker safety climate (CSC) Safety performance	Italy	.93(12) .95(10) .95(12) .84(8)	Two factors confirmed

Note: All studies were cross-sectional survey studies, unless specified otherwise; PAF (principal-axis factor analysis); CFA (confirmatory factor analysis). There was no consistency of items in the different studies with the same variable names.

4.5.3 Control variables

The following demographic variables were included to determine if any relationships existed between worker's perceptions of H&S climate and age, gender, tenure and employment status. According to Nielsen and Mikkelsen (2007), variations amongst participants in a study of 765 Danish manufacturing workers at three different plants, (i.e. seniority of employees, skill levels, age and gender) to explain self-reported injuries. Spector and Brannick (2011) have reported on the importance of demographic variables in research. They recommended that specific roles for each variable be outlined to ensure clarity of findings. Demographic variables such as age, gender, race, educational background, tenure were reported to influence work-related outcomes (Shantz, & Booth, 2014). For this study, participant race, age and gender were used as attributes that could possibly help explain perceptions about H&S climate and could contribute to their H&S behaviour and experience of injuries on the job. Educational level was included because it may influence participant awareness and sensitivity to H&S climate factors in the workplace. Tenure and work status were considered relevant variables because they may influence a workers' understanding of the organisation's H&S climate and influence H&S behaviour and injuries in the long term (Shantz, & Booth, 2014; Spector & Brannick, 2011).

Proposition 15: Employees' age will predict high levels of H&S avoidance behaviour amongst construction workers.

Proposition 16: Employees' race will predict high levels of H&S avoidance behaviour amongst construction workers.

Proposition 17: Employees' gender will predict high levels of H&S avoidance behaviour amongst construction workers.

Proposition 18: Employees' tenure will predict high levels of H&S avoidance behaviour amongst construction workers.

Proposition 19: Employees' education level will predict high levels of H&S avoidance behaviour amongst construction workers.

Proposition 20: Employees' contract type will predict high levels of H&S avoidance behaviour amongst construction workers.

The following table presents a summary of the determinant research propositions to be tested in this study.

Table 4.2

Summary of Determinant Research Propositions

Proposition 1	Proposition 1: Top management's commitment to H&S will predict employees' H&S motivation.
Proposition 1.1	Top management's commitment to H&S will predict employees' individual H&S responsibility.
Proposition 1.2	Top management commitment will predict employees' H&S incident reporting.
Proposition 2	High levels of supervisory H&S leadership will predict high levels of H&S motivation amongst construction workers.
Proposition 2.1	High levels of supervisory H&S leadership will predict high levels of individual H&S responsibility amongst construction workers.
Proposition 2.2	High levels of supervisory H&S leadership will predict high levels of employees' H&S incident reporting amongst construction workers.
Proposition 3	The presence of H&S management systems in an organisation will predict employees' H&S motivation amongst construction workers.
Proposition 3.1	The presence of H&S management systems in an organisation will predict employees' individual H&S responsibility.
Proposition 3.2	The presence of H&S management systems will predict employees' H&S incident reporting.
Proposition 4	The presence of effective H&S communication in organisations will predict employee H&S motivation amongst workers.
Proposition 4.1	The presence of effective H&S communication will predict employees' individual H&S responsibility amongst construction workers.
Proposition 4.2	The presence of effective H&S communication will predict employees' H&S incident reporting amongst construction workers.
Proposition 5	Convening regular toolbox talks will predict employees' H&S motivation amongst construction workers.
Proposition 5.1	Convening regular toolbox talks will predict employees' individual H&S responsibility amongst construction workers.
Proposition 5.2	Convening regular toolbox talks will predict employees' H&S incident reporting amongst construction workers.
Proposition 6	The provision of H&S training for construction workers will predict employees' H&S motivation.
Proposition 6.2	The provision of H&S training for construction workers will predict employees' H&S incident reporting.
Proposition 7	Construction workers' H&S motivation will predict employees' H&S avoidance behaviour.
Proposition 8	Employees' perception of individual H&S responsibility helps predict H&S motivation
Proposition 9	High levels of H&S incident reporting will lead to high levels of H&S avoidance behaviour.
Proposition 10	Perceived H&S workload pressure leads to lower employees' H&S avoidance behaviour.
Proposition 11	Perceived H&S work environment danger will lead to higher employee H&S avoidance behaviour.
Proposition 12	High levels of employee H&S avoidance behaviour will lead to positive H&S performance.
Proposition 13	Low levels of H&S avoidance behaviour will predict low levels of workplace H&S performance.
Proposition 14	Higher levels of H&S performance will lead to lower levels of workplace injuries.
Proposition 15	Employees' age will predict high levels of H&S avoidance behaviour amongst construction workers.
Proposition 16	Employees' race will predict high levels of H&S avoidance behaviour amongst construction workers.
Proposition 17	Employees' gender will predict high levels of H&S avoidance behaviour amongst construction workers.
Proposition 18	Employees' tenure will predict high levels of H&S avoidance behaviour

	amongst construction workers.
Proposition	Employees' education level will predict high levels of H&S avoidance behaviour amongst construction workers.
Proposition 20	Employees' contract type will predict high levels of H&S avoidance behaviour amongst construction workers.

Note: Table excludes propositions testing correlations amongst the variables.

4.6 CONCLUSION

The objective of this chapter was to present the rationale for the selection of variables that were included in the proposed conceptual explanatory model of safety climate in the construction industry. This study contributes to the generation of new knowledge in the study of safety climate in South Africa. To achieve the above research objective a conceptual model was hypothesised and empirically tested. The following chapter presents the dimensions identified and included in this model. The proposed model was presented highlighting the variables that were identified from a review of literature and structured interview field notes. This chapter provided an overview of the literature that informed the development of the proposed H&S climate model. The following chapter describes the research design and tools used to test the constructs in this model.

CHAPTER FIVE

METHOD

5.1 INTRODUCTION

The previous chapters presented the proposed explanatory model and a review of relevant literature. This chapter presents the research design, data collection techniques and procedures and data analyses used to meet the objective of developing an explanatory H&S climate model for the South African construction industry. Creswell (2009) has indicated that empirical research requires clear delineation of the research design, procedures, data collection methods and data analyses if it is to be regarded as valid.

5.2 RESEARCH DESIGN

This study used a descriptive research design (Babbie & Mouton, 2007; Hair, Black, Babin, Anderson, & Tatham, 2006) which combined a quantitative survey method with qualitative research methods of observations and structured interviews as data collection methods. The combination of data collection methods rooted in different research paradigms enabled the researcher to collect diverse types of data to increase a better understanding of the research phenomena (Creswell, 2003). Of the use of multiple data sources allowed for an evaluation of information obtained from the theory-driven literature review and provided a richer insight into the research problem (Babbie & Mouton, 2007; Creswell, 2009). Figure 5.1 illustrates the research design and data collection process.

A quantitative descriptive design was best suited to the questions raised in this study; however, a qualitative approach was important as a preliminary method to explore whether the variables were consistent with employees' perceptions of H&S in the local construction industry. The principle of using more than one data collection method for the research of a multidimensional concept such as safety climate was designed to increase the understanding of the construct with deeper insight into the phenomenon under investigation than the use of a single method approach would allow (Creswell, 2009). The benefits of using both qualitative and quantitative data collection methods have been reported extensively (Creswell, 2009; Teddlie & Tashakkori, 2009). This study used a two-phase approach to data collection. Qualitative data was used to inform the modification of a quantitative measurement tool. A cross-sectional survey was the main data collection approach (Blumberg, Cooper, & Schindler, 2005; Creswell, 2009). A sequential strategy (Creswell, 2009), using the review of literature as a foundation for the selected data collection approach was used. This lens was considered appropriate for use to provide the researcher with a framework for the investigation and informed the methods used for data collection. A sequential data collection process "occurs across chronological phases of qualitative–quantitative (Qual–QUAN), where procedures of one strand depend on the previous phase, and research questions are related to one another" (Teddlie & Tashakkori, 2009, p. 151). The current study combined processes where a theoretical lens was used as an overarching perspective within an approach that used both quantitative and qualitative data. This approach ensured that findings from the exploration phase informed the quantitative phase (Creswell, 2009; Hanson, Creswell, Plano Clark, Pretska, & Creswell, 2005).

Qual → **QUAN**

Qual	Qual	Qual	**QUAN**	**QUAN**	
Data collection →	Data analysis →	Qual data interpretation →	Data collection →	Data analysis →	QUAN data interpretation

Note: Qual = qualitative sequence; QUAN = Quantitative sequence; bold capital letters indicate the dominant data collection method used in this study (Creswell, 2009)

Figure 5.1: Sequential Data Collection Strategy

5.2.1 Rationale for using sequential data collection approach

To investigate and understand the H&S climate in the South African construction industry, the study required a data collection approach that would open alternative viewpoints to the multi-dimensionality of the construct. The use of structured questions during the interview phase enabled respondents to give relatively unrestrained answers which allowed for extended discussions on H&S climate factors (Teddlie & Takkashori, 2009). The use of observations made it possible to observe H&S behaviour without conversing with participants, allowing for data that was not influenced by social desirability (Neumann, 2007). Where qualitative research provided detailed insight to lived H&S work experiences, the quantitative approach offered an opportunity to gather specific targeted answers and an opportunity for generalisation of the findings. This was useful for testing the theory-derived hypotheses (Creswell, 2009; Hanson et al., 2005). The use of a survey tool is acknowledged to be a time-saving data collection method that has the ability to reach large numbers of participants (Babbie & Mouton, 2007) and to offer the benefit of anonymity. The standardised format of surveys offers consistency for the participants to respond to the questionnaire, as they understand it.

During the qualitative phase, a literature review, observations and structured interviews were used to collect preliminary data to inform the quantitative phase. The data collected from these sources allowed for H&S climate themes to emerge. The purpose of observations and interviews in this phase was to explore how the construction workers thought and felt about the H&S climate in the construction industry. The second purpose was to confirm the findings of the literature review that underpinned the development of the proposed H&S climate model. These processes allowed the researcher to include variables that would inform the proposed H&S climate model. Themes from qualitative data were extracted using content analysis (Neumann, 2010).

The second phase comprised a cross-sectional survey assessing construction workers at the individual level of analysis. The researcher chose to use a self-administered questionnaire as the data collection tool, because it is the most commonly used data method in the study of safety climate (Guldenmund, 2000). The use of a questionnaire is described as post-positivism (Creswell, 2003), as it assumes knowledge to be objective and measurable. Close-ended questions were used to answer predetermined questions. The study emphasised the second phase, which was the quantitative survey method. This decision was based on the dominance of quantitative studies of safety climate. The qualitative phase enhanced the findings of the study. The sequential data collection approach of the study, which combined the use of both qualitative and quantitative data, minimised the issue of mono-method bias (Spector, 1994).

5.3 PROCEDURES

The following section is a description of the data collection procedures followed for the qualitative and quantitative data collection phases.

5.3.1 Ethics approval

Before the data for this study could be collected, the researcher applied for written ethical clearance from the Commerce Faculty Ethics in Research Committee of the University of Cape Town. This required the submission of a full research proposal describing the study objectives and a full description of the data collection methods. Data collection commenced once the study proposal received ethical clearance (Appendix A).

The total number of possible construction sites for the study was derived from a database containing more than 400 member organisations of the master builders association Western Cape, South Africa (MBAWC) One hundred and thirty-two organisations identified as national organisations that had branches in the Western Cape formed the population for the study. This list was further reduced in consultation with the researchers contact at MBASA to 22 organisations which were identified with on-going building projects at different construction stages. These organisations were approached for access to the study at their building sites.

5.3.2 Qualitative data collection procedure

For the qualitative phase of the study, the researcher used a purposeful sampling approach to select construction sites for observations and structured interviews (Creswell, 2003). This approach enabled the selection of construction sites based on predetermined criteria by the researcher. Two broad categories of commercial and residential building projects were identified as the target for observation and interview data collection stages. Commonly acknowledged differences of work processes evident at commercial and residential projects were a consideration in the selection of project sites for the qualitative phase of the study. The sample for constructions sites where observations and interview participation were solicited was limited to five organisations which were affiliated members of MBAWC. These organisations had multiple building projects where interview participants could be accessed.

A brief written explanation of the study was presented to the organisation representative, with a copy of the ethical clearance from the University of Cape Town. The researcher asked the respective site managers for a brief description of their current building projects. This was to enable the researcher to identify residential and commercial building sites for sampling purposes. Written permission was obtained from the managers at construction sites who agreed to participate in the study.

5.3.3 Quantitative data collection procedure

As with the qualitative data collection phase, the population for the survey sample were employees at construction sites of the selected organisations. Out of this population, a non-probability sample was drawn based on accessibility of workers at a particular building site. The use of a non-probability convenient sample (Creswell, 2009) was acceptable given the objective of exploration and knowledge generation of the H&S climate construct in the local construction environment. Two main objectives were identified for the use of a survey:

- To enable the researcher assess the proposed H&S climate model, for which a larger sample than that for the preliminary data collection stage had to be targeted; and

- To expand the findings of stage 1, a quantitative cross-sectional survey targeting the individual level of analysis was suitable and used as the dominant data collection tool (Creswell, 2009; Hanson et al., 2005).

Out of this population, a non-probability sample was drawn based on accessibility of workers at a particular building site. The use of a non-probability convenient sample (Creswell, 2009) was best suited to the objective of exploration and knowledge generation of the H&S climate construct in the local construction environment because the target sample was context specific due to the nature construction work. Two main objectives were identified for the use of a survey tool:

- To enable the researcher test the proposed H&S climate model, for which a larger sample than that for the preliminary data collection stage had to be targeted; and
- To expand the findings of stage 1, a quantitative cross-sectional survey targeting the individual level of analysis was suitable and used as the dominant data collection tool (Creswell, 2009; Hanson et al., 2005).

The design and administration of the H&S climate survey tool for this study was subjected to validation of the measurement tool, which involved of a series of sequential qualitative steps, a review of the measurement tool by experts and a pilot study (Babbie & Mouton, 2007; Creswell, 2009; Neumann, 2010).

Once the questionnaire was developed, the items were subjected to an expert review by two senior H&S practitioners. To increase face and content validity the developed scales were reviewed by two H&S industry experts (Babbie & Mouton, 2007). Recommendations from both experts were made on the number of items in the survey tool. These included the use of local terms and phrases to replace words that were not common to the local construction sector. Once the survey tool was reviewed it was deemed suitable for a pilot study (Seo et al., 2004). These recommendations were deemed beneficial to the outcome of the study and were incorporated in the measurement tool. According to Hair, Babin, Money and Samuel (2003), the level of precision wanted and the educational level of respondents should influence whether a five-point or seven-point Likert scale should be used. The language, layout and length of the questionnaire took into consideration the target populations' literacy levels to maximise response rates. The items were simplified where needed to ensure that respondents understood the questions.

After designing and developing the survey tool, and obtaining the necessary ethical clearance from the Ethics in Research Committee, the researcher commenced the survey administration process. Seventeen organisations that had building projects that fulfilled the criteria set out by the researcher were approached to participate in the survey component of the study. These organisations had been preselected by the researcher because they were engaged in either residential or commercial building projects and were members of MBASA.

During the first contact with 17 site managers at these organisations, the researcher presented a written two-page summary of the proposed study outlining the objectives and data collection methods together with a copy of the ethical clearance from the University of Cape Town. From the organisations contacted, ten granted the researcher written permission to survey the workers at their building sites (Appendix B). The researcher obtained a brief description of building projects to identify residential and commercial building sites for sampling purposes. Once the organisations had been categorised into these two categories, two building sites were identified for purposes of administering the quantitative pilot study; the rest of the building sites were retained for the main study.

All questionnaires were hand-delivered by the researcher to all sites. One thousand and two hundred hard copy questionnaires were administered. These were hand-delivered and administered by the researcher. Permission to survey workers was obtained from the organisation's main office and communicated to each building site manager. An appointment was made prior to each site visit with the site manager and a convenient day for the researcher to administer the survey was agreed upon.

The questionnaire had a cover letter with instructions and information regarding confidentiality, anonymity and voluntary participation. The researcher informed the participants of the confidentiality, voluntarism and anonymity of the data given, emphasising that they did not have to indicate their names or identifying tags on the questionnaire each time the survey was being completed. The researcher was available to address any questions posed by the participants at every site. An interesting question was raised at one building site by a participant, who objected to the lack of identifiers on the survey form. He said, "Now, how will they know that we are the people who said these things, because they need to know who said the things on this site." An explanation of research ethics was provided together with an explanation of how the data would be analysed and disseminated.

To avoid low response rates, participants were requested to complete the questionnaire and return it immediately. The sample was a challenge to survey for various reasons. Firstly, workers were not given time to complete the survey form during normal working hours. The researcher had to negotiate specific lunch time sessions on a particular day to conduct the survey. For example, the researcher was not allowed to survey on Monday because the site would be busy with issues from the previous week. The researcher was often asked not come and survey workers on Friday because the workers left work earlier on Fridays. Disadvantages such as clarification of difficult to understand questions were compensated for by the presence of the researcher at each venue to address any questions. Because the survey was administered during lunch, participants were offered a packed lunch to compensate for the time taken. Creswell (2009) supports the offer of incentives to study participants. The quantitative data collection process took place during the period August 2010 to December 2010.

5.3.4 Data collection time frame

Data collection took place over a period of one year. The review of literature began in 2009 and was an on-going process throughout the study. Site observations were conducted between August and September 2009, and together with the literature review informed the development of the structured interview schedule. Structured interviews were conducted during the period January to March 2010. Data obtained from structured interviews was used to develop the survey measurement tool, which was administered between August and December 2010.

Table 5.1

Data Collection Time Chart

	Technique	Time frame		Outcome
1	Review of literature	2008	2009	Safety climate variables identified
2	Observations	2009	2009	Structured interview schedule
3	Structured interviews	2010	2010	Confirmed safety variables for survey
4	Survey	2010	2011	851 respondents

Note: The data collection process was sequential to allow for the outcomes of initial phases to inform the dominant quantitative data collection method.

5.3.5 Qualitative data collection

The first stage of data collection during the period April 2008 to December 2009 involved a review of literature to gain knowledge of the safety climate construct and to identify variables suitable for the proposed study.

5.3.5.1 Documentary data

The first stage of data collection involved a scrutiny of H&S documents available at the sites that were identified for the qualitative phase of this study. These documents included H&S protocols, procedures, H&S behaviour instructions, H&S signs and notices. This phase was aimed at collecting base data on the organisational structures and requirements that were present at the selected sites to determine the common systems at construction sites.

Construction industry documents and reports were obtained from the Construction Industry Development Board (CIDB) website. The documents enabled the researcher to acquaint herself better with the H&S issues in the construction industry and on project sites. Scrutiny of H&S documents helped provide insight of H&S management structures, H&S requirements and actual H&S behaviour on site. The H&S documents were helpful in identifying H&S issues prevalent on sites and assisted in generating a checklist of issues to be observed during site observations.

The review of literature on safety climate studies was initiated with an electronic search of subject databases. Recent journal articles and seminal studies on the construct of safety climate were targeted for review. Through the review of literature, specific construction industry journals and regulatory bodies were identified as potential sources of data.

The outcomes of the scrutiny of H&S documents and review of literature were used to guide the inclusion of themes to be used for the observation and interview phase of data collection.

5.3.5.2 Observations

Observations are an accepted data collection method because they are not intrusive and can be used to obtain useful and insightful data (Hair et al., 2003; Neumann, 2010). The researcher took notes on observed H&S incidents and interactions at the visited sites (Teddlie & Tashakkori, 2009). The review of literature was used as a basis for these observations. A look and see observational approach (Jorgenson 1989) was used during visits to construction sites the researcher took notes. Five sites were selected for observations as sources of valuable information related to the research question. All workers present on site had an equal chance of being observed (Teddlie & Tashakkori, 2009). The data was collected unobtrusively (Hair, Babin, Money & Samouel, 2003), this was achieved by arriving at each site at the agreed date and time. The researcher observed how workers went about their duties. A walk around the construction site provided the researcher with information that either confirmed the documentary review of safety climate studies. Observations were conducted on different days of the week, some sites were visited in the morning when workers were preparing to start the day, at these sites, and the researcher participated in safety meetings. There was no structured programme of what to observe on site, but documented H&S violations on construction site were used as an initial starting point for observations to list the presence or absence of H&S practices or procedures Observation data offered the researcher additional insight into H&S climate factors in the South African context (Babbie & Mouton, 2007). The data collected was used for contextual insight.

This data offered the researcher an opportunity for additional insight to understand existing safety climate perceptions on the observed sites (Babbie & Mouton 2007).

The data collected was used for contextual insight. This data offered the researcher additional insight to understand employee safety climate perceptions on the observed sites (Babbie & Mouton 2007).

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This data offered the researcher an opportunity for additional insight to understand existing safety climate perceptions on the observed sites (Babbie & Mouton 2007).

5.3.5.3 Semi-structured interviews

To gain a deeper understanding of the H&S climate and to explore how workers in the South African construction industry perceive safety climate and investigate antecedents for H&S behaviour, the researcher used semi-structured interviews to gather contextual information not available from the literature review and observations. The interviews were conducted over a period of three months between January and March 2010. A standardised open-ended interview schedule (Appendix C) was chosen because it allowed the researcher control over the line of questioning (Creswell, 2009; Teddlie & Tashakkori, 2009). Interviews have been found to be a reliable tool for accessing respondents' perceptions about their situation (Babbie & Mouton, 2007). Interviews are a useful data source because participants are able to provide information that cannot be easily or directly observed or documented

(Neumann, 2010). The use of interviews in the current study enabled the researcher to have control over the questioning and to probe for details that may not have been documented or observable. Interviews enabled for insight that is relevant to the industry sector and a diverse range of worker perceptions to be elicited.

Prior to the interviews, the researcher introduced herself as a doctoral candidate from the University of Cape Town, and informed participants that all information collected was for academic purposes only. At each construction site, the researcher asked for permission to interview workers from different work roles categorised as senior management on site, operational supervisors and general workers using the letter obtained from the Ethics in Research Committee from the Faculty of Commerce of the University of Cape Town (Appendix B1).

After completion of the qualitative data collection, the information gained from both observations and structured interviews and the notes taken were examined and summarised. Content analysis was used to code the data and derive safety climate themes from the notes (Babbie & Mouton, 2007). Categories were developed for the major themes that emerged and this helped confirm the review of literature. The data from this phase helped to inform the development of the quantitative measurement tool (Neumann, 2010). Considering that most studies of H&S climate have predominantly used quantitative methods, the use of qualitative methods to inform the quantitative phase of the study enhanced the data collection process.

5.3.6 Quantitative data collection

As with the qualitative phase, the population for the survey sample comprised workers at building sites of construction organisations which were members of the MBASA and selected according to the criteria described above. The use of a survey measurement tool has well-established advantages and disadvantages (Terre Blanche, Durrheim, & Painter, 2006), which were considered relevant for this study:

- Cost: The consideration of time to collect data using alternative tools entails taking into account additional costs for the organisation and the researcher. The survey tool collects data from a part of the population and therefore costs less.
- Time: The use of a questionnaire ensures that a high volume of participants can be surveyed in a short time.
- Control: The researcher had control over which data is collected and the format of the data required which is designed to test the proposed model.
- Response: The survey tool enables the researcher to sample fewer workers, in this case, construction workers in the Western Cape, but the findings can be generalised to the construction sector (Terre Blanche et al., 2006). The generalisation of findings in this study can be limited to the common variables that construction sites share taking into consideration that construction sites will experience different environmental hazards.

The researcher concluded that the advantages of a survey tool outweighed the disadvantages and that this method was best suited to the study objectives.

5.3.7 Research participants

The total number of participants in this study was 862 construction workers at construction companies who were members of the MBASA. The qualitative sample of the structured interviews had 11 participants and the quantitative phase survey comprised 851 participants.

5.3.7.1 Structured interview participants

After obtaining permission from the site manager, a list of workers present at each building site was developed by the researcher. The total number of organisations was five, yielding six building sites. Selection of participants for interviews was done using a random sampling process at each site, where the researcher asked for workers from different work roles present on the day of the interview to be participants. This approach allowed for a diverse sample of participants with a variety of work roles and experiences to provide perceptions on H&S (Struwig & Stead, 2003). Participants were given a verbal briefing, outlining objectives of the study and were informed of voluntary participation. All participants were informed that no names would be recorded and that information obtained would not be given out to anyone beyond the need for academic study. Confidentiality was guaranteed and participants were informed that no organisational or individual information would be disclosed to anyone other than the researcher. Participants were told that they could end the interview at any point should they feel uncomfortable. The researcher intended to interview a diverse range of work roles and positions, however most workers approached were not keen to participate and informed the researcher that they were not comfortable being interviewed. The assurance of anonymity and confidentiality was met with statements such as “how can they not know who is talking when people see you talking to me? This response was common amongst the unskilled workers. The participants who voluntarily agreed to participate were interviewed.

Each participant was given a chance to answer questions in an interview schedule (Appendix C) such as:

- What H&S problems do you experience on this site?
- How often do you discuss H&S issues on this site?
- Do managers or supervisors accept H&S suggestions from workers on this site?
- How important is H&S for you? Why/why not?
- How dangerous or risky is your work? Why?

When participants raised questions, clarification was offered. Each interview lasted for approximately an hour. Eleven interviews were conducted before saturation was achieved and no new insights were emerging (Neumann, 2010). Table 5.2 presents the characteristics of structured interview participants.

Table 5.2

Characteristics of Structured Interview Participants

Site	Participant	Occupation	G	Age	Project
1	Participant 1	H&S manager	M	45	Multipurpose community centre
	Participant 2	General worker	M	29	
	Participant 3	Site manager	M	34	
2	Participant 4	Head engineer	M	43	Building and refurbishments – residential
3	Participant 5	Property services manager	M	50+	Tertiary institution
4	Participant 6	H&S officer risk management services	M	50	Risk management services tertiary
5	Participant 7	H&S officer	F	30	Residential building site
6	Participant 8	Site manager	F	32	Refurbishment central Cape Town station
	Participant 9	H&S officer	M	52	
	Participant 10	Senior foreman	M	38	
	Participant 11	General worker	F	18	

Note: Interviews were conducted by the researcher between January and March 2010

5.3.7.2 Pilot study participant sample

After compiling the survey instrument, it was deemed important to evaluate how comprehensive the tool was in meeting the study objectives. A pilot survey was conducted to evaluate the clarity of the measurement tool for the local sample and also to check how practical the tool was for this particular study population. The pilot study was considered necessary to determine whether the target sample would be able to understand the questions in the survey (Neumann, 2010; Terre Blanche et al., 2006). The use of a non-probability convenient sample (Creswell, 2009) was best suited to the selection of building sites to be included in the pilot study. This supported the objective of exploration and knowledge generation of the H&S climate construct in the local construction environment.

Two sites were selected (sites 9 and 10). Site 9 was a small-sized residential refurbishment project, and site 10 was a large-scale commercial refurbishment of the central train and bus station in Cape Town. Because of the magnitude of the work at site 10, a random section of the site was selected for the pilot study based on the number of workers deployed in that section. One hundred and thirty questionnaires were distributed at the two sites: site 9 had 36 workers and site 10 had approximately 96 employees. In total, 150 questionnaires were distributed.

There were 83 responses from participants in the pilot survey, which represented a response rate of 69%. Of these 83 participants in the pilot survey, 26 did not complete at least half of the survey questionnaire and their responses were therefore not used for the refinement of the main measurement tool (Hair et al., 2006). Of the 57 usable responses in the pilot survey, 19 were returned from Site 9 and 38 from Site 10. Of the total number of participants, only four were female (7%), which is not surprising given the male-dominated nature of the construction sector (CIDB, 2009).

The ages of respondents ranged between 25 and 59 *(SD = 10.51*). The race distribution in the sample was African (n = 31), Indian (n = 6), coloured (n = 8) and white (n = 2) (i.e. there were 55 black and 2 white respondents). Of the participants at site 9, four respondents had education beyond Grade 12, and at site 10, two respondents reported an education higher than matric. The rest of the participants were below Grade 12.

After the questionnaire was piloted, it was observed from questions raised by respondents that additional explanations were required on some of the items. These questions were revised to incorporate words or phrases familiar with the local workforce. Once revised, the researcher consulted two industry sector experts to verify the contextual appropriateness of the revised items. After the questionnaire was reviewed, the researcher interviewed two participants to verify correctness of the items changed. Taking into consideration the comments of the participants interviewed, the estimated time taken to complete the questionnaire was 20 minutes. Once verified, the survey was ready to be administered to the target sample.

The researcher noted that during the pilot study the biggest hindrance to the completion of the pilot survey was the low literacy levels of participants. When participants were asked at a later date if they would have been able to complete the same questionnaire if it was translated into a language that is commonly used in the Western Cape, a negative response was received. The researcher decided not to increase the number of items as the survey adequately covered the study data requirements. Taking into consideration the decision to administer the survey during lunch, 20 minutes was considered an acceptable time frame to allow participants to have a break still. No new items were added to the scales. The researcher decided to continue with the survey administration using English as the survey language.

5.3.7.3 Main study participant sample

Given the good response rate obtained in the pilot study, the researcher decided to use the same approach and survey administration process to survey the sample for the main study. In addition, the participants were incentivised with a lunch pack for their participation. Random sampling of individual workers was considered the most appropriate strategy for the main sample in this study providing an opportunity for representativity and generalisation (Terre Blanche et al., 2008). Participants for the survey were randomly selected based on their availability on the day that the researcher visited the site.

The sampling strategy applied to the main study target sample yielded a total of 794 responses, which represented a 66% response rate from the 1 070 questionnaires distributed. In total, eight construction sites were surveyed for the main study. It has been reported that low response rates are common in construction industry surveys (Haupt, 2003). The high response rate in this study is attributed to the administration of the survey during the lunch break and perhaps the provision of an incentive for participation. The response rate was considered adequate and acceptable, and no further data was collected.

A total of 851 survey forms were collected from both the pilot and main study. This sample consisted of 84% male and 13% female respondents while 3% of the participants did not indicate their gender. Overall, the sample had more males than females. This was anticipated in this industry sector, as was the higher level of manual labour categorisation due to the nature of the work on building sites. The age of participants ranged between 18 and 66 years (*M = 33.15; SD = 9.16*). The race distribution in the sample was black (*n = 454*), coloured (*n = 299*), white (*n = 46*), Indian (*n = 3*), and other (*n = 3*). Using the racial categorisation by the Ministry of Home Affairs, participants self-reported on their racial grouping, indicating the following: 93.9% were black and 5.7% were white. Concerning the level of education, 67% (*n = 569*) respondents has less than a Grade 12-level qualification, 20% (*n = 173*) had attained education beyond matric, 13% (n = 109) did not indicate the education level attained.

Employees who had worked for the organisation had an average of 5.5 years tenure with the longest period being 41 years and the shortest period one year (*M = 5.57; SD = 5.12*). The period working with the same supervisor ranged from less than one year to 40 years (*M = 3.93; SD = 4.02*). The average age of respondents and the number of years working with the same supervisor and working for the same company suggested that the respondents knew the organisation's H&S well enough to answer the questionnaire with good insight into the constructs and their respective organisations. The job categories comprised of three levels, namely labourer (*n = 250*), trade skilled worker (*n = 351*) and operational leadership (*n = 149*). Of the respondents, 101 did not indicate their job level.

To ensure that the data was suitable for analysis, data screening and validation was conducted. All the questionnaires were sufficiently completed and were eligible for data analysis.

5.4 MEASURES

Measurement of H&S was done using selected scales. Since some of the items were adapted from previous studies, any notable changes are described and explained in detail. To adapt a scale and reword items is an accepted research practice to ensure that items are relevant to the context in which the survey is administered (Jaros, 2010). The survey tool consisted of 74 items divided into five main sections. All items were measured on a five-point Likert scale. Scales were rated according to the items used (for e.g. strongly agree – strongly disagree when assessing a statement; or always – never for behaviour items).

– ***Top management's commitment to H&S***

Seven items from the Mueller, DaSilva, Townsend and Tetrick (1999) 21-item attitude scale were used to measure perceived top management's commitment to H&S. The original scale does not report psychometric properties. Examples of items used are:

- *Where I work, top management get personally involved in H&S activities*;
- *Management is presently acting to make the work environment safer*; and
- *Management in this organisation is willing to invest money and effort to improve the safety level in the workplace*.

The selection of these items was based on face validity because no Cronbach's alpha was reported for the original scale (Tetrick, personal communication, 2010).

– ***Supervisory H&S leadership expectation***

Perceived supervisory H&S leadership was measured using eight items from Zohar's (2000) 10-item scale. According to Zohar (2000), the original supervisory leadership scale reported a high consistency, with a Cronbach's alpha coefficient of .93. This scale had four items that were used to assess supervisory actions, which were positively worded and included statements such as "My supervisor approaches workers during work to discuss H&S issues". To measure supervisory expectations four negatively worded items from Zohar's (2010) scale were used, which included items such as "As long as there is no accident, my supervisor does not care how the work is done". For this study, two items were excluded because the wording was similar to items on the work pressure scale used in this study. This is discussed later on in this section.

– ***H&S management systems***

Three items from Griffin and Neal's (2000) workplace health and safety scale were used to assess workers' perceptions of H&S management systems on their building site. The original scale reported good internal consistency, with a Cronbach's alpha coefficient of .81. The scale included items such as "Safety procedures and practices in this organisation are useful and effective". This was changed to "Safety procedures and practices are sufficient to prevent incidents occurring" based on feedback from expert reviews who understood the use of language in H&S processes in the South African context.

– ***H&S communication***

To measure construction workers' perception of H&S communication on their building site, Ostrom et al.'s (1993) EG&G Idaho's 10-item communication scale was used. This scale assesses different types of H&S communication such as information sharing through verbal discussions and visual displays of H&S signs. According to Ostrom et al. (1993), the original H&S communication scale reported a high internal consistency, with a Cronbach's alpha coefficient of .91. Examples of items on this scale are:

- *In our company, safety hazards are seldom discussed openly*;
- *In this company, we have very few safety signs or posters*; and
- *Around here employee ideas and opinions on safety are solicited and used*.

Two items were removed for the current study because the statements were similar to items on the supervisory leadership scale.

– ***Toolbox talks***

Construction workers' perceptions of toolbox talks were measured using a three-item scale developed by the researcher. The scale items were constructed after the initial qualitative investigation of safety climate literature and structured interviews (Babbie & Mouton, 2007; Creswell, 2009). Examples of the statements in this scale are:

- *We have regular toolbox talks on our building site*; and
- *Our toolbox talks are relevant to H&S issues I face on site*.

– ***H&S training***

To measure construction workers' perceptions of H&S training, the Griffin and Neal (2000) four-item scale was used to assess participant perceptions on the relevance of training on the building site and their experience of H&S training. According to Griffin and Neal (2000), the original scale has good internal consistency with a Cronbach's alpha coefficient of .73. An example of items from this scale includes:

- *Safety issues are given a high priority in training programs*;
- *Workplace H&S training covers the types of situations that employees encounter in their job*, which was changed to *In my workplace H&S training covers the types of situations that I experience in my job*; and
- *"Employees receive comprehensive training in workplace health and safety issues"* was simplified to "*Employees receive comprehensive training in workplace health and safety"*.

– ***H&S motivation***

Construction workers' perception of H&S motivation was measured using the four-item Griffin and Neal (2000) motivation single factor version scale. Reliability of the scale was reported as Cronbach's alpha coefficient of .80 (Griffin & Neal, 2000). The scale included statements such as:

- *I feel it is worthwhile to put in effort to maintain or improve my H&S*; and
- *I feel it is important to maintain H&S at all times*.

– ***Individual H&S responsibility***

To measure construction workers' perceptions of individual H&S responsibility' the current study used the Cox and Cox (1991) three-item individual responsibility scale. The three items were included based on face validity as no Cronbach's alpha coefficient was reported in the original study. The scale measures participants' perception of individual responsibility for H&S. Items included were adapted for the current study as follows:

- *Safety equipment should always be worn*, which was changed to *Personal protection equipment should always be worn*; and
- *Individuals should encourage colleagues to work safely*, which was changed to *I should encourage colleagues to work safely*.

– ***Incident reporting***

To assess construction workers' perceptions of H&S incident reporting, the current study used Rybowiak, Garst, Frese and Batinic's (1999) six-item covering up errors scale. According to Rybowiak et al. (1999), the incident reporting scale has a high internal consistency with a Cronbach's alpha coefficient of .78. Some items were reworded to facilitate ease of understanding. Items from the scale included:

- *Why mention a mistake when it is not obvious*; and
- *I do not find it useful to discuss my mistakes*, which were changed to *it is not useful to discuss my H&S mistakes*.

– ***Workload pressure***

To measure construction workers' perceived work pressure the current study used Seo et al. (2005) nine-item work pressure scale, which measures participants' perception of risk taking and work prioritisation over H&S when work demands are high. Seo et al. (2005) found a high internal consistency with a Cronbach's alpha coefficient of .88 for the original scale. Examples of items on the scale include statements such as –

- *Production is given higher priority than safety*;
- *We are often in such a hurry that safety is temporarily overlooked*; and
- *We do not have time to do things safely*. In the case of this last item, the word 'safely' was replaced by 'H&S' for purposes of the current study.

– ***Work environment dangers***

Workers' perceptions of construction site environmental H&S conditions were measured using a three-item scale adapted from the Griffin and Neal (2000) physical work environment scale, which measures perceptions of workplace hazards. The items for this scale were significantly modified for the current study. There are no reported internal consistency and Cronbach's alpha coefficient for the original scale. Examples of items from the original scale are:

- *There are significant dangers inherent in the workplace*, which was changed to *Working on a building site is dangerous*;

- *The physical work environment is safe*, which was changed to *My work environment is not safe*; and
- *"Employees are frequently exposed to risky situations"*, which was changed to "*I am exposed to dangerous situations at work"*.

– ***H&S performance***

Employees' H&S performance was assessed using a 10-item scale informed by qualitative data from the structured interview stage. Employees were asked to rate their observed H&S performance over the past week using the rating scale: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually and 5 = Always. Examples of items on this scale were:

- *Over the past week, I talked to fellow employees about H&S*;
- *Over the past week, I did not work on scaffolds with missing guard rails*;
- *Over the past week, I did not use a ladder not tied or secured*; and
- *Over the past week, I did not use a ladder which was broken or not safe*.

– ***H&S avoidance behaviour***

To measure construction workers' H&S avoidance behaviour the current study used an eight-item H&S compliance scale adapted from Griffin and Neal (2000). The original scale reported a Cronbach's alpha coefficient of .56, indicating low internal consistency on the original scale. For the current study, the scale was reworded and adapted to measure employees' H&S avoidance behaviours over a period of one week, For each of the H&S behaviours, employees were asked to rate their behaviour using the following rating scale: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Usually and 5 = Always. Examples of the adapted scale items were:

- *I carry out my work in a safe manner*, which was changed to *Over the past week, I carried out my work in a safe manner*; and
- *I help my co-workers when they are working under any risky or hazardous conditions*, which were changed to *over the past week, I helped my co-workers when they were working under risky or hazardous conditions*.

– ***Injuries***

A dichotomous self-report measure of injuries experienced over a period of one month was used to assess workplace injuries. The measure was developed by the researcher using data obtained from the reviewed literature on construction injuries. Two items used were "*over the past one month I have injured myself on building site but did not need medical attention*" and "*over the past one month I injured myself on building site and needed medical attention*". Workers were asked to state yes or no in response to the statements.

5.5 CONTROL VARIABLES

Control variables were measured using individual worker demographic data and contextual variables. Demographic variables included a dichotomous measure of gender, which used 1 = female and 2 = male. Employees were asked to indicate their age recorded in number of years in a given space. Participants were not asked to give the name of the organisation they work for or the name of the construction site.

Tenure was assessed using a nominal scale to be rated on a five-point Likert scale 1 = less than 3 months, 2 = less than 2 years, 3 = less than 4 years, 4 = less than 5 years, and 5 = more than 5 years. Employees were asked to state how long they had been working with the same supervisor and to use the above scale ratings.

A nominal scale was used to measure employment status, and used the following ratings: 1 = full time; 2 = part time; 3 = contract; and 4 = casual employment.

5.6 DEVELOPMENT OF THE MEASUREMENT TOOL

The H&S climate composite questionnaire was a combination of validated scales that were used base on previous safety climate discourses in different industry sectors together with two additional scales developed from the qualitative phase. The measures were compiled in English and were not translated (Appendix D).

The questionnaire had five main sections, which were consistent with themes from the preliminary stage of the study. The first section requested participants to answer questions on how leadership in the organisation was perceived in terms of H&S commitment, supervisory leadership in relation to H&S leadership, management for H&S, and worker H&S behaviour and performance on their site.

The second section required workers to answer questions on how they perceived the H&S processes on their construction site. Employees' perceptions of H&S processes were measured using four constructs: H&S management systems, H&S communication and H&S training And H&S toolbox talks a construct emerged after the researcher interviews and was added to the H&S processes scale.

The third section requested workers to answer questions on individual attitudes to H&S. Employees were required to assess their own perceptions of their H&S motivation and their individual responsibility for H&S.

The fourth section asked workers about work pressure, work environment and incident reporting separately. The section provides a discussion regarding the relationship between work pressure, the work environment, incident reporting, H&S avoidance behaviour and H&S performance.

The fifth section is a self-report discussion on H&S performance behaviours and H&S avoidance behaviour scales

– ***Injuries***

The distal outcome in the model was injuries. This was measured as a dichotomous variable which asked workers if they had experienced an injury that required medical attention in the past 30 days. The alternative question asked the workers to indicate if they had experienced an injury that did not require medical attention in the same time frame. The measurement of injuries was designed to provide the researcher information of H&S incidents that warranted medical treatment a latent indication of the severity of the injury and also provide the researcher with the frequency of such injuries. The second question provided the researcher with data on the frequency of less severe injuries that did not require medical attention but still considered significant for the workers to remember these incidents in the given time frame of 30 days.

The last section asked the participants to provide demographic details of age, gender, employment status, level of education, period working for one organisation and period working with the same supervisor. In total, 74 items were included in the questionnaire and considered relevant for the developed propositions. Where scales were reworded and adapted it was in consideration of the use of local terminology easily understood by the construction workers (Hair et al., 2003).

5.7 DATA ANALYSIS

Data capturing was done by a professional data entry expert into an Excel worksheet and was verified by the researcher against the paper survey documents. The process of data validation involved checking and adjusting data for omissions and completeness, legibility and consistency required for the testing of the explanatory model. The data (*N* = 851) was checked for out-of-range variable scores, in other words, checking the answers in terms of possible scores that were recorded incorrectly. One respondent's age was for instance recorded as 4 years. The error on age of one of the participants was verified against the hard copy questionnaire, and corrected. Means and standard deviations were verified and found to be plausible. The data was checked for outliers, and none were found.

5.7.1 Missing data

To assess the extent of missing data, the researcher used the missing values analysis (MVA) function in SPSS (Statistical Package for the Social Sciences). The process involved identifying individual cases with missing data and establishing if data was missing completely at random (MCAR) intervals and making a decision to exclude or include it in further analysis. The identified cases had MCAR data but these were below the recommended 30% for exclusion from analysis (Hair et al., 2006). The case of missing data was low (88/852) representing 11% of the sample. Individual cases with missing data were identified and reviewed to ensure that the reported MCAR data was not substantial. All cases were considered valid and were included in the preliminary analysis.

The data analysis techniques selected was chosen on the basis of the research questions formulated for this study. The use of IBM PASW SPSS version

20 for all preliminary analyses allowed the researcher to focus on basic data exploration and descriptive techniques. These analyses were used to determine the breakdown of the study sample. The dimensionality and validity of each measurement scale were assessed within the context of the construction industry in South Africa. Assessing the internal consistency of scales was desirable because the original scales were administered to participants whose work environments were different from the challenges of the local building sector. Correlations and regressions analyses were conducted. Smart Partial Least Squares (SmartPLS©) was used for path modelling to analyse the relationships in the conceptual model.

The sample for this study fulfilled the recommended size of at least 300 cases for an exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to be conducted (Hair, Anderson, Tatham, Black, & Babin, 2010; Tabachnick & Fidell, 2007, p. 613). Nunally (1978) recommends a ratio of ten cases for each item to be analysed, whereas Tabachnick and Fidell (2007) suggest five cases for each item to be adequate. The current study fulfilled both these ratios recommended for sample size and case item as the study obtained a 10.9:1 item ratio. According to Cohen's (1988) statistical power tables, the size of the current sample was adequate for the proposed analysis and therefore required no further manipulation to compensate for a small sample size (Kerlinger & Lee, 2000).

5.7.2 Exploratory factor analysis

Exploratory factor analysis (EFA) was used to identify groupings of variables in the dataset, which reflect the underlying correlation structure of the data (Hair et al., 2006; Tabachnick & Fidell, 2001). These factor groupings are termed "latent" or "unidentified factors" and they provide a means of summarising the data and expressing the original information in terms of fewer variables. Each construct or factor is a combination of the original variables. The researcher was able to determine each factor loading and accept the items for inclusion in the measurement scale for further analysis.

Principal-axis factoring (PAF) and principal component analysis (PCA) were used to identify underlying factors that reflected what the variables shared in common (Tabachnick & Fidell, 2001). The number of factors selected for extraction was determined using the Guttman-Kaiser criterion, together with the scree plot and interpretability criteria. The Gutman-Kaiser criterion was used to examine the eigenvalues, and retained only those factors with eigenvalues greater than or equal to 1. The factor was only retained if it extracted at least as much variance as the equivalent of one original variable (Hair et al., 2006). Tabachnick and Fidell (2001) recommend that values of this index should be greater than 0.6. The scree plot was used to identify the amount of variability explained against the number of factors. The ideal number of factors as determined by the scree plot is the number at which a clear elbow-shaped break is apparent (Hair et al., 2006; Tabachnick & Fidell, 2001).

Assessment of the initial factor solution using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used in order to determine the suitability of the data for analysis (Hair et al., 2010). The scree plot enabled the researcher to determine an acceptable range for the number of factors to be extracted. Hair et al. (2010) identified interpretability criteria, which are used to determine whether or not a factor solution is meaningful. For these criteria to be met; there should be at least three items per factor with significant factor loadings. The variables loading on any particular factor should further share some conceptual meaning (Hair et al., 2010). According to Hair (2010), the variable loadings on different factors should measure different constructs, and the rotated factor solution should demonstrate a simple structure (Hair et al., 2010). The variable loadings are considered with the following criterion: loadings in excess of .71 (50% overlapping variances) are considered to be excellent, .63 (40%) very good, .55 (30%) good, .45 (20%) fair, and .32 (10% overlapping variance) poor (Tabachnick & Fidell, 2001). Identified significant factors with loadings greater than .5, were assigned an appropriate variable label. The raw correlation matrix of the items was also inspected in order to determine whether or not there were any easily identifiable correlations greater than 0.350.

– ***Assessing group level H&S climate***

To assess the homogeneity of H&S climate perceptions for the different sites surveyed interrater agreement (IRA) analysis was conducted. The purpose of using IRA was to estimate 'if responses from one participant were similar to the responses of others in the same workgroup' (Lingard et al., 2010, p. 818). Before IRA was calculated, the assumptions of the analysis technique were checked and were satisfied by the data in the current study (Pallant, 2007). The current study participants were obtained from random sample sites and the researcher determined that no subjects were surveyed twice. The groups had at least 20 participants in each group (Pallant, 2007). According to Ludtke, Trautwein, Kunter and Baumert (2006), an acceptable level of consistency between H&S climate perceptions of the same group of workers (within the same construction site) is considered to exist if $r_{wg(j)} \geq 0.70$.

5.7.3 Regression analysis

Standard multiple regression and hierarchical multiple regression analysis were selected as techniques to test the proposed propositions of the conceptualised model in this study. The use of regression analysis was informed by the need to examine the conceptualised H&S model for overall model significance (*F*-test) to establish if values obtained using regression would be significantly different from zero. Regression enabled the researcher to assess the model in terms of how significant the explained variance (R^2 and adjusted R^2) were. Standard multiple regression was used to determine the ability of each variable in predicting the variance between independent and dependent variables. Regression analysis was considered useful for predicting the unique variance between the variables. The use of hierarchical multiple regression analysis was considered suitable for use in this study because of the flexibility of the technique in providing data that provides each independent variable's predictive ability. This technique was considered in line with a suggestion by Tabachnick and Fidell (2001) who found that a correlation between independent and dependent variables is presumed.

Hierarchical multiple regression was used to evaluate how the different sets of predictor variables in the proposed H&S climate model would significantly increase the explained variance of each dependent variable (Tabachnick & Fidell, 2001). To determine how different sets of predictor variables enhanced the explained variance, organisational variables and individual variables were entered in sequential steps, with each set of independent variable evaluated in terms of the unique contribution it makes after controlling for previous variables. The variables were entered in an order consistent with the proposed H&S model framework, which was developed based on H&S climate literature reviewed in Chapter two (Tabachnick & Fidell, 2001). The use of regression analysis was important in establishing whether the predictors were able to explain variance in the dependent variable above and beyond the selected control variables.

5.7.4 Assumptions of multiple regression

The sample size for this study (n = 851) was suitable to address the issue of generalizability which arises from a small sample (Tabachnick & Fidell, 2001). Another assumption of regression analysis, which was not relevant to this study, was multicollinearity and singularity, where there is high correlation between the independent variables. The following assumptions were considered:

- type of data;
- sample size; and
- Multicollinearity and singularity of independent variables.

The first assumption of regression analysis considered for this study was the type of data collected. This study collected data using a survey tool that was evaluated on a Likert scale of between 1 and 5, thus meeting the assumption of the data (Hair et al., 2010).

The second assumption considered was the sample size to be able to generalise the findings to the broader construction industry. In this regard, the sample size for this study (n = 851) was more than adequate for generalising the findings to ensure that scientific value was derived from the study (Tabachnick & Fidell, 2007), used the proposed formula of $N > 50 + 8m$ (where m = number of independent variables).

The third assumption tested for the use of regression as a data analysis technique was checking the multicollinearity and singularity of the independent variables. The use of SPSS enabled the researcher to check whether there were high correlations between the variables and thus assessing for multicollinearity (Pallant, 2007).

To assess the existence of linear relationships between the independent variable (IV) and dependent variable (DV), a scatter plot was used to ensure that a straight line was present with the predicted DV scores. Data was assessed for singularity of IV to avoid including scales that had a combination of other variables. Normality of the data was established by checking that residuals were normally distributed.

The fourth assumption considered for using regression analysis was that the data would not display any outliers as negative consequences could be experienced in the analysis of data used for prediction purposes (Pallant, 2007; Tabachnick & Fidell, 2001).

The final assumption considered in the use of regression analysis was the distribution of scores and consideration of the underlying relationships between the variables (Pallant, 2007). Using residual scatterplots generated from regression analysis, the researcher was able to determine the normality of the residuals for the predicted DV scores, and also to verify that the variance of the residuals about predicted DV scores was the same for all predicted scores and thus meeting the homoscedasticity assumption. The findings from regression analysis are discussed in Chapter six, giving details of how the above assumptions were met.

5.7.5 Partial least squares

Partial least squares (PLS) is a variance-based technique used by researchers in a diverse range of disciplines (Hensler, Ringle, & Sinkovics, 2009). The use of path analysis has been enhanced by the flexibility and comprehensive analysis that the technique offers (Hensler et al., 2009). As a multivariate technique, PLS is used for specifying relationships between observed variables and it enables the researcher to solve related equations simultaneously to determine parameter estimates.

Having established through the review of literature in Chapter two that no studies of H&S climate had been conducted in South Africa, the use of PLS was a consideration due to the exploratory nature of this study (Gefen, Straub, & Bourdreau, 2000). Beyond exploration, the choice of the PLS method for this study was to be able to determine the predictive ability of the independent variables on the outcome variables (Hensler et al., 2009). The ability of the PLS method to explain endogenous variables was considered appropriate for this study because it offered the researcher the ability to test and validate the proposed H&S climate model (Hensler et al., 2009).

Although the researcher sought to establish the predictive ability of the H&S climate model using standard regression analysis and hierarchical multiple regression, the data was analysed further with SmartPLS (Ringle, Wende & Will, 2005). The use of SmartPLS path analysis techniques for this study was deemed the most suitable tool because the outcome variable was a dichotomous item and therefore not suitable to alternative path analysis techniques (Tenenhaus, Vinzi, Chantelin, & Lauro, 2005). SmartPLS was considered most suitable because the factors in SmartPLS are orthogonal and therefore multicollinearity would not have been a problem.

5.7.5.1 Characteristics of PLS

The characteristics of PLS, which render the analysis technique relevant for social research (Hensler et al., 2009, p. 283), are outlined in the following summary.

- PLS delivers latent variable scores – these are measured using one or several indicators (manifest variables).
- For small samples, PLS offers a reliable explanatory and predictive tool in comparison to other methods.
- PLS is able to analyse complex models with many latent and manifest variables.
- PLS has less stringent assumptions about the distribution of variables and error terms.
- PLS has the ability to handle reflective and formative measurement models.

These identified characteristics were deemed suitable for analysing data in the current study because the proposed model was considered to possess both latent and manifest variables, and the proposed model was complex enough to warrant the use of PLS. PLS was suited to this study because the technique is considered useful when the researcher has clear hypotheses to be tested in a single path diagram, which was the case for this study. The outcome variable of injuries was a dichotomous variable that did not render itself to structural equation modelling (SEM) analysis techniques such as LISREL or AMOS, but could be analysed using PLS. PLS is described as a "second-generation data analysis technique which is used to test the extent to which research meets the recognized standards for high quality statistical analysis" (Gefen et al., 2000, p. 3).

5.7.5.2 Assumptions of PLS

Similar to regression analysis, PLS has a number of assumptions that inform the data analysis technique.

- Multicollinearity – this is not considered a problem in PLS due to the orthogonal nature of factors in PLS (Chin, 1998).
- Because PLS is a distribution-free approach to path modelling, if the data is considered non-normal, then a larger sample size is required (Chin, 1998). This requirement was satisfied in the current study because of the sample of 851 participants. According to Chin (1998), the larger the sample the more reliable the PLS estimates.
- According to Ringle, Sarstedt and Schlittgen (2010), the assumption that data has been collected from a single homogenous population is unrealistic. For the current study the use of PLS was considered appropriate because data was collected from multiple organisations, which had diverse situational factors that could influence the H&S climate and perceptions of the workers.

PLS path modelling was considered appropriate to analyse the measurement and structural models in the study (Hensler, 2009). The first stage of analysis was used to obtain the iterative approximation of latent variables; the second stage estimated the outer weights, outer loadings and path coefficients; and the final stage estimated the location parameters (Hensler, 2009). To test the relationships between latent variables, both the inner and outer models of the proposed conceptual H&S climate model were analysed. The use of PLS was to allow the researcher an opportunity to reinforce the findings of earlier analyses using SPSS techniques, resulting in a more rigorous analysis of the proposed research model and a better measurement tool for the H&S climate.

5.7.5.3 Limitation of path analysis

The popularity of the PLS technique for data analysis does not render the method without disadvantages. According to path least squares analysis, PLS cannot offer an explanation of causality between the variables. Path analysis is not considered useful in the exploratory stage of research and the use of regression analysis is highly recommended (Hair et al., 2001). This limitation was addressed in the current study by the use of both standard and hierarchical multiple regression.

5.8 CONCLUSION

This chapter outlined the methods that were used to collect data. The research design, sample and data collection tools were discussed. The data analysis techniques used were presented. The following chapter presents the findings from this analysis.

CHAPTER SIX

RESULTS

6.1 INTRODUCTION

This chapter provides statistical evidence from the structured interviews and quantitative phase of the study that reports on the proposed H&S climate model that was tested. The objective of the current research was to explore employees' perceptions of the H&S climate construct in the South African construction industry. There are eight sections to this chapter:

- Structured interview outcomes.
- The psychometric properties of the H&S climate scales used in the study.
- The factor structures of the model dimensions.
- Summarised descriptive and distributive statistics of the constructs.
- Findings of internal consistency and construct validity.
- The intercorrelations and predictive ability of this model.
- Hypothesis prediction findings from standard and hierarchical regression analyses.
- Proposition test findings emanating from PLS analysis, which resulted in a redefined H&S climate model presented in a path model diagram.

6.2 STRUCTURE OF THE CHAPTER SECTIONS – AN OVERVIEW

6.2.1 Structured interviews

The structured interview was used to gain an understanding of how the workers perceived the emergent themes from documentary evidence and also observations. The interview phase was used to elicit workers perceptions and understanding of the role of management in the organisation. Interviews were also used to determine if constructs that were investigated elsewhere would be understood in a similar way in South Africa. The results showed that emergent themes such as H&S communication, H&S training, H&S in teams and work pressure were consistent in the local construction industry. Workers interviewed were mostly of the opinion that accidents would not happen to them because they "had a lot of experience" and would quote the number of years that they had been doing their job. This was common to participants younger than 50 years who considered the occurrence of an injury more likely to happen to other employees. During the interviews, one participant mentioned that he had better control over the risks he experiences in his role than the others who were subcontractors who were only present on site for a short period. The participants above 50 were much more cautious always citing accidents they had witnessed or incidents they had personally experienced in the workplace. This process enabled the research to include the identified variables into a survey instrument for quantitative data collection phase.

This section provides a summary of the factor and reliability analyses conducted to establish the psychometric properties of H&S climate. The outcome of these findings informed the inferential statistics that will follow in this study.

6.2.2 Factor analysis

This section describes the results of the exploratory factor analyses of the proposed antecedents and outcomes of H&S climate. The next section describes the analyses regarding control variables. A detailed discussion of the EFA techniques was presented in Chapter Five.

Prior to performing the exploratory factor analysis, the suitability of the data for factor analysis was assessed. Data was assumed to be continuous and arising from a multivariate normal distribution (Hair et al., 2010), and SPSS multivariate analysis procedures were used in the handling of missing data. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used in order to determine the suitability of the data for the analysis. The KMO for the total measurement tool was .94, exceeding the recommended value of .6 (Kaiser, 1974). In addition, Bartlett's test of sphericity was statistically significant ($P<0.001$), supporting the factorability of the correlation matrix. Based on the result of this test and on an assessment of the correlation matrix for the individual items, it was concluded that the variables were highly correlated, and that factor analysis was the correct procedure.

6.2.3 Factor structures: H&S climate dimensions

Factor loadings were interpreted as follows:

- 0.30 to 0.40 were considered to meet the minimal interpretation level of structure;
- 0.50 or greater were considered significant; and
- 0.70 and above were indications of a well-defined structure (Hair et al., 2006).

For this study, the cut-off point for factor structures was established at .350, which is an acceptable level for the social sciences.

6.2.4 Dimensionality of organisational H&S climate antecedents

The total respondent sample of 851 was subjected to an EFA using principal component analysis (PCA) with direct Oblimin rotation. All antecedent items were analysed according to established variable grouping of organisational, individual and situational antecedents using the principal-axis factor (P-AF) extraction method and direct Oblimin rotation.

All 28 items that were used to assess organisational variables of H&S climate were tested to determine whether these variablesof H&S climate could be grouped into a single higher-order structure. A factor was considered as having an interpretable solution if the factor had three or more significant loadings, and the variables that loaded on a factor shared similar conceptual meaning (Hair et al., 2006). This was considered valid if the variables that loaded on different factors measured different constructs, and the rotated factor pattern demonstrated a simple structure (i.e. high loadings on one factor; low on those remaining).

Five factors were generated from the initial solution, and eigenvalues greater than one explained 72.2% of the total number of factors that emerged from the analyses. The scree plot showed that there was a presence of five factors that were above the "elbow bend" of the graph. Clean structures were observed with no cross-loadings on the pattern matrix across four of the five factors. The factor structures of the variables top management commitment, H&S training, H&S management systems, and H&S communication reported high loadings on all variables; therefore, no items were considered for deletion.

The original eight-item supervisory H&S leadership scale used in the current study measured two dimensions of supervisory actions and supervisory H&S expectations. In terms of the data of the total sample (n = 851), the scale did not report the same configuration as displayed in the original scale. The supervisory H&S leadership (shsl) expectation factor reported a solution that showed cross-loadings on four of the eight items. The items shsl1–shsl4 reported low loadings between the items; however, these items did not have any influence on loadings for items shsl5, shsl6, shsl7 and shsl8, which displayed a clean structure with high loadings. An alternative process of deleting the item with the highest cross-loadings first resulted in a single factor emerging with four items (shsl5, shsl6, shsl7 & shsl8). In further analyses, the four items representing supervisory H&S leadership emerged with a theoretically grouped solution of four items (Zohar 2003a), the items were retained for future analytical techniques. Although this scale was reduced to four items, which were a grouping in the original scale as discussed in Chapter Four, the factor was retained. A verification of the factor structures that emerged with PCA was done by conducting further factor analyses using the principal axis factoring approach with Oblimin rotation and confirmed five factor structures with similar item loadings. The results of the PCA analysis were given construct names. The result of the EFA showed that the organisational variables of H&S climate were correlated but different, in that each measured a distinct construct.

Each measurement scale was first assessed for the dimensionality and factorial validity within the context of the current study, which was the construction industry in South Africa. From the EFA-derived factors, reliability analyses were conducted using SPSS scale reliability analysis. The first step in validating the measurement scales that were used in this study was to test if the relationships between variables were valid and had good internal consistency. This test was also done to ensure that good results emerge from the data that was collected using these tools. The measurement scales were validated twice, firstly using the SPSS EFA technique, and secondly using a CFA process in the SmartPLS modelling phase.

Table 6.1

Organisational Antecedents of H&S Climate Factor Structure

Scale item	Factor					
	1	**2**	**3**	**4**	**5**	**C***
mgco2 Top management views H&S regulation violations very seriously even when they do not result in any apparent damage	**.875**	.112	-.041	-.102	.014	.699
mgco3: Our top management acts quickly to correct H&S issues	**.869**	-.021	-.020	.018	.020	.703
mgco6: Top management in this organisation is willing to invest money and effort to improve the level of H&S in the workplace	**.836**	.037	.004	-.046	-.116	.592
mgco4: Top management is presently acting to make the work environment healthier and safer	**.821**	-.062	.060	.083	.028	.740
mgco1: Where I work top management gets personally involved in H&S activities	**.813**	.050	.039	-.057	.018	.633
mgco7: The protection of workers from exposure to hazards is a high priority with top management	**.787**	-.028	.048	.138	.034	.744
mgco5: Our top management is well informed about H&S issues on this site	**.742**	-.054	.048	.159	.058	.668
hsco6r: Employee ideas and opinions about H&S are not asked	.061	**.885**	.024	-.022	-.027	.782
hsco3r: We do not discuss H&S hazards openly on this site	-.028	**.872**	.024	.035	.022	.758
hsco4r: When you report an H&S hazard, you don't get a quick answer	-.026	**.865**	.042	-.002	.045	.761
hsco5r: We have very few H&S signs or posters on this site	.026	**.839**	.018	-.102	-.060	.584
hsco2r: We do not discuss H&S statistics on this site	-.027	**.834**	-.023	.058	.069	.729
hsco8r: We are not informed about all accidents that happen on this site	.016	**.831**	.039	-.008	.013	.678
hsco7r: We do not have regular meetings about H&S	.022	**.809**	.034	.057	.021	.684
hsco1r: On this site there is confusion on who to speak to regarding H&S	.063	**.677**	-.159	.035	.146	.536
msys3: The safety procedures and practices in this organisation are useful and effective	.056	-.029	**.865**	-.070	-.026	.698
msys2: There are H&S systems and procedures in place for preventing breakdowns in workplace H&S	.010	-.032	**.851**	-.115	.086	.616
msys1: H&S procedures and practices are enough to prevent incidents happening	.109	-.147	**.748**	-.055	.109	.540
tbt1: We have regular toolbox talks on our building site	-.011	.190	**.739**	.166	-.084	.653
tbt3: Toolbox talks help me to work and behave more safely	-.001	.025	**.732**	.157	-.037	.563
tbt2 : Our toolbox talks are relevant to H&S issues I face on site	.006	.142	**.728**	.137	.001	.628

Scale item	Factor					
	1	**2**	**3**	**4**	**5**	**C***
trng2: H&S issues are given a high priority in training programmes	.058	-.032	.015	**.853**	.041	.740
trng4: I have received comprehensive training in H&S issues	.052	-.029	-.073	**.841**	.017	.579
trng3: Workplace H&S training covers the types of situations that I experience in my job	.026	.091	.078	**.827**	-.036	.752
trng1: In my work I have been shown how to do my work safely	-.022	-.002	.066	**.808**	.017	.573
shsl6r: As long as there is no accident, my supervisor does not care how the work is done	-.012	.041	.025	.038	**.861**	.749
shsl7r: My supervisor pays less attention to H&S problems than most other supervisors in this company	.084	.055	-.060	.084	**.845**	.802
shsl8r: My supervisor only keeps track of major H&S problems and overlooks routine problems	-.011	.076	.069	.010	**.823**	.715
shsl5r: Whenever pressure builds up, my supervisor wants us to work faster, rather than by the rules	-.035	-.024	.015	-.068	**.787**	.396
Initial eigenvalue	**10.510**	**4.749**	**2.125**	**1.945**	**1.613**	
Initial variance explained %	**36.240**	**16.377**	**7.327**	**6.706**	**5.561**	
Cumulative variance explained %	**36.240**	**52.617**	**59.944**	**66.650**	**72.210**	

NB: N = 722; Extraction method: principal component analysis.
Rotation method: Oblimin with Kaiser Normalization. Item's highest loading is presented in bold. *C = communalities.
factor 1 (mgco1–7) = top management commitment;
factor 2 (hsco1–8) = H&S communication;
factor 3 (msys1–3 & tbt1–3) = H&S management systems;
factor 4 (trng1–4) = H&S training; and
factor 5 (shslr5–8) = supervisory H&S leadership expectations (reverse coded).

6.2.5 Individual antecedents of H&S climate

Proposed individual worker antecedents of H&S climate items were subjected to an EFA analysis to determine the structure of the variables. Thirteen items from three scales, viz. H&S motivation (4 items), individual H&S responsibility (3 items) and H&S incident reporting (6 items), were analysed using PCA and the Oblimin rotation method. The factor analysis resulted in two clear factors, with six items loading on worker incident reporting behaviour and seven items combining the H&S motivation and individual H&S responsibility scales into a single factor. The two factors explained 71.2% of the total variance. The accepted factor structure obtained by the EFA, based on the data of the total sample, is shown in Table 6.2. The communalities reported in this table are very high, fulfilling the recommended cut-off point of .3 (Pallant, 2007), and they were therefore included for further analysis.

Table 6.2

Individual Antecedents of H&S Climate Factor Structure

Scale item	Factor		C*
	1	**2**	
hsmo1: I believe that workplace H&S is an important issue	**.901**	-.060	.785
Hsir2: I should encourage colleagues to work safely	**.881**	-.028	.763
hsmo3: I feel that it is important to maintain H&S at all times	**.874**	.016	.771
Hsir1: Personal protection equipment should always be worn	**.861**	.026	.755
hsmo2: I feel that it is worthwhile to put in effort to maintain or improve my personal H&S	**.855**	-.003	.729
Hsmo4: I believe that it is important to reduce the risk of incidents in the workplace	**.843**	.015	.717
hsir3: I share responsibility for H&S	**.818**	.049	.694
Irep5r: I would rather keep my H&S mistakes <u>to myself</u>	.080	**.841**	.751
Irep4r: It can be useful to <u>cover up</u> H&S mistakes	-.047	**.833**	.674
Irep1r: It <u>is not</u> useful to discuss my H&S mistakes	-.038	**.821**	.658
Irep3r: Why mention an H&S mistake when <u>it is not</u> obvious?	.049	**.818**	.694
Irep2r: It is bad to make one's H&S mistakes public	-.075	**.801**	.614
Irep6r: Employees who admit their H&S errors make a big mistake	.073	**.791**	.662
Initial eigenvalue	**6.054**	**3.215**	
Initial variance explained %	**46.571**	**24.727**	
Cumulative variance explained %	**46.571**	**71.298**	

Note: N = 766; Extraction method: principal component analysis. Rotation method: Oblimin with Kaiser normalization. *C = Communalities. a. Rotation converged in 4 iterations.
factor 1 (hsmo1–4 & hsir1–3) = H&S motivation; and
factor 2(irep1–irep6) = incident reporting.

6.2.6 Outcomes of H&S climate

To determine the structure of the outcomes variables for H&S climate, a factor analysis was conducted on all 18 items: eight were from the H&S performance scale and 10 were from the H&S avoidance behaviour scale. The initial solution reported a three-factor solution, grouping together all items that were theoretically related. Low factor loadings together with cross-loadings were observed between items (hspf 2 and hsab 7; and hsab 10 and hspf 2). The items that reported the highest cross-loadings were removed in an iterative process that resulted in a refined structure.

After a process of interactive factor analysis two factors emerged. The factor solution revealed a two-factor result with distinct theoretically based constructs. Nine items loaded on the H&S performance factor. Two items, which recorded the lowest loadings – hsab2 .719 and hsab9 .539 – were from the second factor but displayed conceptual alignment to this construct. The realignment of items indicated that a composite factor that could be conceptualised as H&S performance Active by workers should be acknowledged. Because of the conceptual grouping of the items in the factor analysis, the new composite scale was labelled *H&S performance Active* (hspfA). All variables had significantly high loadings of between .539 and .864 for factor one and between .650 and .819 for factor two. The accepted factor structure obtained by the EFA, based on the data of the total sample, is shown in Table 6.3. The factors reported above the recommended communality cut-off point of .3 and therefore all items were included for further analyses. Factor one items related to positive H&S behaviours in which the respondent had engaged during the previous week. The variables in this factor were relevant to general H&S actions. Factor two items related to negative H&S behaviours in which the respondent did not engage (indicating that the workers has observed positive H&S behaviour) and were therefore labelled *H&S avoidance behaviour* (hsab).

Table 6.3

Outcomes of H&S Climate Factor Structure

Scale item	Factor 1	Factor 2	C*
hspf4 Ensured the highest levels of H&S when I carried out my job	**.864**	-.031	.759
hspf3 Used the correct H&S procedures to carrying out my job	**.861**	.013	.736
hspf6 Put in extra effort to improve the H&S of the workplace	**.850**	.064	.703
hspf1 Carried out my work in a safe manner	**.798**	-.025	.646
hspf7 Helped my co-workers when they were working under risky or hazardous conditions	**.794**	.036	.619
hspf5 Promoted H&S programmes within the organisation	**.792**	-.010	.630
hspf8 Voluntarily carried out tasks or activities that help to improve workplace H&S	**.782**	.167	.582
hsab2 Used H&S equipment whenever I was on site	**.719**	-.110	.564
hsab9 Asked colleagues for suggestions on safe ways to do our work	**.539**	-.197	.376
hsab5r Did not use a ladder not tied or secured	.039	**.913**	.819
hsab6r Did not use a ladder which was broken or somehow not safe	.070	**.896**	.780
hsab8r Did not work on scaffolds not totally boarded	.090	**.849**	.695
hsab4r Did not climb up or down scaffolding when a ladder was not provided	-.126	**.801**	.703
hsab3r Did not work on scaffolds with missing guard rails	-.130	**.768**	.650
Initial eigenvalue	**6.039**	**3.222**	
Initial variance explained %	**43.137**	**23.018**	
Cumulative variance explained %	**43.137**	**66.154**	

Note: N = 722; Extraction method: principal component analysis. Rotation method: Oblimin with Kaiser normalization. a. Rotation converged in 4 iterations.
Note: *C = Communalities;
factor 1 (hspf1,3–8) = H&S performance; NS
factor 2 (hsabr2–6,8) items relate to reverse coded items for H&S behaviours.

6.2.7 Contextual factors: H&S climate

A review of literature informed the inclusion of two scales with items derived from peer-reviewed articles and validated measurement tools (Griffin & Neal, 2000; Seo et al., 2005). Exploratory factor analysis resulted in a two-factor solution, with accepted communalities above the recommended .3 cut-off point (Pallant, 2007). The two-factor solutions were accepted as separate constructs. The accepted factor structure obtained by the EFA, based on the data of the total sample, is shown in Table 6.4.

For factor 1, item wlhs6 (There is a lot of pressure to complete the job quickly) reported a higher loading of .470. Although the same item (wlsh6) reported a loading of .32 on factor 2, the item was retained because removing the item from the analysis resulted in weaker factor loadings on the other items in the work pressure scale.

Table 6.4

Contextual H&S Climate Factor Structure

Scale Item	Factor 1	Factor 2	C*
wlhs2 We are usually in such a hurry that H&S is often overlooked	**.894**	-.090	.764
wlhs3 I take H&S shortcuts when I need to get the job done in a timely manner	**.880**	-.040	.758
wlhs4 It is difficult to finish a job while following all the H&S rules	**.857**	-.030	.722
wlhs1 Production is given higher priority than H&S	**.816**	-.126	.628
wlhs5 Risk taking and shortcuts are common due to the heavy workload	**.800**	.007	.644
wlhs7 We often do not have time to do things safely	**.661**	.256	.592
wlhs6 There is a lot of pressure to complete jobs quickly	**.470**	.321	.403
wdng3 I am exposed to dangerous situations at work	.023	**.856**	.744
wdng1 Working on a building site is dangerous	-.179	**.829**	.641
wdng2 My work environment is not safe	.320	**.562**	.513
Initial eigenvalue	4.742	1.666	
Initial variance explained %	**47.425**	**16.658**	
Cumulative variance explained %	**47.425**	**64.083**	

Note: N = 734; Extraction method: principal component analysis. Rotation method: Oblimin with Kaiser normalization.
*C = Communalities. a. Rotation converged in 5 iterations.
factor 1 (wlhs1–7) = workload pressure; and
factor 2(wdng1–3) = work environment danger.

6.3 CREATION OF SUMMATED VARIABLES BASED ON EFA

For ease of interpretability, summated variables were created for each factor by obtaining the average of the variables identified as loading highly on that particular factor. The use of summated factors is encouraged to test basic assumptions in survey research (Hair et al., 2001). Summation of items was appropriate after the factor analysis had established the factorial validity of the items in each scale. The new scales were used in place of the original variables in all further analyses. The next section presents the reliability analyses for the summated variables that emerged from factor analysis.

6.3.1 Internal reliability of EFA-derived scales

Following the factor analysis presented above, the reliability of each EFA-driven subscale (factor) was determined. This was done to investigate the reliability of indicators on each latent variable, and to determine the homogeneity of each subscale. According to Nunally (1978), the generally acceptable recommendation of .70 is ideal for early stages of research or measures that are hypothesised. Nunally (1978) argues that, for applied settings, a reliability of .80 should be the aim, and further states that "in instances where decisions have to be made based on study outcomes, a reliability of 0.90 should be the tolerated minimum" (Nunally, 1978, p. 246).

To answer the first research hypothesis, which was concerned with the reliability and validity of the measurement tool, this study used the SPSS scale reliability procedure to assess the internal consistency of each factor that emerged after EFA analysis. A summary of the internal reliability results is presented in Table 6.5 below and discussed in the following section.

Table 6.5

EFA-derived Factor Composition and Cronbach's Alpha

	Scale	**Cronbach's alpha**
1	***H&S management systems (msys)*** = msys1, msys2, msys3, tbt1, tbt2, tbt3	0.896
2	***H&S motivation (hsmo) =*** hsmo1, hsmo2, hsmo3, hsmo4, hsir1, hsir2, hsir3	0.940
3	***Top management commitment (mgco) =*** mgco1, mgco2, mgco3, mgco4, mgco5, mgco6, mgco7	0.925
4	***Supervisory H&S leadership expectations (shsle) =*** shsl5r, shsl6r, shsl7r, shsl8r	0.877
5	***H&S performance Active (hspfA) =*** hspf3, hspf4, hspf5, hspf6, hspf7, hspf8, hspf1, hsab2, hsab9	0.916
6	***Workload H&S pressure (wlhs)*** = wlhs1, wlhs2, wlhs3, wlhs4, wlhs5, wlhs6, wlhs7	0.896
7	***H&S training (trng) =*** trng1, trng2, trng3, trng4	0.882
8	***H&S avoidance behaviour (hsabA) =*** hsab3r, hsab4r, hsab5r, hsab6r, hsab8r	0.904
9	***H&S communication (hsco) =*** hsco1r, hsco2r, hsco3r, hsco4r, hsco5r, hsco6r, hsco7r, hsco8r	0.934
10	***H&S incident reporting (hsir)*** = irep2r, irep3r, irep4r, irep5r, irep6r	0.882
11	***Environment work danger (wdng)*** = wdng 1, wdng2 wdng3	0.708

Note: H&S = health and safety; scale items included in the analysis are presented with abbreviated item labels as presented in the table.

The Cronbach's alpha values reported were all greater than 0.80, except for environmental work dangers, which reported a .708 Cronbach's alpha. This is an accepted level for the social sciences (Nunally, 1978). Individual items on each of the subscales recorded high item statistics, indicating that no advantage would be gained from deleting any items. Having established that the measurement tool conformed to its conceptual definition and uni-dimensionality and exceeded the necessary levels of reliability, the above solutions were determined to be valid. The Cronbach's alpha of the total measurement tool used in this study was .916. A discussion of the EFA-derived subscales is presented in the following section.

6.3.2 Reliability: Organisational antecedents of H&S climate

The generated EFA scale items were grouped into composite scales, which were subjected to reliability analysis to test the internal consistency of the EFA-derived constructs. Strong internal consistencies were obtained for all five scales:

- Top management's commitment to H&S (α = *925*).
- H&S communication (α = *.925*).
- H&S management systems (α = *.896*).
- H&S training (α = *.882*).
- Supervisory H&S leadership expectations (α = *877*).

The accepted factor structure obtained by the EFA, based on the data of the total sample, is shown in Table 6.5.

The reported factor structure and the internal consistency of the scales indicated reliable and valid organisational antecedents of H&S climate constructs. EFA scale internal consistency results for each organisational factor are discussed further below. The results of the EFA for the organisational antecedents of H&S climate listed seven items for top management commitment, eight items for H&S communication, four items for H&S training, six items for H&S management systems, and four items for supervisory H&S leadership scale. As can be seen from Table 6.5 above, all communalities were above the recommended .3 level (Pallant, 2007); therefore, the scale items were all included for further analysis.

The EFA-derived factors were aligned with the initially proposed item groupings as obtained from previously validated studies, as reported in Chapter Four. The EFA solutions are discussed in three separate sections of organisational determinants of H&S climate, individual determinants of H&S climate, and contextual determinants of H&S climate.

6.3.2.1 Reliability: Top management's commitment to H&S

Factor 1 includes the items from a single grouping only, namely that of *Top management's commitment to H&S*, but excludes the statement "The protection of workers from exposure to hazards is a high priority with top management", which did not load highly on any factors. The above loadings are significant and in the same positive direction. The management commitment scale exceeded the recommended .90 range for reliability when decisions have to be made using study outcomes (Cohen, 1988). In the current study, the scale reported a high Cronbach's alpha coefficient of α = .925. Item statistics indicated the scale had a high internal consistency and no benefit for the scale would be achieved if any item was deleted. Scale statistics reported *M* = 26.43; *SD* = 5.62, N = 663. The scale was considered a reliable and valid measure of top management's commitment to H&S in the study population.

6.3.3 Reliability: H&S communication

Factor 2 includes all items from the *H&S communication* variable. All loadings were significant and in the same positive direction. The H&S communication scale reported a Cronbach's alpha coefficient of α = .934, which was above the recommended .90 required for decision-making purposes (Cohen, 1988). In this study, item total statistics indicated high internal consistency with a range of between .92 and .93 for all items. Scale statistics reported *M* = 28.73; *SD* = 7.8, N = 663. The scale was considered a reliable and valid measure of H&S communication in the sampled population.

6.3.3.1 Reliability: H&S management systems

Factor 3 combined six items, which were originally conceptualised as two separate scales: *H&S management systems* and *Toolbox talks* scales. All items loaded highly on the factor, and in the same positive direction, with the statement "The safety procedures and practices in this organisation are useful and effective" having the highest loading. The direction of the relationship indicated that higher-valued responses to these statements result in higher values on the factor. The H&S management systems scale reported a Cronbach's alpha coefficient of α = .896, which, although lower than the recommended .90 for decision-making purposes, is high enough to inform H&S decisions. The inter-item analysis indicated that no significant difference to the Cronbach's alpha would occur if any item was deleted. All items registered between 7.54 and 7.64. Item total analysis reported *M* = 23.32; *SD* = 4.43, N = 663. The scale was accepted as a reliable and valid measure for H&S management systems for the target sample.

6.3.3.2 Reliability: H&S Training

Factor 4 includes all items from the *H&S training* scale as conceptualised. All loadings were significant and in the same positive direction, i.e. more highly valued responses to these items resulted in a higher factor value. The four-item H&S training scale reported a Cronbach's alpha coefficient of α = .882. Although the Cronbach's alpha for the current study was lower than the recommended .90 for decision-making, the scale reliability had good internal consistency of between .82 and .86, an indication that all items added to the reliability of the scale at high levels. Scale statistics were reported as M = 15.05; SD = 3.10, N = 663. The scale was accepted as a reliable and valid measure for H&S training for the target study population, and the coefficients were high enough to inform decision-making.

6.3.3.3 Reliability: Supervisory H&S Leadership expectations

Factor 5 had four items derived from Zohar's (2003a) leadership scale, which was discussed in detail in Chapter Five. The derived EFA factor loadings were highly significant. The items were reverse coded and achieved high values on all items. For this study, the supervisory H&S leadership scale reported a Cronbach's alpha coefficient of .877, which was slightly lower than the .90 cut-off value recommended for decision-making (Cohen, 1988). Of the remaining four items, total item statistics indicated good consistency with *M* = 10.65; *SD* = 3.033, N = 663.

6.3.4 Reliability: Individual antecedents of H&S climate

The second factor analysis included all 13 items from three variables that measured individual H&S, H&S motivation, individual H&S responsibility, and H&S incident reporting. The common feature that underlies the grouping of these scales was that all items were addressing the individual workers' feelings and perceptions about H&S.

6.3.4.1 Reliability: H&S motivation

The individual antecedents of H&S climate EFA returned a two-factor solution. Factor 1 combined items from the H&S motivation scale and the individual H&S responsibility scale, and generated a single seven-item factor. All item loadings were significant and in the same positive direction, which showed that all items contributed to the high internal consistency of this scale and that no benefit would be derived if any item was deleted. The combination of two previous scales created a new scale with a higher number of items and a higher Cronbach's alpha coefficient of α = 94, which is well above the recommended .90 (Cohen, 1988) for decision-marking purposes. Inter-item total statistics ranging between .87 and .89 and scale statistics of *M* = 16.42; *Variance* = 10.04; *SD* = 5.24 (N = 766) indicated good internal consistency.

6.3.4.2 Reliability: H&S incident reporting

Factor 2 includes all items from the *H&S incident reporting* grouping. All loadings were significant and loaded in the same negative direction, i.e. more highly valued responses to these items resulted in a lower factor value. The H&S incident reporting scale reported a Cronbach's alpha coefficient of .88, which was well above the accepted range as per Nunally (1978). In the current study, good internal consistency was established with item total statistics ranging between .87 and .89 and scale statistics of *M* = 21.02; *Variance* = 30.71; *SD* = 5.52 (n = 766). The scale was accepted as a reliable and valid measure of H&S incident reporting.

6.3.5 Reliability: Outcomes of H&S climate

Two factors of H&S performance Active (hspfA) and observed H&S Avoidance (hsabA) were extracted from the EFA of the proposed H&S climate outcome variables.

6.3.5.1 Reliability: H&S performance Active

From the original eight items (Griffin & Neal, 2000), one item, hspf2 "Made sure colleagues were wearing personal protective equipment as required" was deleted because of cross-loadings with hsab7, which was "During the past week, I used all the necessary H&S equipment to do my job" from the observed H&S scale. The EFA-derived structure included all items from the *H&S performance* scale with the addition of hsab2, "Used H&S equipment when I was on site" and hsab9 "Asked colleagues for suggestions on safe ways to do our work". All loadings were significant and in the same positive direction. The EFA-derived nine-item *H&S performance active* scale with a Cronbach alpha coefficient of α = .916 and a good internal consistency with item total statistics ranging between .91 and .92 and descriptive statistics of *M* = 35.73; *SD* = 7.08. The scale was accepted as a reliable measure of the H&S performance Active construct for the target sample.

6.3.5.2 Reliability: Observed H&S Avoidance

Factor eight included five items from the original 10-item observed safety scale. Of the original 10 items, two items (hsab2 and hsab9) loaded on the hspfA factor as reported in the above section. Three items, namely hsab1 "Talked to fellow employees about H&S", hsab7 "Made sure colleagues were wearing personal protective equipment as required", and hsab10 "Made sure there was clear access to exits and fire extinguishers", were deleted because of high cross-loadings (hsab7 & hspf2) and low loadings for hsab1 and hsab10. The excluded statements did not load highly on any factors in the analyses conducted. All loadings for the remaining items were significant and in the same positive direction. When subjected to a reliability analysis, this scale reported a Cronbach's alpha coefficient of α = .904. The scale reported good high internal consistency with item total scores ranging between .84 and 86 with scale statistics of *M* = 15.64; *SD* = 6.301. The scale was accepted as a reliable and valid measure of H&S avoidance behaviour for the target sample.

6.3.6 Reliability: Contextual factors

Two contextual factors were included in this study. An EFA analysis on the variables reported two distinct factors, as proposed.

6.3.6.1 Reliability: Workload H&S

The solution derived from the EFA indicated a clean structure consistent with the original scale as described in Chapter Four. All loadings were significant and in the same positive direction. The work pressure scale reported a Cronbach's alpha coefficient of .896. The scale reported high internal consistency with all items ranging between .87 and .90, with item total statistics of *M* = 19.74; *SD* = 6.094, N = 768. The scale was accepted as a valid and reliable measure of workload H&S pressure.

6.3.6.2 Reliability: Environmental Work Danger

The second factor solution included all three environmental work danger items. All items had high loadings and a good internal consistency, with all items ranging between 78 and 89, and total item statistics of M = 9.56; *SD* = 2.680, N = 768. The scale was accepted as a reliable measure of work environment danger.

After conducting reliability analyses for all the scales in the developed model, the researcher analysed the descriptive statistics of the study sample. The findings are presented in the next section.

6.4 DESCRIPTIVE STATISTICS

A summary of descriptive statistics is presented in Table 6.6, giving the sample size, mean, mean standard error, and standard deviations together with skewness and kurtosis as distributions statistics. The skewness values indicate the symmetry of the response distributions, whereas kurtosis provides information on the "peakedness" of the data distribution (Pallant, 2007). According to Tabachnick and Fiddell (2007, p. 80), there is no substantive difference in the analysis arising from skewness for large samples. The authors further suggested that kurtosis can result in an underestimation of the variance; however, this risk is reduced with a sample greater than 200 cases, which was the case for the current study. When the sample is a good representation of the total population, the reported standard error of the sample mean will be small.

Taking the descriptive statistics into account, it would appear that most of the sample in the current study obtained a moderate score, as most of the constructs obtained between 2.58 and 3.9 (where 1 was strongly agree and 5 was strongly disagree). Health and safety motivation (4.13) and H&S management systems (3.82) recorded higher score ratings. The skewness of the data was mostly positive, except for H&S motivation and H&S management systems. A relatively flat distribution of scores was observed for kurtosis. Table 6.6 presents descriptive and distribution statistics before the variable transformation.

Table 6.6

Descriptive and Distribution Statistics (All Variables)

	N	Mean	SE Mean	SD	Skewness	SSE	Kurtosis	KSE
1. H&S performance active	761	**3.97**	.257	7.080	-.937	.089	.993	.177
2. Age	785	33.08	.328	9.199	.873	.087	.621	.174
3. H&S motivation	806	**4.13**	.185	5.254	-1.218	.086	2.215	.172
4. 4. H&S communication	791	**3.54**	.276	7.756	-.458	.087	-.391	.174
5. Top management commitment	790	**3.70**	.201	5.645	-.742	.087	.772	.174
6. 6. H&S management systems	753	**3.82**	.163	4.465	-.993	.089	1.388	.178
7. H&S incident reporting	784	**3.50**	.198	5.542	-.328	.087	-.275	.174
8. Workload pressure	787	**2.81**	.217	6.101	.301	.087	-.498	.174
9. H&S avoidance behaviour avoidance	797	**3.12**	.223	6.301	-.166	.087	-1.024	.173
10. H&S training	823	**3.76**	.111	3.173	-1.000	.085	1.677	.170
11. Supervisory H&S leadership expectation	810	**2.58**	.110	3.123	-.278	.086	-.663	.172
12. Environmental work danger	809	**3.13**	.096	2.733	-.256	.086	-.385	.172
13. Years working for the same company	688	5.50	.195	5.108	2.394	.093	8.971	.186
14. Contractor type	750	2.13	.026	.717	-.205	.089	-1.043	.178
15. Years working with the same supervisor	759	1.59	.038	1.041	10.263	.089	194.153	.177
16. Education level	742	1.23	.016	.423	1.265	.090	-.402	.179
17. Gender	820	1.13	.012	.336	2.214	.085	2.909	.171

Note: N = sample size; SD = standard deviation; SE Mean = standard error of the mean. SSE – skewness standard error; KSE = kurtosis standard error

6.5 CORRELATION ANALYSIS

To enable the researcher to answer the second research question and hypothesis, the following statistical procedures were used: Pearson's product moment correlation coefficient (r) and standard multiple regression.

This study used the Pearson product moment correlation coefficient (r) to investigate relationships between the EFA-derived factors (subscales), using the summated variables. The use of parametric statistical techniques to investigate relationships in the current study was decided because of the predominantly interval data which was collected from survey (Fiddell & Tabachnick, 2007). In consideration of the study correlational research design which set out to establish perceived relationships between H&S climate dimensions, workers' H&S attitudes, H&S behaviour and H&S performance and the distal outcome of injuries; parametric statistics were considered best suited to answer the study research question. The research hypotheses were developed to determine (significant) relationships between variables in this study. Basic assumptions that inform the uses of parametric statistics (Tabachnick & Fiddell, 2007) were met for each analysis undertaken; these are presented in each section before the reported findings from each analysis conducted. For each analysis, basic assumptions were determined. For the Pearson product moment correlation, all measures were checked for normal distribution using histograms for each variable. Linearity and homoscedasticity (similarity of variables) were verified using scatterplots for the variables. Normal distribution of the data was established and linearity was established using scatterplots (Pallant, 2007).

The strength of relationships between variables was determined using statistical guidelines (Cohen, 1988), which propose that results between $r = .10$ to $.29$ are considered small; $r = .30$ to $.49$ are medium and $r = .50$ to 1.0 are large. The reported relationships were interpreted using the actual size of the Pearson's r together with the reported shared variance between the constructs. To assess and interpret the effect size, the researcher was guided by Cohen (1988). Intercorrelations for organisational, individual, situational and contextual factors can be found in Table 6.7.

Table 6.7

Summary Intercorrelations and Reliabilities of the Variables in the Study

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Management commitment	***(.925)***													
H&S communication	**.337****	***(.934)***												
H&S incident reporting	**.262****	**.557****	***(.882)***											
H&S training	**.481****	**.223****	.051	***(.882)***										
Supervisory H&S leadership expectations	**.215****	**.501****	**.422****	.177**	***(.877)***									
H&S management systems	**.551****	.196**	.150**	**.459****	**.215****	***(.896)***								
H&S performance	**.575****	**.334****	**.245****	**.538****	**.242****	**.530****	**(.916)**							
H&S avoidance behaviour	.075*	-.007	.003	.182**	-.072*	.080*	**.244****	**(.904)**						
Workload H&S	**-.230****	**-.553****	**-.599****	-.164**	**-.453****	-.141**	**-.277****	.049	***(.896)***					
Work environment danger	.099**	**-.243****	**-.224****	-.055	-.112**	-.016	-.088*	-.080*	**.341****	***(.708)***				
H&S motivation	**.524****	**.372****	**.281****	**.520****	**.241****	**.529****	**.590****	.147**	-.183**	-.047	***(.940)***			
12. Age	.049	.090*	.110**	.038	.137**	.063	.077*	.024	-.136**	-.059	.006	-		
13. Tenure	-.040	.032	.021	.027	.065	.000	-.042	.055	-.013	-.101**	-.021	**.466****	-	
14. YSS	-.067	.051	-.028	-.011	-.033	-.138**	-.023	.113**	-.064	-.156**	.010	-.134**	-.045	-

Pairwise deletion 689–810
Note: A = age; Tenure = years with the same company; YSS = years with the same supervisor

The Pearson's correlation analysis depicted in Table 6.8 showed significant correlation between most of the variables in this study. Details of the relationship are presented below.

The following variables for the proposed H&S climate explanatory model presented results of correlations of greater than r = > .40 in the positive direction.

Using Cohen's (1988) guideline, the Pearson's correlation coefficient correlated with hspfA for the following:

- H&S motivation and H&S performance active (hspfA) ($r = .600, p<.01$);
- top management commitment ($r = .552, p <.01$);
- H&S management systems and top management commitment ($r = .562, p<.01$);
- H&S training and H&S performance active ($r = .518, p <.01$); and
- H&S management systems ($r = 506, p <.01$).

Positive substantial intercorrelations emerged between:

- H&S communication and H&S incident reporting ($r = .575, p<.01$);
- supervisory H&S leadership expectations and H&S motivation ($r = .536, p<.01$); and
- H&S motivation and top management commitment ($r = .545, p<.01$).

Other substantial relationships were observed between:

- H&S training and top management commitment ($r = .475, p <.01$);
- supervisory H&S leadership expectations and H&S incident reporting ($r = .487, p <.01$);
- H&S management systems and H&S training ($r <.454, p <.01$);
- H&S motivation and H&S communication (r = .430, p <.01);

- H&S motivation and H&S training (*r = .499, p <.01*); and
- H&S motivation and H&S management systems (*r = .489, p <.01*).

Moderate positive correlations (Cohen, 1988) (.30 and above) were evident between the following variables:

- H&S communication and top management commitment (*r = .374, p <.01*);
- H&S incident reporting and top management commitment (*r = .318, p <.01*);
- H&S performance and H&S communication (*r = 388, p <.01*);
- H&S performance active and supervisory H&S leadership expectations (*r = 338, p <.01*);
- H&S motivation and H&S incident reporting (r = .338, p <.01); and
- H&S motivation and supervisory H&S leadership expectations (*r = .325, p <.01*).

Statistically significant positive correlations emerged between the following variables:

- H&S training and H&S communication (r = .265, p <.01);
- supervisory H&S leadership expectations and top management commitment (r = .276, p <.01);
- H&S management systems and H&S communication (r = .208, p <.01); and
- H&S performance active and H&S incident reporting (r = .271, p<.01).

Negative correlations were observed between H&S motivation and workload H&S pressure and between proposed control variables of workload:

- H&S pressure and H&S incident reporting (*r = -.616, p <.01*);
- workload H&S pressure and H&S communication (*r = -.592, p <.01*); and
- workload H&S pressure and supervisory H&S leadership expectations (*r = .539, p <.01*).

Moderate correlations were found between:

- workload H&S pressure and hspfA (*r = .-330, p <.01*);
- workload H&S pressure and top management commitment (*r = -.252, p <.01*); and
- workload H&S pressure and H&S training (*r = .-242, p <.01*).

None of the intercorrelations were strong enough to warrant exclusion of potential multicollinearity.

A moderate positive correlation was found between environmental work danger and workload H&S pressure (*r = .369, p <.01*). Weak correlations were found between environmental work dangers and H&S incident reporting (*r = -.223, p <.01*) and H&S communication (*r = -.210, p <.01*).

The results of the Pearson's product moment correlation analysis show substantial positive correlations amongst the constructs, as was proposed. The negative correlations and weak relationships of the control variables confirmed what was anticipated of the relationships between the constructs and control variables. Seeing that the correlations were not above the high significant levels that could indicate multicollinearity, a conclusion was made that multicollinearity did not exist between the constructs, and therefore all variables were included for further analyses.

6.5.1 Demographic variables correlation analysis

Demographic variables were analysed with outcome variables to determine the correlation between the constructs. This was done to establish whether there were any direct relationships between the variables that would explain H&S behaviour and

H&S performance in the local construction industry. The analysis was also used to test for multicollinearity between the variables (Hair et al., 2006). This was done to ensure that future analysis was based on rigorous screening of the variables and data according to statistical guidelines (Hair et al., 2006; Tabachnick & Fiddell, 2007). Pairwise deletion was used with the demographic data intercorrelations and reliabilities (Cronbach's alpha) analysis. Pairwise deletion enabled the retention of more cases for analysis in comparison to listwise deletion. The findings from this analysis are presented in Table 6.8.

Table 6.8

Summary Correlations of Demographic Data and Outcome variables

	1	**2**	**3**	**4**	**5**
1. Gender	1				
2. Years working for the same company	**-.127****	1			
3. Years working with the same supervisor	.035	-.045	1		
4. H&S performance active	.020	-.042	-.023	1	
5. H&S avoidance behaviour avoidance	-.065	.055	**.113****	**.244****	1

Note: **. N = 628–820;
Correlation is significant at the 0.01 level (2-tailed). **.
Correlation is significant at the 0.05 level (2-tailed).

The Pearson's product moment coefficient analysis between the demographic variables of gender, years working for the same company, years working for the same supervisor, H&S performance active and H&S avoidance behaviour yielded no significant correlations. A small correlation was observed between H&S avoidance behaviour and H&S performance *($r = .244$, $p < .01$)*. The correlation between working for the same supervisor and H&S avoidance behaviour yielded a weak small coefficient ($r = .113$, $p < .01$). Similarly, a weak small relationship was observed between years working for the same company and gender ($r = .127$, $p < .01$). The finding in relation to gender is interesting, considering the ratio of female to male workers surveyed in the current study. These findings give an indication that demographic variables have no influence on H&S performance or H&S avoidance behaviour for this sample.

Observed H&S avoidance was the variable that had the least significant correlations with the other dimensions, as depicted in Table 6.8. These findings could be due to the double negative wording of the items, which, even when reverse coded, did not change the statistics in terms of Cronbach's alpha or correlations. All other reverse coded variables reported significant correlations with some of the predictor and explanatory constructs. Overall, the results of the Pearson's correlation coefficient show that H&S motivation is pivotal in this model. This explanatory variable is substantially correlated with all other variables, except for one outcome variable (observed H&S avoidance) and one contextual variable (workload H&S pressure).

6.5.2 Group level H&S climate

After calculation of the Pearson’s correlation coefficients of the variables of interest across the different construction sites, the researcher was interested in testing whether there were statistically significant differences in perceptions of H&S climate of the workers when grouped according to construction site.

Using the Pearson correlation coefficient from the large sample that is considered not normally distributed, the scores from the *r* were transformed to z scores. It is recommended that the sample size be large enough for the central limit theorem to apply (Fisher, 1992), the sample must be greater than or equal to 20 for the calculation to be applied (Pallant, 2007). Assuming a significance level of 5%, the correlation coefficients differ between groups if $Z_{obs} \geq \pm 1.96$.

An assessment of the group level agreement between the workers at the same construction site was calculated using the IRA formula (Ludtke, et al., 2006). The results of this analysis are presented in Table 6.9.

Table 6.9

Inter-Rater Agreement Scores for construction sites and H&S climates

Site	HSC
1	0.83
2	0.74
3	0.75
4	0.55
5	0.68
6	0.58
7	0.59
8	0.89
9	0.82
10	0.68

Note: consensus exists for construction sites with IRA scores greater than .70 (Ludtke, et al., 2006)

The inter-rater agreement scores for workers at the different sites are represented in Table 6.9. Of the total number of construction sites surveyed, five sites (1, 2, 3, 8, 9) satisfied the requirement of having scores of .70 or higher indicating agreement on the perceptions of H&S climate at those building sites. The inter-rater agreement for the remaining five construction sites did not satisfy the >.70 requirement indicating that there was no consensus of worker perceptions of H&S climate on these sites. The overall Z_{obs} for H&S climate for all ten sites was .71, which is above the required .70 threshold. Of the ten sites assessed five reported high levels of IRA, averaging .80 which is well above the required .70. Two of the highest scoring sites belonged to the same organisation. Of the other five construction sites that recorded IRA levels below the recommended .70 ranging between .55 – .68; three sites belonged to the same organisation: (.55, .68 & .59). The other two sites reported IRAs of .58 and .68 respectively indicating low levels of inter-rater agreement of the construct.

6.6 REGRESSION ANALYSIS

To be able to analyse multivariate relationships further, the different dimensions were used to determine prediction of one another. Standard multiple regression was used to obtain this information. The validity of regression analysis depends on whether or not various assumptions are met (Hair et al., 2010). One of the assumptions is that the residuals of the regression are normally distributed. Diagnostic checks were run for each of the regression models obtained, and conclusions were made regarding the validity of the models. A standard multiple regression was conducted to test the proposed correlations between organisational antecedents of H&S climate and individual variables of H&S climate as independent variables. The findings from this analysis are presented in Table 6.10 and Table 6.11. The standard multiple regression process was subjected to the assumptions and issues checklist recommended by Tabachnick and Fidell (2001), which were discussed in detail in

Chapter Five. For this study, the sample requirements and statistical power were examined. These were outlined and presented in Chapter Five.

6.6.1 Standard multiple regression: Incident reporting

To test the proposition that organisational antecedents of H&S climate (top management to H&S; H&S training; H&S communication; supervisory H&S leadership expectations; and H&S management systems) are a good predictor of H&S incident reporting, a standard multiple regression was performed between the independent variables and the dependent variable. Analysis was performed using SPSS regressions and SPSS frequencies for evaluation of assumptions. A test for multicollinearity was performed, and variables reported correlations of above .70 (Pallant, 2007). As a result, all variables were retained. The Tolerance and VIF values were checked to assess how much of the variability of the independent variables were not explained by the other variables in the model. The results indicated that there were no values of less than .10 and therefore the multiple correlations were acceptable, because there was no multicollinearity. The normality P-P plot results indicated no outliers in data, and normality and homoscedasticity of the data was established.

All of the organisational antecedents of H&S climate were included in the model. Diagnostic plots indicated that the assumptions of the regression model could be considered valid. The normal probability plot was checked and the histogram of the standardised residuals appeared to be normally distributed. There did not appear to be any multicollinearity, and the homoscedasticity assumption was not violated. The result from analysis predicting H&S incident reporting is presented in Table 6.10 below, which displays the unstandardised coefficients (β), the R^2, and the adjusted

R^2. Incident reporting (as a dependent variable) was predicted by a model consisting of organisational antecedents for H&S climate, and this model was able to explain 38% of the variance in H&S incident reporting *(R^2 = .62)*. H&S management system was observed as the variable that offered the lowest prediction ability in this model, and did not make a significant contribution to the model *(R^2 = .027)*. Four of the independent variables contributed significantly to the prediction of H&S incident reporting. The variable that made the largest unique contribution to explaining the dependent variables was H&S communication *(R = .416)*. Supervisory H&S leadership expectations made a significant contribution *(R^2 = .255)*.

Table 6.10

Multiple Regression Analysis Predicting H&S Incident Reporting

	Coefficients			
	B	***BSE***	***Beta***	***p***
Top management's commitment to H&S	.142	.041	.143	.001
H&S communication	.297	.027	.416	.000
H&S training	-.326	.067	-.179	.000
Supervisory H&S leadership expectations	.473	.070	.255	.000
H&S management systems	.035	.050	.027	.488

Note: *N* = 640; *B* = unstandardised coefficient; *BSE* = *B* standard error;
Beta = standardised coefficient; *p* = significance level (p < .005).
R = .62; R^2 = .39; Adjusted R^2 = .38 (p = <.001)

These findings indicate a good model fit, and the model may be said to explain 38% of the variability in the response variable. This finding indicates that the model's organisational H&S antecedent variables are all significantly and positively related to incident reporting. Increases in the value of any of these variables would result in increases in incident reporting.

To analyse the hypothesis that organisational antecedents of H&S climate will predict individual H&S behaviour, hierarchical multiple regression analysis was conducted. This controlled for demographic and control variables to predict H&S performance as a dependent variable. Two models were tested using hierarchical multiple regression. The following conclusions can be drawn from the findings, as presented in the next section.

To analyse the hypothesis that organisational antecedents of H&S climate will predict individual H&S behaviour, the following analysis controlled for demographic and control variables to predict H&S incident reporting as a dependent variable. Two models were tested using hierarchical multiple regression. The following conclusions can be drawn from the findings, as presented in the next section.

To assess what the effect of controlling for demographic and contextual variables would be on the prediction of H&S incident reporting, the total sample (851) was analysed using hierarchical multiple regression. Variables were entered sequentially (Tabachnick & Fidell, 2001), with the use of pairwise deletion, as the process of addressing missing data was used to determine whether the proposed antecedents were able to explain H&S climate beyond the demographic and contextual variables. The variables were entered in a logical pattern consistent with theorised propositions. The analysis was conducted in three stages:

- Step 1: all the demographic variables were entered.
- Step 2: the contextual variables were introduced.
- Step 3: the organisational antecedents of H&S climate were analysed.

Table 6.11

Hierarchical Regression Analysis Predicting H&S Incident Reporting

	B	BSE	Beta	*p*
Step 1 Demographic differences				
Racial grouping	2.992	.928	.129	.001
Contractor status	.399	.464	.036	.390
Gender	.828	.669	.050	.216
Age	.078	.028	.129	.005
Years working for the same company	-.040	.050	-.036	.425
Years working with the same supervisor	.002	.220	.000	.992
Step 2 Contextual differences				
Racial grouping	1.913	.751	.083	.011
Contractor status	.067	.379	.006	.859
Gender	.749	.543	.045	.168
Age	.015	.023	.025	.496
Years working for the same company	.003	.040	.002	.950
Years working with the same supervisor	-.335	.179	-.063	.062
Workload pressure	-.530	.032	-.584	.000
Environmental work danger	-.060	.072	-.030	.405
Step 3 Proposed antecedents				
Racial grouping	1.672	.693	.072	.016
Contractor status	.114	.351	.010	.744
Gender	1.122	.504	.068	.026
Age	.009	.021	.015	.672
Years working for the same company	.005	.037	.005	.895
Years working with the same supervisor	-.287	.166	-.054	.085
Workload pressure	-.343	.035	-.378	.000
Environmental work danger	-.081	.068	-.040	.232
Top management's commitment to H&S	.123	.039	.125	.002
Supervisory H&S leadership expectations	.205	.064	.116	.002
H&S management systems	.021	.047	.017	.659
H&S communications	.192	.028	.269	.000
H&S training	-.294	.062	-.169	.000

Note: Sample size ranging from N = 688 to *N* = 823 (pairwise); *B* = unstandardised coefficient; *BSE* = *B* standard error; *Beta* = standardised coefficient; *p* = significance level.
After step 1: R = .183 R^2 = .034; adjusted R^2 = .024; ΔR^2 = .03 (p < .001)
after step 2: R = .611; R^2 = .374; adjusted R^2 = 365; ΔR^2 = .34 (p < .001)
after step 3: R = .690; R^2 = .476; adjusted R^2 = .464; ΔR^2 = .10 (p < .001)

6.6.1.1 Predicting H&S motivation and H&S incident reporting

Hierarchical multiple regression was used to assess organisational antecedents of H&S climate variables (top management's commitment to H&S, supervisory H&S leadership expectations, H&S management systems, H&S communications, H&S training) and contextual variables workload pressure and environmental work danger to predict H&S incident reporting after controlling for the influence of demographic variables. In step one, the demographic variables (contractor type, gender, work status, race, years working with the same supervisor, age in years, years working for the same company) were added to the model. Overall, these variables explained 3.4% of the total variance in this model. The analysis using demographic variables reported a weak predictive ability ($R^2 = .034$, $p = <.000$). This analysis was followed in step two by the addition of contextual variables. The addition of contextual variables reported an increase in the predictive ability of the model ($R^2 = .340$, $p = <.000$), indicating that this model was able to predict incident reporting at 34.0%. In step three, organisational antecedents of H&S climate variables were added to the model. This model revealed an overall higher predictive ability than step one and step two ($r^2 = .476$, $p = <.000$). This is a statistically significant unique contribution, as indicated by the sig F. change value *(.000)*.

To assess which of the variables contributed to the final model, the coefficients table was examined. Seven variables were identified as making a statistical contribution to the model. In the first step, race reported a statistical contribution ($\beta = .129$, p = .001), and age reported ($\beta = .129$, p = .005). In the second step, workload pressure ($\beta = -.584$, $p = .000$) was the only significant contributor to the model. In the third step, which included H&S communication ($B = .269$, $p = .000$), H&S training ($\beta = .169$, $p = .000$), top management's commitment to H&S *(β = .125, p = .002),* workload pressure H&S *(β = - .378 p = .000),* supervisory H&S leadership expectations *(β = .116, p = .002),* race *(β = .103, p = .001),* only four of the five organisational antecedents of H&S climate were statistically significant and one contextual variable reported a statistically significant negative value.

The influence of race and age in step one was unexpected. The lack of reported significance of years working for the same supervisor and level of education was surprising. The other demographic variables did not play a significant role in the prediction of H&S incident reporting. The next analysis investigated the predictive ability of the same antecedents with H&S motivation.

6.6.2 Standard multiple regression: H&S motivation

To test the proposition that organisational antecedents of H&S climate (top management to H&S; H&S training; H&S communication; supervisory H&S leadership expectations; and H&S management systems) are a good predictor of H&S motivation, a standard multiple regression was performed between the independent variables and the dependent variable.

All of the organisational antecedents of H&S climate were included in the model. Diagnostic plots indicated that the assumptions of the regression model could be considered valid: the normal probability plot was checked and the histogram of the standardised residuals appeared to be normally distributed. There did not appear to be any multicollinearity, and the homoscedasticity assumption was not violated. The result from the analysis predicting H&S motivation is presented in Table 6.13, which displays the unstandardized coefficients (β), the R^2, and the adjusted R^2. H&S motivation (as a dependent variable) was predicted by a model consisting of organisational antecedents for H&S climate, and this model was able to explain 44.5% of the variance in H&S motivation (R = .670). The variable supervisory H&S leadership expectations offered the lowest prediction ability in this model, with no significant contribution to the model *(β = - 004, p = .944*). Four of the independent variables contributed significantly to the prediction of H&S incident reporting. Overall this model is significant at *p = .005*.

Table 6.12

Multiple Regression Analysis predicting H&S Motivation

	B	**BSE**	**Beta**	***p***
Top management's commitment to H&S	.169	.034	.182	.000
H&S communication	.135	.023	.200	.000
H&S training	.439	.055	.265	.000
Supervisory H&S leadership expectations	-.004	.055	-.002	.944
H&S management systems	.316	.041	.269	.000

Note: *N* = 702–707; *B* = unstandardized coefficient; *BSE* = *B* standard error;
Beta = standardised coefficient; *p* = significance level; (p < .005).
R = .661; R^2 = .437; adjusted R^2 = .432 (p < .001).

6.6.2.1 Hierarchical multiple regression: H&S motivation

To analyse the hypothesis that organisational antecedents of H&S climate will predict individual H&S behaviour, the following analysis controlled for demographic and control variables to predict H&S motivation as a dependent variable. Certain conclusions below can be drawn from the findings, as illustrated in Table 6.11.

Hierarchical multiple regression was used to assess the ability of the organisational antecedents of H&S climate (top management's commitment to H&S, supervisory H&S leadership expectation, H&S communication, and H&S training) to predict H&S motivation, after controlling for demographic and contextual variables. Preliminary analyses were conducted to ensure that no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity were present in the data.

The demographic variables of race, contractor status, gender, age, years working for the same company, and years working with the same supervisor were entered in step one, explaining 1.4%. After entry of the contextual variables (workload pressure and environmental work danger) in step two, the total variance explained by the model as a whole was 4.4%, with workload pressure the only variable making a significant contribution to the model (*β = .037, p < .000).* During the third step, the organisational antecedents of H&S climate (top management's commitment to H&S, supervisory H&S leadership expectation, H&S communication, and H&S training) were added, explaining 46.1% of the variance in H&S motivation, after controlling for demographic and contextual variables, R^2change = .41.7.

In the final model, only four of the organisational antecedents of H&S climate were statistically significant, with the H&S management system recording a high beta value (*β = .27, p <.000*), which was slightly higher than that of the H&S training variable (*β* = .63, p <.000), H&S communication (*β = .23, p <.000)* and top management's commitment to H&S *(β = .181, p < .000).* Although the study had proposed that supervisory H&S leadership expectations would predict H&S motivation, the results in this analysis reported a weak prediction ability, which was far removed from the 5% level (*β = .28, p <.443).*

The absence of demographic variables predicting H&S motivation was an unexpected outcome for this analysis, considering that motivation is an individual attribute that was expected to be influenced by individual attributes of demographic variables. Because the data was obtained from different construction sites, the influence of demographic variables was expected to be a common factor amongst the workers from the different organisations. The results of this regression analysis indicated no predictive ability from race (*β = .055, p <.172),* gender (*β = .035, P*

<.397), contractor status (*β = .102, p <.016)*, working for the same supervisor (*β = .035, p <. 403)*, or working for the same company (*β = .041, p <.377).* The addition of contextual variables in the second step increased the model's predictive ability substantially (R^2 = *.30, p = < .000*).

Table 6.13

Hierarchical Multiple Regression Predicting H&S Motivation

	B	BSE	Beta	*P*
Step 1 Demographic differences				
Racial grouping	1.215	.888	.055	.172
Contractor status	1.074	.444	.102	.016
Gender	.543	.641	.035	.397
Age in years	.010	.026	.018	.705
Years working for the same company	-.042	.047	-.041	.377
Years working with the same supervisor	.176	.210	.035	.403
Step 2 Contextual differences				
Racial grouping	.906	.879	.041	.303
Contractor status	.960	.443	.091	.031
Gender	.543	.636	.035	.393
Age in years	-.008	.026	-.013	.771
Years working for the same company	-.028	.047	-.027	.554
Years working with the same supervisor	.088	.210	.018	.674
Workload pressure	-.154	.037	-.179	.000
Environmental work danger	.010	.084	.005	.905
Step 3 Proposed antecedents				
Racial grouping	.161	.666	.007	.809
Contractor status	.643	.337	.061	.057
Gender	.399	.484	.026	.410
Age in years	-.019	.020	-.033	.344
Years working for the same company	-.021	.036	-.020	.565
Years working with the same supervisor	.319	.160	.063	.046
Workload pressure	.076	.034	.089	.024
Environmental work danger	-.032	.065	-.016	.630
Top management's commitment to H&S	.169	.038	.181	.000
Supervisory H&S leadership expectations	.048	.062	.028	.443
H&S management systems	.324	.045	.275	.000
H&S communication	.156	.027	.230	.000
H&S training	.435	.059	.263	.000

Note: Sample size ranging from N = 688 to *N* = 823 (pairwise); *B* = unstandardized coefficient; *BSE* = *B* standard error; *Beta* = standardised coefficient; *p* = significance level.
After step 1: R = .120 R^2 = .014; adjusted R^2 = .005; ΔR^2 = .014 (p < .001)
after step 2: R = .211; R^2 = .044; adjusted R^2 = 032; ΔR^2 = .030(p < .001)
after step 3: R = .679; R^2 = .461; adjusted R^2 = .450; ΔR^2 = .417 (p < .001)

6.6.3 Outcome Variables

The next proposition was concerned with the predictive ability of the individual antecedents of H&S climate of H&S performance Active (hspfA) and observed H&S

Avoidance (hsabA). Having tested the predictive ability of organisational antecedents on individual H&S antecedents, SPSS standard multiple regression was used to test the next step in the model.

6.6.4 Predicting H&S performance active

To test the proposition that individual antecedents of H&S incident reporting and H&S motivation would predict H&S performance Active, a standard multiple regression analysis was conducted between the dependent and the independent variables. Diagnostic plots showed that the assumptions of the regression model may be considered valid. The normal probability plot was checked and confirmed to comply with the recommended standards, with points registered on a straight diagonal line (Tabachnick & Fidell, 2001), and the histogram of the standardised residuals appeared to be normally distributed. There did not appear to be any multicollinearity, and the homoscedasticity assumption was not violated. Findings from the standard multiple regression analysis are presented in Table 6.13.

Table 6.14

Multiple Regression Analysis Predicting H&S Performance Active

	Model summary			**Coefficients**			
				B	**BSE**	**Beta**	***p***
H&S incident reporting	.598	.357	.355	.088	.040	.070	.027
H&S motivation				.774	.042	.573	.000

Note: N = 717; B = unstandardized coefficient; BSE = B standard error; *Beta* = standardised coefficient; p = significance level ($p < .005$).
R = .598; R^2 = .357; R^2 = .355

The two individual responsibility variables together explained 35.7% of the variance in hspfA. The adjusted R^2 was .355. The change in R^2 in the model was significant *(p = < .000)*. A difference was observed between the two regression paths, which implied a significant regression model R for the regression equation. The final plot provided an assessment of model fit, together with the R^2-statistic (*0.355*). The model fit was adequate, and explained 35.5% of the variability in the response variable (Tabachnick & Fidell, 2001).

6.6.4.1 Hierarchical multiple regression: H&S performance active

Hierarchical multiple regression analysis was used to assess whether the proposed antecedents explained significant variance in H&S performance above and beyond the demographic and contextual variables. A sequential logical pattern was followed when entering the predictor variables with demographic data (contractor type, gender, work status, race, years working with the same supervisor, education level, age in years, years working for the same company) entered in step one. In step two, contextual variables (workload pressure and environmental work danger) were added to the model. In step three, individual H&S variables (H&S motivation and H&S incident reporting) were added to the model. Finally, in step four, the organisational antecedents of H&S climate (top management's commitment to H&S, supervisory H&S leadership expectation, H&S communication, and H&S training) were added to the model.

Hierarchical multiple regression was used to assess the ability of the organisational antecedents of H&S climate (top management's commitment to H&S, supervisory H&S leadership expectation, H&S communication, and H&S training) to predict H&S performance after controlling for the influence of demographic, individual and contextual variables. Preliminary analyses were conducted to ensure that no violations of the assumptions of normality, linearity, multicollinearity and homoscedasticity were present. The findings of this analysis are presented in Table

6.14. In step one, demographic variables were entered, and explained 2.3% of the total variance. In step two, contextual variables were included, and explained 9.2% of the variance, contributing 6.9% over and above the 2.3% explanation offered by demographic variables. In step three, individual H&S variables were added, explaining 38.9% of the total variance in the ability to predict H&S performance. This represents 29.7% prediction ability over and above the prediction ability of demographic and context variables. In step four, the organisational antecedents of H&S climate were added to the model, and explained 52.0% of the entire model, indicating that organisational variables were able to predict 13.1% over and above the predictive ability of demographic, contextual and individual variables. Overall, the model shows that the organisational antecedents of H&S climate were able to predict H&S performance Active in the South African construction industry worker sample.

In step one, age ($\beta = .118$, $p = .011$), working for the same company ($\beta = .111$, $p = .016$), and contractor status ($\beta = .098$, $p = .020$) were the only demographic variables that reported ability to predict H&S performance Active, but the prediction levels were not significant. In step two, workload pressure ($\beta = -.262$, $p = .000$) was the only contextual variable to report significant predictive ability of H&S performance. Contractor status ($\beta = 085$, $p = .039$) and years working for the same company ($\beta = 094, .036$) reported weaker significance levels in comparison to step one. In step three, workload pressure ($\beta = -.179$, $p = .000$) and H&S motivation ($\beta = .561$, $p = .000$) were the positive significant contributors to H&S performance. Age ($\beta = .079$, $p = .32$), and years working with the same supervisor ($\beta = .079$, $p = .33$) reported weaker insignificant prediction abilities than in step one. In step four, the organisational antecedents of H&S climate reported significant predictive abilities for the following variables: H&S motivation ($\beta = .250$, $p = .000$), top management's commitment to H&S *(β = .233, p = .000),* H&S training *(β = .203, p = .000),* and H&S management systems *(β = .154, 000).* Workload pressure did not report any significant predictive ability (*β = .081, p = .045).* The number of years with the company was significantly negatively related to H&S performance (*β = -.075, p = .024)*, indicating that increases in this variable would result in lower values of H&S performance, i.e. that the longer an employee remains with the same company, the lower the values of H&S performance, implying complacency towards H&S behaviour.

The model outcome variable H&S performance Active was assessed to determine the predictive ability of the organisational antecedents of H&S climate variables (H&S motivation, H&S training, top management's commitment to H&S, and H&S management systems). The results show that all variables were significantly and positively related to H&S performance. Increases in the value of any of these variables would result in increases in H&S performance. Improvements in H&S motivation, top management commitment, H&S training, and H&S management systems led to higher values of H&S performance.

In the final model, significant predictors of H&S performance active were H&S motivation, H&S training, top management's commitment to H&S, and H&S management systems, indicating a combination of individual and organisational factors for H&S performance Active to be present in an organisation.

Table 6.15

Hierarchical Regression Analysis Predicting H&S Performance Active

	B	BSE	Beta	*P*
Step 1 Demographic differences				
Racial grouping	.196	1.191	.007	.870
Contractor status	1.390	.596	.098	.020
Gender	.648	.859	.031	.451
Age in years	.091	.035	.118	.011
Years working for the same company	-.154	.064	-.111	.016
Years working with the same supervisor	.059	.282	.009	.835
Step 2 Contextual differences				
Racial grouping	-.424	1.154	-.014	.713
Contractor status	1.202	.582	.085	.039
Gender	.600	.835	.028	.473
Age in years	.055	.035	.071	.115
Years working for the same company	-.130	.062	-.094	.036
Years working with the same supervisor	-.136	.276	-.020	.622
Workload pressure	-.304	.049	-.262	.000
Environmental work danger	-.038	.111	-.015	.733
Step 3 Proposed individual antecedents				
Racial grouping	-1.037	.954	-.035	.277
Contractor status	.478	.481	.034	.320
Gender	.217	.688	.010	.753
Age in years	.061	.029	.079	.032
Years working for the same company	-.109	.051	-.079	.033
Years working with the same supervisor	-.215	.227	-.032	.344
Workload pressure	-.208	.049	-.179	.000
Environmental work danger	-.048	.091	-.018	.600
H&S motivation	.757	.045	.561	.000
H&S incident reporting	-.038	.053	-.030	.475
Step 4 Proposed organisational antecedents				
Racial grouping	-1.434	.853	-.048	.093
Contractor status	.381	.431	.027	.376
Gender	.129	.620	.006	.835
Age in years	.047	.025	.061	.066
Years working for the same company	-.103	.046	-.075	.024
Years working with the same supervisor	.043	.205	.006	.835
Workload pressure	-.094	.047	-.081	.045
Environmental work danger	-.146	.083	-.056	.081
H&S motivation	.337	.053	.250	.000
H&S incident Reporting	.004	.051	.003	.933
Top management's commitment to H&S	.292	.049	.233	.000
H&S Communication	.025	.036	.028	.490
H&S Training	.453	.081	.203	.000
Supervisory H&S leadership expectations	.000	.080	.000	.996
H&S Management systems	.245	.060	.154	.000

Note: Sample size ranging from N = 688 to *N* = 823 (pairwise); *B* = unstandardized coefficient; *BSE* = *B* standard error; *Beta* = standardised coefficient; *p* = significance level.
After step 1: R = .153 R^2 = .023; adjusted R^2 = .014; ΔR^2 = .023 ($p < .001$)
After step 2: R = .304; R^2 = .092; adjusted R^2 = 080; ΔR^2 = .069(p < .001)
After step 3: R = .623; R^2 = .389; adjusted R^2 = .378; ΔR^2 = .296 ($p < .001$)
After step 4: R = .721; R^2 = .520; adjusted R^2 = .508; ΔR^2 = .131 ($p < .001$)

6.7 PREDICTING H&S AVOIDANCE BEHAVIOUR (hsab)

To test the proposition that individual antecedents of H&S climate will predict H&S avoidance behaviour (hsab), regression analyses were conducted. The hsab variable reported the lowest correlations with other variables in a Pearson's product moment correlation, as reported above. Table 6.7 presents the correlation results for hsab and other variables, indicating that the proposed individual variables of H&S climate correlated poorly with hsab $r = .051, p = < .001$, for incident reporting and $r = .094, p = <.001$. Regression analysis performed on the prediction ability of these antecedents did not produce any significant prediction ability of the two independent variables. The regression model was poor and below the recommended level (Hair et al., 2006). Although the P-Plot of the regression standardised residual plot reported mild homoscedasticity, the standardised predicted value in the scatter plot confirmed the prevalence of outliers on the scatter plot, thus confirming the weak prediction ability of this model, with 15% as the prediction level.

Table 6.16

Multiple Regression Analysis Predicting Observed H&S Avoidance

				Coefficients			
	R	R^2	AdjustedR^2	B	BSE	Beta	*p*
H&S incident reporting	.149	.022	.020	-.048	.042	-.043	.258
H&S motivation				.183	.045	.155	.000

Note: *N* = 743; *B* = unstandardized coefficient; *BSE* = *B* standard error; *Beta* = standardised coefficient; *p* = significance level.

It is evident from Table 6.16 that the model (individual antecedents of H&S climate and H&S avoidance behaviour) explained a very small percentage (2.2%) of the variance. H&S motivation was the only variable of the two that made a unique contribution to the H&S avoidance behaviour variable. When one considers the threshold for practical significance, this model can be considered not to have reached the practical significance level; therefore, the proposition that individual antecedents for H&S climate will predict H&S avoidance behaviour avoidance is rejected.

6.8 HIERARCHICAL MULTIPLE REGRESSION H&S AVOIDANCE BEHAVIOUR AVOIDANCE (HSAB)

Hierarchical multiple regression was used to assess the ability of organisational antecedents of H&S climate top management's commitment to H&S, supervisory H&S leadership expectation, H&S communication, and H&S training to predict observed H&S avoidance behaviour, after controlling for the influence of:

- demographic variables (contractor type, gender, work status, race, years working with the same supervisor, education level, age in years, years working for the same company);
- contextual variables (workload pressure and environmental work danger); and
- individual variables (H&S motivation and H&S incident reporting).

Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

The demographic variables were entered in step one, explaining 2.2% of the total variance. In step two, contextual variables of workload pressure and work environmental danger were included. These explained 3.6% of the total variance. After entry of the individual variables of H&S motivation and H&S incident reporting in the third step, the total variance explained by the model was 6.1%. In the fourth step, the organisational antecedents of H&S climate were included, and the total variance explained by the model was 9.2%.

From the findings, it is clear that the model fit was not good, as assessed by an appraisal of the final plot, and the R-squared value of .031. The model explained only 9.2% of the variability in the response variable. In step one, years working with the same supervisor was positively significant (β = .127, p = .002). In step two, years working with the same supervisor was the only significant variable (*β = .122, p = .003).* Contextual variables showed insignificant prediction ability with workload pressure *(β = .103, p = .019)* and environment work danger *(β = .105, p = .017).* In the third step, H&S motivation had the strongest significant prediction ability *(β = .160, p = .000),* years working with the same supervisor was still significant *(β = .121, p = .004),* while workload pressure *(β = .141, p = .007)* and environment work danger *(β = .105, p = .016*) reported statistically insignificant findings. In the final step, H&S training had the highest prediction ability *(β = .181, p = .000*), and years working with the same supervisor *(β = .123, p = .003)* showing a significant finding. Other variables that had insignificant prediction abilities but worth mentioning are: gender *(β = .102, p = .012),* workload pressure (*β = .128, p = .022*), supervisory H&S leadership expectation (*β = .111, p = .022*) and environment work danger (*β = .102, p = .022*). The model indicated that improvements in H&S training resulted in significant increases in observed H&S avoidance behaviour.

Table 6.17

Hierarchical Regression Analysis Predicting H&S avoidance behaviour

	B	BSE	Beta	*P*
Step 1 Demographic differences				
Racial grouping	.961	1.061	.037	.365
Contractor status	.367	.531	.029	.489
Gender	-1.139	.765	-.061	.137
Age in years	.005	.032	.007	.876
Years working for the same company	.055	.057	.045	.330
Years working with the same supervisor	.768	.251	.127	.002
Step 2 Proposed contextual differences				
Racial grouping	1.141	1.059	.043	.281
Contractor status	.596	.534	.047	.265
Gender	-1.339	.766	-.071	.081
Age in years	.013	.032	.019	.683
Years working for the same company	.031	.057	.025	.585
Years working with the same supervisor	.741	.253	.122	.003
Workload pressure	.106	.045	.103	.019
Environmental work danger	-.242	.101	-.105	.017
Step 3 Proposed individual antecedents				
Racial grouping	.933	1.052	.035	.376
Contractor status	.410	.530	.033	.439
Gender	-1.457	.758	-.078	.055
Age in years	.014	.031	.021	.652
Years working for the same company	.037	.056	.030	.517
Years working with the same supervisor	.730	.251	.121	.004
Workload pressure	.145	.054	.141	.007
Environmental work danger	-.243	.100	-.105	.016
H&S Motivation	.192	.050	.160	.000
H&S Incident Reporting	.018	.058	.016	.755
Step 4 Proposed organisational antecedents				
Racial grouping	.639	1.044	.024	.541
Contractor status	.396	.527	.031	.452
Gender	-1.906	.759	-.102	.012
Age in years	.015	.031	.022	.629
Years working for the same company	.033	.056	.027	.554
Years working with the same supervisor	.742	.251	.123	.003
Workload pressure	.132	.057	.128	.022
Environmental work danger	-.234	.102	-.102	.022
H&S motivation	.108	.065	.090	.096
H&S incident reporting	.106	.062	.093	.090
Top management's commitment to H&S	-.002	.060	-.002	.974
H&S Communication	-.033	.045	-.041	.455
H&S Training	.360	.099	.181	.000
Supervisory H&S leadership expectations	-.224	.097	-.111	.022
H&S Management systems	-.009	.073	-.007	.896

Note: Sample size ranging from N = 688 to *N* = 823 (pairwise); *B* = unstandardized coefficient; *BSE* = *B* standard error; *Beta* = standardised coefficient; *p* = significance level.
After step 1: R = .150 $R^2 =$ .022; adjusted $R^2 =$ .013; ΔR^2 = .022 (p < .001)

After step 2: R = .189; R^2 = .036; adjusted R^2 = 023; ΔR^2 = .013(p < .001)
After step 3: R = .248; R^2 = .061; adjusted R^2 = .046; ΔR^2 = .026 (p < .001)
After step 3: R = .304; R^2 = .092; adjusted R^2 = .069; ΔR^2 = .031 (p < .001)

The diagnostic plots indicate that the assumptions of the regression model may not necessarily be considered valid. Although the residuals appear to be reasonably normal, the tails of the P-P plot pull away from the diagonal line, indicating departures from normality. Additionally, there are strong striations in the scatter plot of the standardised residuals against the predicted values, indicating possible violations of the homoscedasticity assumption.

6.9 LOGISTIC REGRESSION

To assess the predictive ability of the independent variables of H&S performance Active and observed H&S avoidance behaviour on reported injuries, a logistic regression was conducted. The outcome variable in this study (injuries) had two possible answers, namely workers reported injuries within the past month and sought medical attention, or no reported injuries. For the logistic regression analysis, the data was coded as injuries or no injuries. According to Tabachnick and Fidell (2001), logistic regression requires fewer assumptions and is statistically more robust. Logistic regression is considered robust because it uses binomial probability theory (Pallant, 2005; Tabachnick & Fidell, 2001), which predicts only two probabilities: the probability that a worker was injured on a construction site, or the probability that a worker was not injured. The use of the maximum likelihood method enabled logistic regression to form a best-fitting equation, therefore maximising the probability of classifying the observed data into the correct category (Pallant, 2007).

Similar to standard and hierarchical regression, the use of logistic regression assumes that the number of cases in the sample will be larger than the number of predictor variables. This is to allow for the solution to converge (Pallant, 2007). A second assumption is that the dependent variable is dichotomous, and that a linear relationship does not exist between the independent and dependent variables. Multicollinearity, normality of the data, and the absence of outliers were of the variables that were established, as discussed above. For this study, direct logistic regression was performed to assess the impact of a number of factors on the likelihood that workers would report injuries experienced in the 30 day timeframe.. In this study, variables were entered in the regression model in a stepwise fashion in order that the researcher specified.

6.10 INJURIES REPORTED

A stepwise model building procedure for the regression of all totals above on the binary injuries indicator was used to determine the likelihood of injuries being reported. The analysis was based on the predictive value of the summated subscales for H&S performance active and observed H&S avoidance behaviour, together with the demographic and occupational variables. The response was created as a binary rating scale, where a value of 1 indicated an injury, regardless of whether medical attention was required or not, and the value of 0 indicated no injury.

The case processing summary indicated that the correct number of cases were included in the analysis with 61% (n = 521) valid for inclusion and 39% (n = 330) excluded for missing cases. The categorical variable coding reported a problem with the racial categories due to small numbers, combining the categories according to the Department of Home Affairs groupings, which did not improve the category numbers. These were analysed according to the different groupings to obtain any nuances that might emerge from the data.

Taking into consideration that logistic regression makes no assumptions about distribution of scores in the predictor variables, the researcher checked for high correlations amongst the variables to assess multicollinearity. None were found. Since no outliers were identified, the data was accepted for further analysis. The next step in the logistic regression process was to determine the frequency of injured workers during the previous 30 days. Table 6.17 presents the summary of reported injuries.

Table 6.18

Reported Injuries

Injuries	**Frequency**	**Per cent**	**Cumulative %**
No	535	62.87	62.87
Yes	231	27.14	90.01
Missing	85	9.99	100
Total	**851**	**100**	

The proposition that H&S avoidance behaviour would predict injuries was not supported in this study. No evidence emerged from analyses to support this proposition; therefore, alternative propositions were considered using H&S performance Active as the IV and injuries as the DV.

Further analysis of the re-specified model reported insignificant prediction abilities of H&S performance Active, but other independent variables in the model reported statistically significant findings, which are reported in Table 6.19 below. The full model with all predictor variables was statistically significant, $\chi^2(11, N = 521) = 41.19$, $p < .001$, indicating that the predictors as a set were able to distinguish reliably between respondents who reported having been injured during the previous 30 days and those who did not experience any injuries. The model as a whole explained between 39% (Cox & Snell R Square) and 10.9% (Nagelkerke R Square) of the variance in reported injuries, which correctly satisfied 72% of cases. As shown in Table 6.18, only six of the total number of independent variables made a unique statistically significant contribution to the model (general contractor, trade skills, general worker, H&S motivation, H&S incident reporting, and work environment dangers). The strongest predictor of injuries reported was the category of general contractors, which represented a skilled workforce with high levels of skills beyond the second category, which was trade skills. This indicated that after controlling for all other factors in the model, workers who were in the higher operational levels at a construction site were most likely to report an injury (over 5.4 times more likely). The odds ratio of .90 for work environment dangers shows that this was less than 1, indicating that for every work environment danger, workers were .90 times less likely to report being injured, controlling for other factors in the model.

Table 6.19

Stepwise Logistic Regression Injuries

		B	SE	Wald	df	Sig.	Exp (B)
Step 1[a]	H&S incident reporting	-.093	.021	19.842	1	.000	.912
Step 2[b]	Contractor type			9.233	2	.010	
	Contractor type(1)	-.633	.258	6.019	1	.014	.531
	Contractor type(2)	-.033	.269	.015	1	.902	.968
	H&S incident reporting	-.090	.021	18.409	1	.000	.914
Step 3[c]	Contractor type			8.034	2	.018	
	Contractor type(1)	-.554	.262	4.479	1	.034	.575
	Contractor type(2)	.037	.273	.018	1	.892	1.038
	H&S incident reporting	-.097	.022	20.049	1	.000	.907
	Work environment danger	-.084	.038	4.940	1	.026	.920
Step 4[d]	Contractor type			7.577	2	.023	
	Contractor type(1)	-.541	.263	4.242	1	.039	.582

Contractor type(2)	.036	.274	.017	1	.895	1.037
H&S motivation	-.052	.021	5.943	1	.015	.950
H&S incident reporting	-.077	.023	10.956	1	.001	.926
Work environment danger	-.097	.038	6.505	1	.011	.907

Note:
a. Variable(s) entered on step 1: incident reporting;
b. Variable(s) entered on step 2: contractor type;
c. Variable(s) entered on step 3: work environment danger;
d. Variable(s) entered on step 4: H&S motivation.

Table 6.20 indicates that increasing values of incident reporting and H&S motivation results (significantly) decreased likelihood of injury (odds ratios all less than 1). Trade contractors (contract_2) have a lower likelihood of injury than general contractors, and labour contractors have an increased likelihood of injury when compared to general contractors, although the latter of these two results is not statistically significant. The finding that the higher the environmental work danger, the lower the incidence of reported injuries, presents an interesting finding that implies that an individual worker has the ability to evaluate the risk in his or her work environment and adjust H&S behaviour to reduce the incidence of injury or incidents.

Table 6.20

Logistic Regression Odds Ratio

Injuries	**Odds ratio**	**SEerr.**	**z**	**P> z**	**95% conf. interval**	
Incident reporting	.9378146	.0185687	-3.24	0.001	.9021177	.974924
Contract_2	.5603041	.1464899	-2.22	0.027	.3356446	.9353366
Contract_3	1.034149	.2822051	0.12	0.902	.605762	1.765487
Work environment danger	.907207	.0345696	-2.56	0.011	.8419202	.9775566
H&S motivation	.9559577	.019021	-2.26	0.024	.9193948	.9939746

Note: *N = 527;* LR chi 2(5) = 38.88; Prob > chi2 = 0.0000; Pseudo R2 = 0.0619;
Log likelihood = -294.39891; SE = standard error.

Table 6.21 indicates that increasing values of H&S incident reporting and H&S motivation results in a significantly decreased likelihood of injury (odds ratios all less than 1). Trade contractors (contract_2) have a (significantly) lower likelihood of injury than general contractors, which can be explained by the skill level differences between these groups of workers. Labour contractors (casual workers with short-term contracts) have an increased likelihood of injury when compared to general contractors (who were categorised as workers on long-term contracts or permanent positions, therefore likely to participate in the organisation's H&S programmes and training). Although the result for general contractors is not statistically significant, it is worth noting together with an observation that the significance levels may have been impacted by the sample ratios between general contractors and labour contractors. Once again, environmental work dangers reported similar findings in terms of higher environmental risks and the smaller likelihood of injury occurrence, indicating a possible worker awareness of environmental risk and adjustment of behaviour to minimise injuries.

Table 6.21

Logistic Regression Odds Ratio Table2

Injuries	Odds ratio	SE.	z	P> z	95% Conf. interval	
H&S incident reporting	.9242653	.021077	-3.45	0.001	.8838648	.9665124
Contract_2	.5561738	.1456752	-2.24	0.025	.3328592	.92931
Contract_3	1.037975	.2839339	0.14	0.892	.6072171	1.774311
Work environment danger	.9086002	.0345513	-2.52	0.012	.843343	.9789069

H&S motivation	.957373 1	.019165 7	-2.18	0.030	.920536 5	.995683 8

Note: *N = 527*; LR chi 2(5) = 40.35; Prob > chi2 = 0.0000; Pseudo R2 = 0.0643; Log likelihood = 293 = -293.66251; SE = standard error.

Having conducted and finalised standard, hierarchical multiple regression and logistic analyses to determine the predictive ability of the IV in the proposed model, the model was subjected to a SmartPLS path analysis to determine the structural model's ability to predict injuries above and beyond regression analysis. The findings of this analysis are discussed in the following section.

6.11 PATH ANALYSIS

Having established the predictive ability of the H&S climate model using standard regression analysis and hierarchical multiple regression, the data was further analysed with SmartPLS (Ringle, Christian, Wende, Sven, Will, & Alexander, 2005).

6.11.1 Justification for the use of Path Analysis

The use of SmartPLS path analysis techniques for this study was deemed the most suitable tool, because the outcome variable was a dichotomous item and therefore not suitable to alternative structural equation analysis techniques (Tenenhaus et al., 2005). SmartPLS was also considered most suitable because the factors in SmartPLS are orthogonal and therefore multicollinearity was not a problem. SmartPLS enabled the assessment of both independent and dependent variables in one structural model analytical process together with the measurement model analysis, which provided loadings of observed items on the latent variables. This combination of analysis enabled the analysis of measurement errors to be an integral part of the H&S climate model, inclusive of factor analysis as well as hypothesis tests. This form of combined analysis processes offered an opportunity to reinforce the findings of earlier analyses using SPSS techniques, resulting in a more rigorous analysis of the proposed research model and a better measurement tool for H&S climate.

6.12 PATH ANALYSIS: ASSESSMENT OF H&S CLIMATE MODEL

The next section demonstrates the reliability and validity of the measurement model, followed by a report on the effects and the prediction quality of the structural model.

6.12.1 Path Analysis Reliability

For this model, both the internal consistency measures of Cronbach's alpha and indicator reliability recorded acceptable levels of reliability. The finding from the PLS internal consistency reliability analysis revealed high item loadings of between >.731 and .899 for all items included in the analysis (Appendix G). This finding supports SPSS findings on scale reliability, with item loadings identical to the ones discussed in the earlier section of this chapter. All item loadings in the study reported loading >0.731, except for item wlhs6 and item hsab9 (Appendix H), which reported 0.492 and 0.599 respectively. These items were still included in further analyses, as deleting did not yield higher loadings on the remaining items.

Table 6.22

H&S Climate Conceptual Model Composite Reliability

Variable	**CR**	**AVE**
H&S communication	0.948	0.6957
H&S motivation	0.9514	0.7369
H&S performance active	0.9321	0.6061

H&S incident reporting	0.9191	0.6549
Management's commitment to H&S	0.9403	0.6928
H&S management systems	0.9197	0.6569
Supervisory H&S leadership expectations	0.9093	0.716
H&S training	0.918	0.7372
Workload H&S pressure	0.9131	0.6061

Note: AVE = Average variance explained. CR = composite reliability

6.12.2 Path analysis validity

Factorial validity was assessed using convergent and discriminant validity techniques in SmartPLS. Factorial validity was accepted if the items correlated strongly with a construct to which the item is related (Chin, 1998). Acceptable factorial validity was also assessed by ensuring that each measurement item was weakly correlated with other constructs, thus establishing discriminant validity (Chin, 1998).

6.12.2.1 Path Analysis convergent validity

Convergent validity measures the amount of variance captured by a latent construct in relation to the variance due to random measurement error. The common factor (latent variable) explains the ratio of the total variance in the indicators. The ratios should range between 0 and 1. According to Fornell and Larcker (1981), convergent validity is established if the loadings are > 0.5. For convergent validity, it was required that each measurement item loaded with a significant t-value on the latent construct. Convergent validity was established with AVE ranging between 0.6061 and 0.7372, indicating a high validity measurement tool, which was developed and used.

6.12.2.2 Path analysis discriminant validity

The requirement for discriminant validity was that each latent variable obtained a square root that was larger than the established correlation of the specific construct in relation with other constructs (Chin, 1998). To determine this, the analysis reported appropriate patterns of loadings of items on the investigated constructs and of the average variance extracted (AVE).

Table 6.23

PLS Discriminant Validity Construct Cross-Correlation Matrix and Cronbach Alphas

	1	2	3	4	5	6	7	8	9	10
1. H&S communication	***(83.4)***									
2. H&S motivation	0.3692	***(85.8)***								
3. H&S performance active	0.3529	0.6274	***(77.8)***							
4. Injuries	0.2027	0.1937	0.0994	***(0)***						
5. H&S incident reporting	0.5704	0.3033	0.2647	0.2265	***(80.9)***					
6. Management's commitment to H&S	0.317	0.5654	0.5903	0.1238	0.2541	***(83.2)***				
7. H&S management systems	0.2085	0.5568	0.5398	0.1052	0.1637	0.5627	***(81.0)***			
8. Supervisory H&S leadership expectations	0.5297	0.2435	0.2884	0.1246	0.4806	0.2251	0.1992	***(84.6)***		
9. H&S training	0.2406	0.5361	0.5603	0.0412	0.0804	0.5106	0.4772	0.2088	***(85.8)***	
10. Workload H&S pressure	-0.568	-0.228	-0.3067	-0.1572	-0.605	-0.2405	-0.1554	-0.589	-0.216	***(77.8)***

Note: Cronbach alphas are in parentheses and italicised.

The findings indicate that the Fornell-Larcker criterion check with a cross-correlation matrix confirmed good discriminant validity of the measurement tool, with squared correlations above the AVEs of the latent variables. The observed factor matrix reported higher factor loadings on the study constructs. Reliability correlation coefficients, determining the H&S climate measurement tool as a reliable and valid measure of H&S climate for the construction industry in the Western Cape, were high, validating the scale as a reliable measurement instrument.

6.13 PATH ANALYSIS CONFIRMATORY FACTOR ANALYSIS

Having assessed both the convergent and discriminant validity of the measurement tool, the factors as conceptualised were confirmed with these analyses.

- Measurement model (outer) is good with effect loadings of between 0.731 and 0.932. Desired t-values ($t > 20$) for the item loadings in the measurement model were reported. T > values of > 1.196 for the path coefficients in the structural mode were recorded.

In practice, it is acceptable if insignificant path coefficients remain in the structural model or are eliminated (Ringle et al., 2005). The researcher eliminated the insignificant relationships in the re-specification of the H&S climate model presented below.

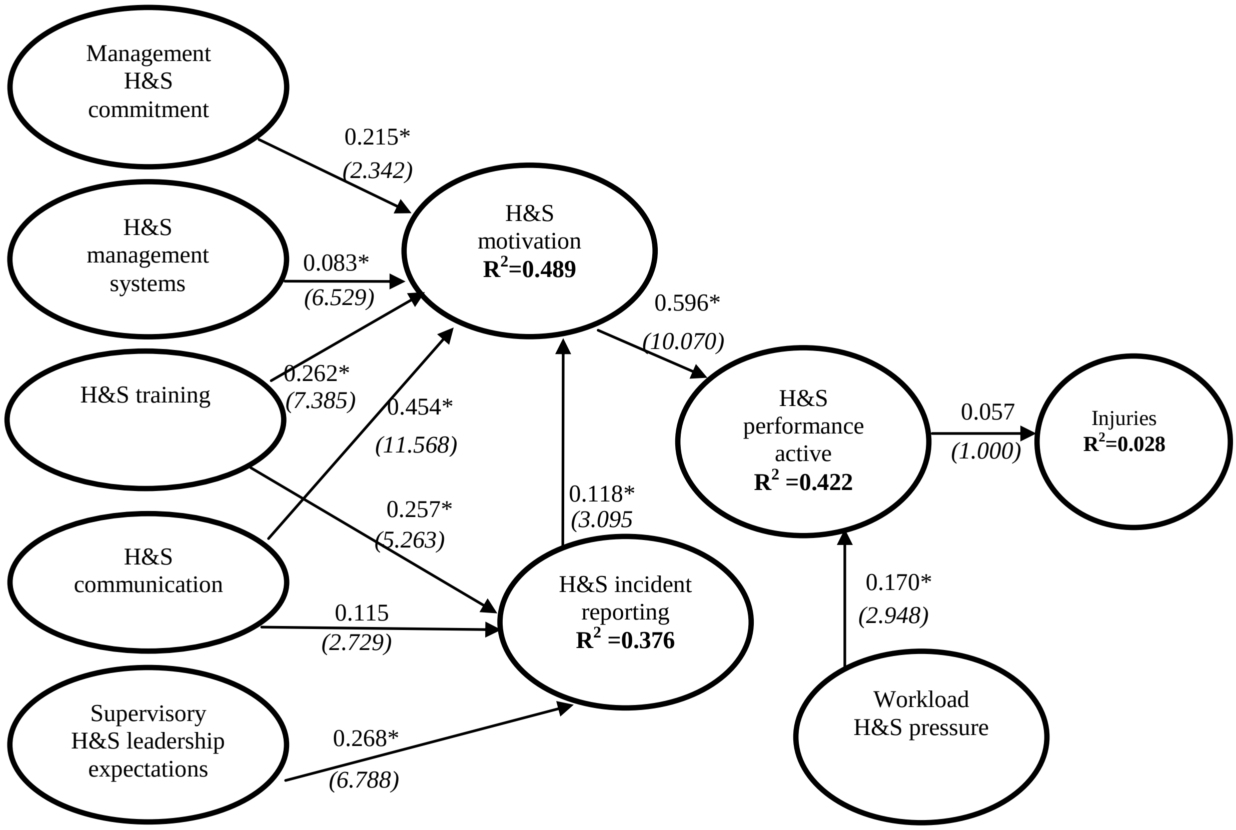

Figure 6.1: The re-specified H&S climate conceptual model showing relationships between IV and DV.

Note: injuries is a dichotomous variable (0 = none, 1 = injury);
t-values significant at" *p < .05; **p <.01; ***p <.001.

The proposed conceptual model for the H&S climate in the South African construction industry found a significant positive predictive ability explanation of 37.6% for the variance in organisational antecedents and H&S incident reporting. The dependent variable was predicted in a manner that renders the finding to be of practical significance based on the f^2 criteria. H&S communication, followed by supervisory H&S leadership, made the strongest unique contribution to the H&S incident reporting prediction score.

The model dimensions of management's commitment to H&S, H&S training, H&S communication, and H&S management systems explained 48.9% of the total score for H&S motivation. The strongest contribution was made by H&S training (t-value 7.389), followed by H&S management systems (6.788), and management's commitment to H&S (t = 2.342) and H&S communication (at 2.729).

The independent variable, H&S motivation, had a significant positive predictive ability over H&S performance active at 42.2% (t = 10.070). This prediction of the dependent variable is performed in a manner that renders the finding to be of practical significance based on the f^2 criteria.

Further analysis of the ability of H&S performance to predict injuries in the construction industry indicated no statistical significance could be determined. However, it should be noted that even a small explanation could be of practical importance in the construction sector where costs for compensation for 2010 – 2011 were reported at R2 708 203 689 (Ramutloa, 2012b).

To enable the researcher to test the proposed conceptual model to establish whether mediating relationships or causal processes were manifested, path analysis was used to assess the implied correlations in this study. From the t-values indicated in the model (Figure 6.1), there is evidence that weak positive direct relationships reporting $t > 1.96$ exist between the variables: H&S motivation, management's commitment to H&S, H&S training, and H&S management system. Weak positive relationships exist between H&S motivation, H&S communication and H&S incident reporting. From the t-values in Figure 6.1 a significant path coefficient is reported between H&S training and H&S incident report, but only a weak correlation (0.083). Furthermore, significant positive direct relationships were observed between H&S communication and supervisory H&S leadership expectations.

The t-values reported in Figure 6.1 indicated that a significant strong positive relationship exists between H&S motivation and H&S performance, and a significant negative relationship between workload H&S pressure and H&S performance. A weak direct effect is further observed between H&S performance Active and injuries. The analysis that was conducted using PLS assessed the entire conceptual H&S climate model. The process used in the current study involved taking all interactions into account and is consistent with results obtained in earlier studies with analysis that used standard regression, hierarchical and logistic regression analyses. The emergence of similar results from both multiple regression analyses and PLS path analysis indicates model validity.

The following conclusions were drawn after the findings of the assessment of the complete conceptual H&S climate model:

- The findings of the path analysis of the H&S climate model were consistent with findings from standard and hierarchical multiple regression. The model explained between 37.6 and 42.2% of the total variance in the dimensions between H&S communication, management's commitment to H&S, H&S training, H&S management systems, H&S communication, and H&S incident reporting and H&S motivation.
- The re-specified H&S climate model showed that a weak positive predictive ability exists between H&S performance active and injuries, which was not consistent with logistic regression findings. Although a very low percentage was obtained, it was considered of practical importance to help organisations to target reduction of workplace fatalities and injuries using the predictive percentage as a guide.

To summarise the findings of the current study, two tables are presented below. Table 6.24 provides a summary of the correlations reported in the current study.

Table 6.24

Summary of Pearson's Product Moment Correlation Findings

Proposition	**Findings**
MGCO is positively related to HSMO	Pearson's correlation *r = .545, p = .01.*
MGCO is positively related to HSIR	Pearson's correlation *(R = .318, p = .01)*
MGCO is positively related to HSPFA	Pearson's R = *.552, p = .01*
MGCO is negatively related to WLHS	Confirmed by Pearson's correlation *R = -.253, p = .01*
MGCO is positively related to M SYS	Confirmed by Pearson's correlation *R = .562, p = .01*
MGCO is positively related to SHSLE	Confirmed by Pearson's correlation *R = .276, p = .01*
MGCO is positively related to HSCO	Confirmed by Pearson's correlation *R = .374, p = .01*
MGCO is positively related to	Confirmed by Pearson's correlation *R = .475, p = .01*

Proposition	Findings
TRNG	
SHSLE is positively related to HSMO	Confirmed by Pearson's correlation *R = .325, p = .01*
SHSLE is positively related to MSYS	Confirmed by Pearson's correlation *R = .264, p = .01*
SHSLE is positively related to HSIR	Conformed by Pearson's correlation *R = .487, p = .01.*
SHSLE is positively related to HSPFA	Pearson's correlation *(R = .338, p = .01)*
SHSLE s negatively related to WLHS	Confirmed Pearson's correlation *R = -.539, p = .01*
MSYS is positively related to HSMO	Pearson's correlation *R = .489, p = .01.*
MYSYS is positively related to HSIR	Pearson's correlation *(R = .271, p = .01)*
MSYS is positively related to HSAB	Pearson's correlation (*R = .036, p < .01*)
TRNG is positively related to SHSLE	Confirmed by Pearson's correlation *(R = .243, p = .01)*
TRNG is positively related to MSYS	Confirmed by Pearson's correlation *(R = .454, p = .01)*
TRNG is negatively related to WLHS	Confirmed by Pearson's correlation *(R = -.539, p = .01)*
TRNG is positively related to HSMO	Confirmed by Pearson's correlation (*R = .499, p = .01).*
TRNG is positively related to HSIR	Weak Pearson's correlation *(r = .103, p = .01).*
TRNG is positively related to HSPFA	Pearson's correlation *(R = .216, p = .01)*
TRNG is positively related to HSAB	Pearson's correlation *(R = .138, p = .01)*
HSCO is positively related to HSIR	Pearson's correlation *(R = .575, p = .01).*
HSCO is positively related to HSMO	Pearson's correlation *(R = .430, p = .01).*
HSCO is positively related to HSPF	Confirmed by Pearson's correlation *(r = .388, p = .01).*
HSCO is positively related to TRNG	Confirmed by Pearson's correlation *(R = .265, p = .01)*
HSCO is positively related to SHSLE	Confirmed by Pearson's correlation *(R = .536, p = .01)*
HSCO is positively related to MSYS	Confirmed by Pearson's correlation *R = .208, p = .01*
WLHS is negatively related to HSCO	Confirmed by Pearson's correlation *(R = -.592, p = .01)*
WDNG is negatively related to HSCO	Confirmed by Pearson's correlation *(R = -.210, p = .01)*
HSCO is positively related to HSAB	Not confirmed by Pearson's correlation

Proposition	Findings
HSMO is positively related to HSPFA	Pearson's correlation *(R = .660, p = .01).*
HSMO is positively related to HSAB	Pearson's correlation (r = .114, p = .01)
HSIR is positively related to HSMO	Pearson's correlation (*R = .430, p = .01).*
HSIR is positively related to HSCO	Pearson's correlation *(R = .338, p = .01).*
WDNG is negatively related to HSIR	Pearson's correlation *R = -.223, p = .01*
WLHS is negatively related to HSIR	Pearson's correlation *(R = -.616, p = .01)*
HSIR is positively related to HSPFA	Pearson's correlation *(R = .271, p = .01)*
HSIR is positively related to HSAB	Not confirmed with Pearson's correlation
WLHS is negatively related to HSPFA	Pearson's correlation *(R = - .330, p = .01)*
WDNG is negatively related to WLHS	Pearson's correlation *(R = .369, p = .01)*
WLHS is negatively related to HSMO	Pearson's correlation *(R = -.290, p = .01)*

Note: Table excludes predictive propositions

The following Table 6.25 presents the findings from the hypothesised propositions in the current study.

Table 6.25

Summary of Findings for Predictive Research Propositions

	Hypotheses used in the current study	Findings of the current study
Proposition 1	The identified constructs and tools used to measure safety climate in previous studies will be reliable and valid measures for the South African construction industry.	Scale reliability and validity confirmed by SPSS reliability analysis and SmartPLS path analysis, showed consistent strong Cronbach alphas of between .708 and .940. Both discriminant and construct validity outcomes were high.
Proposition 2	Top management's commitment to H&S can be used to predict employees' H&S motivation.	Confirmed by standard and hierarchical multiple regression *(r^2 = .46, p < .01)* path analysis *(r = 0.215, t-value 2.342)*
Proposition 2.1	Top management's commitment to H&S can be used to predict employees' individual H&S responsibility.	
Proposition 2.2	Top management's commitment can be used to predict employee H&S	Confirmed by standard and hierarchical multiple regression *(r^2*

	Hypotheses used in the current study	Findings of the current study
	incident reporting	*= .47, p < .01)*
Proposition 3 Proposition 3.1	Supervisory H&S leadership can be used to predict H&S motivation. Supervisory H&S leadership can be used to predict individual H&S responsibility	Not supported
Proposition 3.2	Supervisory H&S leadership can be used to predict employee H&S incident reporting.	Confirmed by path analysis *(r = 0.268, t-value 6.788)*
Proposition 4 Proposition 4.1 Proposition 6 Proposition 6.1	H&S management systems can be used to predict employees' H&S motivation. H&S management system can be used to predict individual H&S responsibility. Toolbox talks can be used to predict employees' H&S motivation. Toolbox talks can be used to predict employees' individual H&S responsibility.	Confirmed by standard multiple regression *(r^2 = .43, $p < .01$)*, hierarchical multiple regression *(r^2 = .46, $p = .01$)* and path analysis *(0.083, t-value 6.529)*
Proposition 4.2 Proposition 6.2	H&S management systems can be used to predict employee H&S incident reporting. Toolbox talks can be used to predict employee H&S incident reporting	Confirmed by hierarchical multiple regression *(r^2 = 47, $p = .01$)* and standard multiple regression *(r^2 = .39, p = < .01)*
Proposition 5 Proposition 5.1	H&S communication can be used to predict employees' H&S Motivation. H&S communication can be used to predict employees' individual H&S responsibility.	Confirmed by hierarchical multiple regression *(r2 = .46, $p < .01$)*, standard multiple regression *(r = .43, $p = .01$) and* path analysis *(r = .454, t-value 11.568)*
Proposition 5.2	H&S communication can be used to predict employee H&S incident reporting.	Confirmed by hierarchical multiple regression *(r.47, $p < .01$)*, standard regression *(r = .39, $p = .01$)* and path analysis *(r = 0.115, t-values 2.729)*
Proposition 7 Proposition 7.1	H&S training can be used to predict employees' H&S motivation. H&S training can be used to predict employees' individual H&S responsibility.	Confirmed by standard multiple regression (r^2 = .43, $p < .01$) and path analysis *(r = 0.262, t-value 7.385)*
Proposition 7.2	H&S training can be used to predict employee H&S incident reporting.	Confirmed by hierarchical multiple regression *(r = .47, $p < .01$)*, standard multiple regression *(r^2 = .39, $p < .01$)* and path analysis *(r = 0.257, t-values 5.263)*
Proposition 8 Proposition 8.1	H&S motivation can be used to predict employees' H&S performance. Employees' perception of individual H&S responsibility can be used to predict H&S performance	Confirmed by hierarchical multiple regression *(r^2 = .52, $p < .01$)*, standard multiple regression (r^2 = .35, p = .01) and path analysis *(r = 0.596, R^2 = 0.489, t-value 10.070)*
Proposition 8.2	H&S incident reporting can be used to predict employees' H&S motivation.	Confirmed with path analysis *(r = 0.118, t value = 3.095)*
Proposition 10	H&S incident reporting can be used to predict H&S performance.	Confirmed with hierarchical multiple regression *(r^2 = .52, $p < .01$)*, standard

	Hypotheses used in the current study	Findings of the current study
		multiple regression *(r^2 = .35, p = .01) and* Pearson's correlation *(R = .271, p = .01)*
Proposition 10.1	H&S incident reporting can be used to predict H&S motivation	Confirmed with hierarchical multiple regression (r^2 = .47, p < .01), standard multiple regression (r^2 = .39, p = .01) and path analysis *(r = 0.118, t-values 3.095).*
Proposition 11	Perceived workload pressure can be used to predict employees' H&S performance.	Not confirmed with hierarchical multiple regression; confirmed with Pearson's correlation *(R = - .330, p = .01)*
Proposition 11.1	Perceived workload pressure can be used to predict employees' H&S avoidance behaviour.	Not supported
Proposition 12	Employee H&S performance can be used to predict employees' H&S avoidance behaviour.	Not supported
Proposition 13	H&S avoidance behaviour can be used to predict workplace injuries.	Not supported
Proposition 14	H&S performance can be used to predict workplace injuries	Path analysis confirmed a weak predictive ability *(r = 0.057, R^2 = 0.028)*
Proposition 15	There will be significant differences between the demographic variables of age, gender; race, tenure, education level and employment contract type and H&S performance.	Weak predictive abilities were observed for age and tenure and working with the same supervisor

Note: Table excludes propositions tested using Pearson's product moment correlations amongst the variables.

6.14 CONCLUSION

The purpose of this chapter was to present the findings that the researcher obtained for this study, as described in the chapter. Although the propositions are not fully supported by the results obtained in the current study, the findings of this study provide significant results that met the objectives of the study. The next chapter provides conclusions that are drawn from the findings of this study. The section will discuss practical as well as theoretical implications, and offer recommendations for future studies.

CHAPTER SEVEN

DISCUSSION

7.1 INTRODUCTION

This chapter presents a discussion of the results obtained from this study, which were presented in Chapter Six. Limitations of the study are presented, as well as recommendations and suggestions for future research. The conclusions and recommendations presented in this chapter are designed to make significant contributions to the field of organisational psychology and to the South African construction industry. The chapter will conclude with a discussion of the theoretical and practical implications of the present study to address the "so-what" question.

7.2 THE PURPOSE OF THE STUDY

The objective of this study was to conduct empirical research using systematic and critical investigation of the H&S climate construct in the South African construction industry. The study was guided by H&S climate theory and hypotheses about the proposed relationships amongst the study phenomena (Kerlinger & Lee, 2000). According to Kerlinger and Lee (2000, p. 218), "evidence at satisfactory levels of probability is sufficient for scientific progress". The approach and orientation of this thesis are aligned to present evidence that support principles informing the field of organisational psychology. The study is consistent with the objectives of OP and reinforces the early approaches to this field of psychology, which sought proactive efforts to workplace H&S as indicated below:

> No mass disorder afflicting mankind is ever brought under control or eliminated by attempts at treating the afflicted individual (Albee, 1983).
>
> Any incidence in the reduction in the incidence (of disease) must rely heavily on proactive efforts with large groups; such actions rely upon primary intervention (Albee, 1983).

The field of organisational psychology and the related discipline of occupational health psychology are geared towards this problem-solving approach that targets workplace health and wellness issues at the primary level. This approach aims to reduce and eliminate injuries and fatal incidents, thereby decreasing absenteeism and increasing organisations' performance and productivity, and reducing associated economic and social costs.

The main objective of this study was aligned with commonly acknowledged objectives of workplace wellness concerns in the field of organisational psychology, namely to address workplace problems at the source through work design, management and organisation of the work (Houdmont & Leka, 2010). This objective was aligned to the development and validation of an explanatory H&S climate model for the construction industry in South Africa. The study set out to develop a conceptual theoretical H&S climate model, which would link leadership variables of top management's commitment to H&S, supervisory H&S leadership, H&S management systems, H&S training, H&S motivation, H&S communication, workload H&S pressure, and outcome variables of H&S avoidance behaviour, H&S performance, incident reporting, and injuries.

To gain insight into the H&S climate construct, the researcher set out to determine and test a proposed H&S climate model developed for the South African construction industry. To this end, five research questions were proposed and discussed in Chapter Five. These research questions led to the development of hypotheses, which were subjected to empirical analysis. These hypotheses were developed in Chapter Four, after the researcher reviewed literature on the multiple constructs under investigation. The results of this assessment were presented in Chapter Six.

7.3 PERSONAL REFLECTIONS

My intention with this study was to develop an H&S climate model that would be suitable for the local construction industry. Having conducted a review of literature on safety climate, I envisaged building a distinct model with clearly established guidelines, drawing on previous models which had investigated antecedents and outcomes of H&S climate. My approach to this study is termed post-positivist (Creswell, 2003), since I held assumptions that outcomes of the H&S climate would be determined by antecedents. Using this line of thought had an influence on the study, as the problem of injuries was examined by modelling the antecedents of H&S climate, derived from the literature review, to determine their influence on the outcome variable of injuries.

This study objective – to test the antecedents and outcomes of H&S climate – and the researcher's assumptions have since shifted. This study used a predominantly quantitative research method, which is rooted in post-positivism (Creswell, 2003), with the use of qualitative methods contributing to the mixed-method approach discussed in Chapter Five. The choice of a quantitative self-reporting survey as the main data collection tool was informed by previous research on the H&S climate (Table 5.2), rendering the method appropriate for knowledge generation on the local H&S climate construct. To enable the researcher to explore the H&S climate topic and prepare the quantitative phase, the qualitative approach was used. A review of H&S climate literature, construction site observations, and structured interview data informed the selection of H&S climate variables for the quantitative phase.

During the course of the study, the researcher realised that the H&S climate phenomenon was a complex construct, and to develop one model that is transferable to other work contexts would not be an objective aspiration. This realisation was reinforced by the different work experiences and contexts evident at the sites where the researcher collected data for this study. Having come to the realisation that it would not be possible to develop a universal model for the construction industry, the researcher acknowledged that the H&S climate model developed and assessed in this study applied to the specific context and situations that were measured. The study offered a particular way of measuring H&S climate, which may vary in different construction contexts and situations. Having used both qualitative and quantitative approaches to investigate this phenomenon, the researcher realised that there was a need for both a pragmatic perspective (Creswell, 2003) and an understanding of the use of pluralist approaches in research.

7.4 IMPORTANT FINDINGS OF THIS STUDY

This study set out to test an explanatory model of the H&S climate for the local construction industry by adapting tools developed in industries and work contexts that are different from South Africa. The first important finding was that the measures used were reliable, valid and consistent with previous studies that used the scales in different work and social environments, as discussed in Chapters Two and Four. The second important finding of this study was the predictive ability evident between individual H&S motivation and H&S performance. The better the H&S motivation of the individual worker, the better the H&S performance in the organisation, which will in turn result in reduced injury rates. This finding argues for H&S interventions targeted at the individual worker to develop individual factors that would lead to high H&S motivation attributes that would result in better H&S performance. This finding contradicts previous findings, which suggested that targeting the level above the employee whose safety behaviour the organisation is trying to influence (Luria & Zohar, 2003) was the most effective approach to developing H&S behaviour of employees. The third important finding was the relationship between H&S performance and injuries. Although a weak predictive ability of injuries was established, this finding presents an opportunity for further research to investigate this relationship, in order to enhance the ability of interventions to target specific organisational and individual factors that could reduce the high rate of injuries and fatalities in the construction industry.

Theoretical implications of these findings are important for establishing a basis for future research of H&S climate dimensions in the local construction environment. This is relevant for construction organisations to enable the improvement of the H&S climate in the industry sector. The original dimensions of H&S climate used in this study were valid, with H&S motivation emerging as the strongest predictor of H&S performance. This study had one major difference from studies that examined supervisory leadership and H&S climate, in that it used a four-item scale derived from Zohar's (2002) supervisory leadership scale. The scale used in this study reported the largest unique contribution to incident reporting.

The contribution of findings from this study to the field of H&S climate in the South African work environment is enhanced by providing an empirically derived framework within which organisations seeking to improve H&S performance and reduce workplace injuries can operate. The current legal requirements for the construction industry in South Africa require that construction companies are mandated to ensure safety procedures and practices implemented by trained personnel, although no national standard exists for a uniform construction sector induction safety manual. This has created an environment where the mobile subcontractor-oriented workforce receives different H&S messages at each project. This study provides an opportunity for the future development of a universal evidence-based structure for managing H&S in this sector. The study findings are discussed further in the following sections.

7.4.1 Nature of H&S climate

This section of the discussion chapter provides a summary of the validity and reliability of the findings of the H&S climate model investigated in this study. Having assessed and established the validity and reliability of the H&S climate measurement tool used in this study, this section presents a brief discussion of the implications for research arising from this finding.

7.4.1.1 Dimensions of H&S climate

Recent H&S climate discourse was used as a foundation for the proposed model dimensions for the construction industry in the South African context. The definition of H&S climate used in this study regards the construct as a composite of dimensions manifested at the organisational, structural, situational and individual levels in organisations. Taking into consideration previous studies that investigated the H&S

climate construct, a conceptual model proposed from this body of literature was tested in the South African context.

This study confirmed the organisational concepts of top management commitment, supervisory leadership H&S expectations, H&S communication, and H&S training as distinct constructs. This finding means that the findings are valid in the South African context with regard to the focus on the H&S climate model. The emergence of single factors for all variables of organisational factors established that the South African sample was able to distinguish between these constructs. The scales are therefore considered acceptable for use in the local environment, and can be tested in other industry sectors.

- ***Top management H&S commitment***

The finding that study participants in the local construction industry perceived the top management H&S commitment scale as originally conceptualised is interesting as no known studies have utilised this scale in the local environment to measure H&S perceptions. This finding confirms the universality of this scale and its applicability in the local context, showing that perceptions of top management's commitment to H&S are universal, and that the construct manifests itself in the same manner across the different industry sectors where this scale has been administered. The different social, economic and historical work groupings have resulted in the South African workplace being predominantly divided, in terms of work processes, along racial lines. In the construction industry this is evident in the unskilled workforce at the bottom of the ladder.

– ***Supervisory H&S leadership expectations***

The four items measuring supervisory H&S leadership expectations, though not consistent with the original scale configuration, found a high internal consistency coefficient, as reported in Chapter Six. This result is important in determining employee perceptions of supervisory H&S leadership roles. As previous studies have reported (Zohar & Luria, 2003), the role of the supervisor is important in establishing a positive H&S climate. This finding indicates that supervisory expectations have a much more relevant bearing on employees' H&S behaviour and H&S performance than the role of top management. This finding can be attributed to the proximity of the supervisor on construction sites and his or her monitoring oversight over work processes. This is important to note in order to emphasise H&S interventions that recognise the important role of supervisory H&S expectations on employees' H&S behaviour and H&S performance, with the objective of reducing injuries and fatalities on construction sites. For the current study, the absence of significant findings and predictive ability of supervisory leadership on H&S could not be attributed to the South African sample. The failure to replicate Zohar's' (1980) leadership scale is not unique to the current study; similar findings were reported in North American samples (Brown & Holmes's, 1986; Dedobbeleer & Beland, 1991). The absence of a significant finding in this study can also be attributed to the fact that only four of the eight items emerged in the EFA, which resulted in the full scale items (eight) not being used in the survey. This finding presents an opportunity for further research on the applicability of the H&S leadership scale in the South African work environment, where different cultural and social-political factors may influence the perception of leadership.

-H&S communication

During the data collection for this study, the Ostrom et al. (1993) EG&G Idaho 10-item H&S communication scale emerged, with seven dimensions measuring H&S communication, which produced one factor. The scale replicated the configuration of the items in the original Ostrom et al (1993) study. The factor which emerged was considered a clean factor. This result can be taken to mean that the H&S communication construct can be established as a universal construct that was validated in the South African context, and that is consistent with global manifestations of the construct.

– ***H&S management systems***

The H&S management system variable reported one factor which combined two scales. The emergence of one factor indicated that the respondents that made up the present sample were not able to establish a difference between H&S process and toolbox talk dimensions, which led to the emergence of a single factor. The emergence of a single factor in this case established that the sample was not able to distinguish between organisation procedures that deal with structural aspects of H&S, and practical H&S processes that are manifested at each site. This finding is interesting, as it serves to inform organisations that workers on site consider structural H&S procedures and actual H&S practice as one and the same, and therefore organisations cannot presume that workers will be able to understand the required H&S behaviour associated with different levels of H&S management systems.

– ***H&S training***

The four items that measured the H&S training scale emerged as a single factor, retaining its original structure (Griffin & Neal, 2000). This finding led to an assumption that the H&S training construct can be considered universal when measured with this particular tool, as it is understood in similar ways in different industries with different social, economic and cultural backgrounds. The implication for the construction industry is that effective H&S training specifically designed for the industry sector will enable organisations to gauge employee perceptions about the H&S training levels in the organisation. The findings from this measure will be used to intervene using programmes that will enhance the H&S performance of the organisation.

The individual dimensions of H&S incident reporting – individual H&S responsibility and H&S motivation – were subjected to an EFA process. While H&S incident reporting retained its original structure, the H&S motivation scale did not.

– ***H&S motivation***

The H&S motivation four-item scale (Griffin & Neil, 2000) combined with the individual H&S responsibility scale (Griffin & Neal, 2000). The validation of this factor becomes important in measuring employees' H&S motivation, as previous studies have established the importance of individual employees' motivation (Flin et al., 2000; Geller, 2001; Glendon et al., 2006) in influencing employees' H&S behaviour, and contributing to H&S performance and the reduction of injuries.

– ***H&S incident reporting***

All six items of the covering-up errors scale (Rybowiak et al., 1999) were adapted and used as the H&S incident reporting scale. The original configuration of the scale was maintained, with high loadings on all six items indicating that the scale was a reliable and stable measure of H&S incident reporting behaviour in the local environment. This finding validates the scale for use to assess this construct, and it can be assumed that the suggested configuration of this measurement tool can be considered consistent across samples from different cultures and work environments.

– ***H&S performance Active***

The variable that measured H&S performance Active emerged with one factor, which was considered a reflection of the underlying processes that inform a positive H&S climate in the South African construction industry. For this study, the measure was important in establishing the contribution of individual H&S performance, as it reports actual behaviour rather than intention. According to Lin and Mills (2001), employees' commitment to H&S in the workplace is a major contributing factor to the establishment of a positive H&S performance in an organisation. Choudhry et al. (2007) found that the creation of a positive H&S climate or H&S culture was dependent on implementing systems that influence employees' H&S attitudes and behaviour, which in turn inform H&S performance. Choudhry et al. (2008) indicated that a combination of management attitudes, formal processes, and individual attitudes reinforce each other and influence the H&S behaviour of workers, resulting in an overall positive H&S climate in an organisation.

– ***H&S workload pressure***

The situational dimensions of H&S workload pressure (seven items) and work environment danger (3 items) retained the original structures and emerged as two distinguished constructs. This finding is important for establishing dimensions that determine specific factors relating to H&S workload pressure that influence employees' H&S behaviour. Using the perceived work pressure scale as validated in this study would provide organisations with vital information to derive primary interventions that address workload processes to ensure that employees' H&S performance is enhanced. Previous studies (Dickety et al., 2002, Flin et al., 2000; Hoffmann & Morgeson, 1999; Zohar, 2003b) reported a negative influence of work pressure on employees' H&S behaviour.

– ***H&S avoidance behaviour***

The H&S avoidance behaviour scale, which was an adapted version of the H&S compliance scale from Griffin and Neal (2000), returned only five of the original ten items. After studying the items that loaded on this factor, and considering the original factorial structure, further analysis was conducted on the five items. One factor emerged from the five items, which measured worker H&S behaviour. This factor was given a new name, and was labelled *H&S behaviour Active* in recognition of the items that measured helping H&S behaviour that goes beyond the expected employee H&S behaviour.

The findings of this study, which established that original factors were evident in the South African construction industry, are considered as confirmation that the underlying variables were assessed effectively. Although there were diversions for some scales in the number of items being excluded due to low loadings, these differences can be attributed to the sample differences, and also to the variation that may arise due to different industry sectors being measured.

Language is one distinguishing feature between the South African sample and the samples used in previous studies where the original scales were used. There are 11 official languages in the South African workplace. For most participants in this study, English was not the first language, although it is the dominant communication medium in most workplaces. This sample comprised predominantly blue-collar workers in the Western Cape. Language in the South African workplace is also location-specific. In the Western Cape Afrikaans is the commonly used language, which brings into question the sample's ability to understand the questionnaire and to answer the items in terms of specific words used in the questionnaire, even after simplification of the items. This study did not include a home language measure and could not determine how this could have affected the respondents' responses.

When determining the amount of explained variance for each of the measurement factor models, it was found that EFA explained between 28.5 and 67.2% of the variance in the data. The homogeneity of all the subscales was determined. Having validated the H&S climate measurement tool developed for the South African construction industry, it was suggested that the validated measurement instrument for eliciting employee perceptions on the identified variables should be accepted to be congruent with other H&S climate scales validated in previous studies.

7.5 CONCLUSIONS ON MEASUREMENT TOOL INTERNAL RELIABILITY AND VALIDITY

The construct validity of the H&S climate measurement model scales for specific industry sectors was found to be important in enabling organisations to design interventions that would target context-specific H&S problems (Zohar, 2010). The validity of H&S climate scales is important to show that the construct can be used for further investigation of the phenomenon, and to enhance future studies that could inform H&S interventions in different industry sectors.

The Cronbach's alpha coefficients for all scales, derived from the EFA reported above, recommended acceptable levels of internal reliability (Cohen, 1988). In this study, most of the EFA-derived scales reported substantially higher Cronbach's alpha coefficients than the original scales. This finding is important for informing the use of validated scales for future research. The pursuit of empirical knowledge in the local and global academic environment, using a validated measure of H&S climate, represents a contribution to H&S knowledge. The current study generated a scale that is reliable and that reflects the underlying variables of the derived factors. For consistency and stability in other industry sectors besides the construction industry in South Africa, future studies are recommended.

After establishing the internal reliability of the measurement tools, and ascertaining that these scales were suited for the South African construction industry, the study employed strategies to understand the construct of H&S climate in the South African construction industry. The objective of the various strategies followed when analysing and obtaining the findings was to gain insight into how the constructs are related to the outcome variables, and to serve the objective of the current study, which was to investigate the plausibility of the proposed conceptual model and the implied relationships that were elicited from the review of literature. The proposed model was examined in order to determine how the constructs influence H&S behaviour amongst workers in the local construction industry. The model in the current study converged on all the data obtained from the sample (n = 851). The obtained path coefficients indicate significant relationships between the latent variables when the complete model is taken into account.

The objectives of the current study were to gain insight into the H&S construct, and to explain which variables may create an environment conducive to the establishment of a positive H&S climate to reduce injuries and H&S incidents on construction sites. The next section provides a discussion to help explain relationships between variables that measured organisational level variables and individual variables. These relationships are expected to provide information relevant for organisations wanting to offer ways in which H&S performance active and employees' H&S avoidance behaviour can be influenced. The guidelines provided by Cohen (1988), as discussed in Chapter Six, were used to assess the relationships between the independent and dependent variables.

7.6 H&S CLIMATE VARIABLES

The organisational variables of H&S climate (management's commitment to H&S, H&S management systems, H&S training, and H&S communication) showed moderate positive relationships with H&S motivation.

7.6.1 Top management commitment and H&S motivation

The current study hypothesised that a positive relationship would exist between top management H&S commitment and worker H&S motivation. Support for this proposition was established in this study. A bivariate relationship was established with Pearson's product moment correlation, and predictive ability was determined using regression and path analysis (Chapter five refers). These results confirm findings from previous studies that examined the effect of management's commitment on individual motivation to work in a safe manner (Cooper, 2000; Gadd & Collin, 2002; Zohar, 2002, 2003b). The relationship between management commitment and worker performance has been well established in previous empirical studies (Bass, 1990; Cheyne et al., 1998; Dedobbeleer & Beland, 1998; Flin et al., 2000; Gadd & Collin, 2002; Mulenga et al., 2011; Thompson et al., 1998; Simard & Marchand, 1994; Zohar, 2000, 2002; Zohar & Luria, 2003).

From the findings of the current study, and previous findings on the role of top management's commitment to H&S in an organisation, it can be argued that the relationship between top management's H&S commitment and H&S communication in an organisation is determined by the investment that the top decision-makers in an organisation make in H&S initiatives. For the construction industry, the investment of resources poses a particular challenge due to the structural organisation of the industry, which is a composition of various professions and organisations working on a single project. The investment of top management in H&S is evident in the type of relationships that exist between top management and the workers. This poses a further challenge for the construction industry, due to the fragmentation of role players, such as building project contractors in various professional categories and with various levels of technical expertise. According to Bass (1990), relationships that are closer and of higher quality increase top management's commitment to employee welfare. This form of commitment poses a special challenge for the construction industry, due to the difficulty of determining who is responsible for the wellbeing of employees on a construction project, because of the multiplicity of contractors and professions, each of which experiences different risks and hazards.

Though dealing with a fragmented and segmented workforce, top management's commitment to H&S can be implemented through the setting of policies and procedures that are required of all project participants on building sites. Top management's responsibility to ensure employees' compliance with H&S procedures, and to promote a positive H&S climate on their projects, has been identified as a key intervention area, because top management is comprised of the organisations' decision-makers who are able to ensure enforcement of H&S decisions on policies at all operational levels (Zohar, 2002; 2003b). Other studies (Gillen et al., 2004; Mearns et al., 2001) provided support for the role of top management in ensuring that resources are allocated for various initiatives that promote H&S communication in the workplace. These arguments contribute to the suggestion that top management is important in increasing a positive H&S climate in a work environment. According to Zohar (2010), workplace injuries and incidents are an outcome of unsafe conditions. This suggests that, if top management can commit to a safe work environment by supporting interventions and initiatives that reduce incidents, a positive H&S climate can be developed, which can lead to reduced injuries and incidents.

The results from the present study confirm that top management's commitment to H&S may be important in increasing workers H&S motivation. This focus of top management's commitment to worker H&S motivation over other variables in an organisation may be one explanation for the manifestation of a positive H&S climate, but cannot be the only factor that contributes to H&S performance in an organisation. This is in consideration of the different stakeholders that are involved in a building project, rendering the role of one particular organisation peripheral to H&S practices of contractors on site.

7.6.1.1 H&S management systems and H&S motivation

The hypothesis proposed that a significant positive relationship between H&S management systems and employee H&S motivation could be expected. This hypothesis was supported by findings in this study. When bivariate relationships, regression and path analysis were considered (Chapter Five), the relationship between H&S management systems and H&S motivation was a significant substantial finding that established the importance of policies and processes that are implemented in organisations and which affect workers' H&S motivation. When the proposed model was subjected to path analysis with H&S management systems as the latent variable, significant path relationships were established in the structural model. The significant positive relationship between H&S management systems and H&S motivation was confirmed, using different data analysis techniques validating the importance of this dimension in promoting H&S motivation.

This finding is not unique to the current study, as it confirms previous empirical studies that have found positive significant relationships between H&S management processes and H&S performance in an organisation (Cooper, 2000; Evans et al., 2007; Flin et al., 2000; Guldenmund, 2000; Landy & Conte, 2004; Rowlinson, 2004; Zohar, 2002). The importance of H&S management systems in establishing a positive H&S climate is evident in the roles that policies, procedures and the practice of H&S play in an organisation, when these are embedded in the systems that an organisation establishes to manage H&S performance of its workers.

H&S management systems are important organisational structures that manage the manner in which organisations implement H&S policy and procedures which are important in influencing workers' H&S practice. The construction industry faces specific challenges in ensuring that policies and procedures implemented by the main contractor are carried out on a construction site, which is usually host to a number of divergent subcontractors from organisations that have differing H&S compliance levels. Beyond the main contractor or the client implementing a written agreement with an H&S officer who is often a consulting practitioner, H&S management systems pose a challenge because of the different ways that risk and danger are perceived, both by management and by the workers on site. With this in mind, it is important that organisations that are either clients or main contractors ensure that the different policies and procedures that inform H&S in the construction industry are presented and shared by all participants in a building project to improve H&S compliance and reduce H&S incidents and injuries.

The effectiveness of H&S management systems can be enhanced by ensuring that processes such as the appointment of H&S committees and H&S officers are supported by top management. This support can be in terms of resources to ensure that the roles are represented at organisations' decision-making forums. The status of the H&S committee or the H&S representative in an organisation has been reported to indicate the importance that top management attach to H&S in that organisation, and offers an effective H&S management system. For this study, H&S management systems are considered critical to the effectiveness of H&S climate on construction sites. For the different role players on site, the ability to have effective H&S processes and procedures will be beneficial in ensuring a common understanding of H&S behaviour requirements, and in establishing standard H&S expectations.

The implementation of H&S management systems enables an organisation to move from the common practice of implementing H&S processes as a prescriptive legal compliance issue to one of self-regulation (Rowlinson, 2004). The ability of these activities to influence the attitudes of both leadership and workers towards H&S is especially important for organisations in implementing H&S strategy, systems, structures and processes. Previous studies have reported that having formalised H&S management systems is not in itself a guarantee or a reflection of a positive H&S climate (Guldenmund, 2000; Zohar, 2002). Mulenga et al. (2011) found that top management commitment was important for the success of H&S interventions, that it required the important role of supervisors for interventions to be implemented, and that the role of operational leadership became critical in instances where top management commitment was weak.

7.6.1.2 H&S training and H&S motivation

The current study proposed that a significant positive relationship will emerge between H&S training and H&S motivation. This notion was supported by the results of the study. The findings for this dimension in predicting workers' H&S motivation were consistently high over bivariate, regression and path analysis, as reported in Chapter Six.

Further path analyses found a strong positive predictive ability of H&S training on H&S motivation. The results from the current study confirmed previous empirical evidence supporting the positive relationship between H&S training and H&S performance (Adie et al., 2005; Dryer, 2000; Gillen et al., 2004; Glendon et al., 2006; Griffin & Neal, 2000; Vredenburgh, 2002). The importance of H&S training in the H&S performance relationship is explained briefly. Training employees, and equipping them with the necessary skills to be able to identify risks and hazards in their work environment and to address identified risks and hazards, represent the most significant strategic investment that an organisation can make. To establish and maintain a positive H&S climate, top management's commitment to H&S should include the provision of resources for H&S training, which is specific to the risks and hazards that the organisation experiences and the workers face in the work environment (Glendon et al., 2006).

For the construction industry, equipping workers on a building site with context-specific risk and hazard identification skills will enhance the H&S behaviour of employees and improve the site's H&S performance. This approach would reduce the challenge that construction organisations face in implementing H&S programmes due to the diversity of contractors and subcontractors on building sites.

H&S training requires an investment of time and resources for organisations. This investment poses a challenge for the construction industry, due to the structure and mobility of work teams on building sites. The absence of consistent risks and hazards that workers in this environment face creates a situation where H&S have to be evaluated on a continuous basis at each project. The fragmented organisation of contractors further enhances challenges for H&S training in this industry sector. The role of H&S management systems, such as toolbox talks, becomes important, since these may incorporate the different contractors on site and they address risks and hazards that workers face on a daily basis. This approach would ensure that workers on site are given skills to address context-specific risks and hazards, which would enhance the H&S climate on the specific site and for the broader organisation. This would lead to workers developing positive feelings towards the organisation, and could lead to H&S citizenship behaviours.

The finding that H&S training improves H&S motivation is important to note in terms of the organisation, as it provides an opportunity for interventions to be targeted at increasing workers' awareness of H&S risks and hazards in the work environment. Previous studies have found that organisations that invest in H&S training benefit by having workers who observe the H&S requirements, and by reducing the occurrence of injuries and associated costs (Dryer, 2000; Gillen et al., 2004; Glendon et al., 2006). This has been confirmed by the findings from the current study. The finding that H&S training and H&S motivation reduce the occurrence of injuries is important for the construction industry, because workers who observe H&S motivation behaviours would be the flag bearers for the organisation in sharing their H&S knowledge and experiences with subcontractors who come on site for brief specific project aspects.

7.6.1.3 H&S communication and H&S motivation

The current study proposed that there would be a relationship between H&S communication and H&S motivation. This proposition was supported by the different data analysis techniques used. When considering the bivariate relationship, the correlation coefficient showed that there was a medium positive relationship between H&S communication and H&S motivation. Both multiple regression and path analysis showed a moderate predictive value of H&S communication for H&S motivation. This finding is not unique to this study, and has support from previous empirical studies (Mearns et al., 2001; Reason, 1997; Wong, Sze, Lo, Hung, & Loo, 2005; Zohar, 2003b). The role of communicating H&S procedures, processes and training was highlighted in Chapters Two and Four.

Open H&S communication has been highlighted as a mechanism through which workers understand the H&S requirements that are important for the organisation. Together with commitment from top management, H&S procedures, processes and expected practices need to be communicated to workers to ensure that the organisation's H&S strategy is implemented and maintained. This requires the involvement of different strategies to communicate these H&S requirements. For construction safety, the use of notice boards, toolbox talks, and H&S training forums are important mechanisms to ensure that workers understand the H&S requirements and comply with these. These arguments contribute to the perception that H&S communication is a necessary precondition for workers, firstly to understand the organisation's H&S requirements, and secondly to be able to comply with the H&S requirements, once understanding has been achieved. H&S communication will therefore involve other dimensions of H&S climate, such as management's commitment to ensure that resources and structures for communication are provided, H&S training to generate knowledge and skills required to perform work safely, and H&S management systems as the framework within which different communication systems will be implemented (for e.g. written, oral or visual).

7.6.1.4 Inter-rater agreement (IRA)

Inter-rater agreement was used to determine whether workers at a construction site shared similar perceptions of H&S climate as a construct with multiple dimensions as conceptualised in the current study. The findings from the current study indicated that there were similar perceptions of H&S climate in 50% of the surveyed sites supporting the concept of group level H&S climate at these sites. This is consistent with previous findings (Lingard et al., 2010; Zohar & Luria, 2005). This finding is interesting in that the sample from the site was the level of analysis and not the sub-contractor level (Lingard et al., 2010) or work responsibility level (Zohar & Luria, 2005). The combination of multiple contractors and different levels of responsibility that resulted in a common perception of H&S climate offers an interesting point of research interest for the future. This finding requires further studies with data collected at subcontractor or work responsibility level to establish if the consistency of group level agreement can be maintained at these levels in the South African work environment. The other five sites with IRAs of below .70 offer an interesting opportunity for further studies, in view of the finding that three of the five sites belonged to the same organisation. Future studies could consider investigating H&S climate at the group level targeting the organisations with low IRA scores.

7.6.2 Predicting H&S incident reporting

The following section provides findings for H&S climate model variables that were proposed to predict H&S incident reporting.

7.6.2.1 Supervisory H&S leadership expectation and incident reporting

The current study proposed that a positive relationship existed between supervisory H&S leadership and incident reporting. From the correlation coefficient results that took the bivariate relationships into account, and the regression and path analysis findings, a substantial significant positive relationship emerged. This finding confirmed previous findings that the relationship between supervisors at the operational level influence the H&S behaviour of workers (Zohar, 2000, 2002). Supervisor H&S expectations are manifested through activities such as observing workers' adherence to H&S requirements. These actions have been found to offer clarification of expected H&S behaviours. According to Hopkins (2005), such expectations are supported by organisational structures.

The current finding is consistent with previous empirical research, which reported the influential role of the supervisor in instilling a sense of responsibility and co-operation in workers through effective interpersonal relationships (Cooper, 2000; Guldenmund, 2000; Hopkins, 2005; Zohar, 2002; Zohar & Luria, 2003). Zohar (2002) identified two important attributes of effective H&S leadership, namely performance-based monitoring, and timely communication of consequences of unsafe behaviour.

These two attributes are particularly useful for incident reporting as they would be used to offer the operational-level supervisor a framework for use to assess incidents that occur at work on a daily basis, through monitoring workers' H&S behaviour and ensuring that compliance is observed in line with established H&S requirements. Timely communication is important for incident reporting, and addresses the issue of apportioning blame for accidents or incidents in organisations. Where supervisors foster a trusting and open environment and are involved in H&S activities, workers consider the actions and expectations from such a supervisor, and behave accordingly. The level of support that a supervisor will receive from top management when H&S decisions are made at operational level, becomes important in the effectiveness of the supervisor's role. Reported poor H&S behaviour and breach of H&S requirements are associated with ineffective supervision (Zohar, 2003a).

Open and supportive relationships have been found to influence employees' H&S behaviour, which can be interpreted to include H&S incident reporting (Hoffman & Morgeson, 1999; Zohar, 2002). Being directly responsible for interpreting and implementing H&S policies and procedures for the organisation places supervisors in a position of influence in terms of the amount of discretion they use when deciding whether H&S behaviour is acceptable or not at the operational level. This form of influence creates a situation for supervisors to interpret the policy or procedure in line with the organisation's structures and rigidity. In an environment where the supervisor cannot react intuitively to any environmental risks or hazards for fear of transgressing the set boundaries, a lack of flexibility to react to hazards is created. This is not conducive to a positive H&S climate in an environment where natural elements that cannot be controlled are a regular occurrence.

The influence of supervisor actions on employees' H&S behaviour has been reported (Mearns et al., 2001; Zohar & Luria, 2003). Studies in the construction industry found that greater influence is wielded by managers on construction sites (Collinson, 1999), due to the proximity of line management in this sector.

The level of supervisory expertise has a determining influence on the supervisor's ability to discriminate between procedures that need strict adherence and ones where discretion can be exercised. This is important for supervisors in work environments such as the construction industry, where there are factors beyond the control of the organisation that can influence H&S performance on site. The expectations of workers' H&S behaviour and reporting of incidents can be subject to the discretion of each supervisor. Weather conditions or machine failures need immediate reaction from the supervisor on site. Sticking to rigid structural processes, such as reporting lines, will in certain cases not be a prudent H&S decision, due to the unpredictability of risks and hazards in this industry sector.

The role of supervisory leadership H&S expectations in ensuring incident reporting has been confirmed in this study. It could be argued that the role is only effective where the leader is actively involved in monitoring and communicating H&S requirements to the workers and to top management. The need for dual communication is to ensure that support from top management in the form of resources is obtained, that support from workers in the form of adherence is assured, and that the occurrence of safety incidents is reported timely for both strategic planning and development of interventions to avoid future incidents.

7.6.2.2 H&S training and incident reporting

The current study proposed that there would be a significant positive relationship between H&S training and incident reporting. A weak but positive relationship was found between H&S training and incident reporting from the correlation coefficient analysis, whereas the regression analysis found a negative but statistically significant correlation with a negative weak predictive ability (Chapter Four). Findings from standard multiple and hierarchical regression and path analyses (Chapter Four) reported a moderate negative relationship, while path analysis found a significant positive predictive ability of H&S training on incident reporting.

Previous studies found incident reporting as an antecedent of H&S climate (Cullen, 2001; Masden, 2001a; Reason, 1997), and further found that incident reporting led to the prevention of accidents, creating a positive H&S climate. In the current study, incident reporting was examined as a dependent variable of organisational antecedents to H&S climate, and did not achieve the anticipated results. For future studies, the researcher would recommend that this variable be investigated as a predictor variable, rather than an outcome variable, because incident reporting has been investigated previously (Clarke, 2000; Cullen, 2001; Masden, 2001a; Reason, 1997; Zohar, 2002) and found to be indicative of the presence of a positive H&S climate. In future, incident reporting can be investigated together with documentary data available for accidents and incidents that occur on a building project.

7.6.2.3 H&S management systems and incident reporting

It was proposed in this study that there would be a significant positive relationship between H&S management systems and incident reporting. H&S management systems were defined as processes that inform the implementation of H&S policy and practice in an organisation. These included H&S training, toolbox talks, H&S communication, and H&S structures such as H&S committees and officers. Support was found for this proposition, as a significant positive bivariate correlation coefficient relationship was established between H&S management systems and incident reporting. This finding, though considered small according to Cohen (1988), was accepted in this study, since H&S management systems combine organisational processes that were investigated separately and reported findings that supported the integrated conceptual model.

In previous studies, incident reporting has been found to be an aspect of a no-blame culture (Cullen, 200). A no-blame culture originates in a workplace where organisational policies and procedure are designed to promote and support a positive H&S climate. H&S management systems are the mechanisms and framework within which a positive H&S climate is developed and nurtured. For H&S management systems to be effective and to lead to a safer work environment, the role of the supervisor is once again brought into discussion, because the supervisor becomes responsible for implementing the policies and procedures, and for ensuring that the H&S management systems are interpreted from paper policies to practical application on the construction site. This role was emphasised in previous studies (Zohar, 2002; Zohar & Luria, 2003). Zohar (2002) also reported on the importance of intervening at a level higher than the one where H&S behaviour is anticipated to take effect.

The construction site poses a perfect work environment where this recommendation can be examined. This is because the fragmented nature of workforce configuration on a construction site as reported in previous studies

(Lingard et al., 2010) places the supervisor in a prime position to be able to monitor both main and subcontractor H&S behaviour, which could include incident reporting. Future research is recommended to investigate how the different H&S management systems applicable on a construction site can be used to promote H&S amongst a mobile and fragmented workforce.

7.6.2.4 H&S communication and incident reporting

Based on the literature review and the observation and structured interview data, this study proposed that there would be a significant relationship between H&S communication and incident reporting. The findings obtained in this study supported this proposition. Considering the above bivariate relationship, the correlation coefficient reported a positive and large significant relationship. This finding was further supported by multiple regression analysis findings, which showed that H&S communication was a practical significant predictor of incident reporting. When the proposed conceptual model was subjected to path analysis, the relationship was found to be weak in the structural model. The significant positive relationship between H&S communication and incident reporting was confirmed using multiple techniques in this study.

This finding confirmed previous empirical evidence of a positive relationship between H&S communication and incident reporting, as discussed in several studies (Clarke, 2000; Cox & Cheyne, 2000; Cullen, 2001; Masden, 2001a; Mearns et al., 2001; Reason, 1997; Wong et al., 2005; Zohar, 2003b). The importance of incident reporting in the prevention of injuries is important and is well established in the referenced studies.

The gap between what individuals know and what they actually do to prevent injuries and promote H&S becomes critical. The issue of incident reporting assumes a no-blame culture, where workers will not be afraid to report incidents for fear of reprisals (Alexander et al., 1995). When workers experience negative feelings towards their leadership, there is bound to be low incident reporting, resulting in poor H&S communication (Mearns et al., 2001). For the construction industry, establishing a trusting and comfortable relationship, where workers develop positive feelings toward leadership, is a challenge in view of the constantly evolving teams that operate on different work projects. For such a relationship to grow, there needs to be consistency in the team configurations, which is most often not practical for construction teams. This poses extra challenges for top management's H&S initiatives that aim to improve H&S safety in the organisation.

The findings in this study support the previous evidence, which indicated that incident reporting will be high in cases where H&S communication is good. Incident reporting has been found to reduce injuries, especially in cases where all H&S incidents and ‘near misses’ are reported (Reason, 1997). When H&S incidents are consistently reported, the organisation benefits from the ability to collect data on incidents and events, and to develop a database of occurrences and ‘near misses’, which can be used to track trends and patterns of events. This database can be used to inform H&S information-sharing sessions for the organisation's future projects.

The presence of H&S incident data in an organisation would be beneficial for top management decisions on H&S resource allocation policy, as this data would provide evidence of lost time and associated costs, which could be reduced should the root causes of the incidents be identified and addressed proactively through policy and procedure implementation. To cultivate a positive H&S climate, top management needs to consider the prevailing H&S policy and the ways in which this is promoted and implemented in the organisation (Sawacha, Naoum, & Fong, 1999). Where instances of a blame culture are identified, mechanisms should be put in place to develop positive trusting relationships between leaders and workers, to negate the workers' negative perceptions of leaders.

The following section discusses incident reporting as an outcome of antecedents of H&S performance, and therefore does not investigate the relationship between incident reporting as a predictor of H&S avoidance behaviour.

7.6.3 Predicting H&S performance

It was proposed that a significant positive relationship exists between H&S motivation and H&S performance. Evidence obtained from the data in this study supported this notion. When the bivariate relationship in this study is considered, the correlation coefficient was barely below the large significance category of above 0.50 (Cohen, 1988). When the entire conceptual model was subjected to path analysis, the H&S motivation path was found to be significant. The significant positive relationships between H&S motivation and H&S performance were evidence that individual responsibility for H&S plays an important role in promoting H&S performance and in establishing a positive H&S climate in an organisation. This finding is consistent with previous studies that have established a link between H&S motivation and H&S behaviour (Geller, 2001; Glendon et al., 2006; Vecchio-Sadus & Griffiths, 2004*).*

Previous studies (Flin et al., 2000; Glendon et al., 2006) have reported the important effect of individual H&S motivation on the level of team H&S performance at a construction site. Where an employee is consciously aware of the risks and hazards on site, motivation to perform duties becomes pivotal to the collective H&S

performance. Previous studies (Flin et al., 2000; Glendon et al., 2006) have reported the effect of employees' beliefs about and attitudes towards H&S, and have indicated that motivation to behave in a certain manner was important for determining employees' H&S behaviour. This finding is important for organisations in the construction industry to be able to intervene at individual level by promoting initiatives that will enhance H&S motivation amongst workers. When workers take individual responsibility for their H&S, the issue of supervisory H&S leadership micromanaging individual H&S behaviour becomes simplified, as workers will be motivated to practice H&S based on self-motivation, rather than on the fear of punitive action from the supervisor.

Geller (2002) found that workers are aware of the risks and hazards in their work environment, and that they know how to perform their work safely, but lack the competency to be responsible in terms of H&S behaviour. Individual H&S motivation, and the ability of workers to take personal responsibility, can be a demonstration of the individual's knowledge of H&S through exhibited H&S behaviour. Zohar (2002) found that a high percentage of injuries occurred as a result of workers not wearing personal protective equipment (PPE). If workers are motivated and take individual responsibility for H&S, the possibility of reducing the number of injuries in the workplace can be enhanced with interventions that promote motivations and individual responsibility for H&S. Organisations can apply measures to identify interventions that promote H&S motivation and individual responsibility for H&S. They can also make strategic decisions that commit the organisation to the implementation of these H&S management systems through processes such as training.

There may be other variables that affect H&S motivation and H&S performance, which were not investigated in this study. It is important that future studies give consideration to factors such as H&S training, group cohesion, and leadership variables to determine what influence these have on individual motivation.

H&S motivation is an important aspect for the development of a positive H&S climate on which construction organisations can focus. The importance of this variable in relation to workers' H&S performance lies in the potential that motivated workers have in promoting H&S on building sites. A worker who is motivated and understands the organisation's requirements for H&S will also possess a level of awareness of the overall H&S objective of the organisation. This will enable such a worker to be able to access knowledge of H&S strategy by interacting with top management, and to share this information with workers at operational level.

7.6.4 Predicting Workplace Injuries

The insignificant finding that H&S avoidance behaviour did not report predictive ability for injuries in this study is not surprising, considering that the variable was not significant in both the correlation and regression analyses. Further analyses of other IVs (H&S motivation, H&S incident reporting, contractor type, and work environment danger) found significant predictive abilities for workplace injuries, which are reported below. The findings of this study indicated that increasing values of incident reporting would lead to reduced injuries, and that H&S motivation would lead to significantly reduced workplace injuries.

The conceptual model in the current study found a very weak 2.8% predictive ability in terms of injuries. Earlier analysis, using stepwise logistic regression, indicated that H&S performance had no predictive ability on injuries. However, the IVs of H&S motivation and incident reporting showed significant ability to predict injuries. Further analyses of the conceptual model indicated a weak predictive ability for H&S performance regarding injuries. The weak predictive ability of H&S performance for injuries is interesting, considering the reported significant predictive ability between individual H&S motivation and H&S performance. From the regression analysis, it would seem as if the individual variables (IV) are better predictors of injuries in the workplace. These variables require further investigation in future research. Further studies can also establish whether any significant relationship exists between these two variables that would moderate or mediate H&S performance and workplace injuries.

The finding that a higher level of environmental danger leads to a lower incidence of workplace injuries suggests that there is a conscious evaluation of workplace hazards and risks by workers, and that their behaviour is adjusted to suit the risk. Previous studies (Glendon & Litherland, 2001; Cooper & Phillips, 2004; Rundmo, 1995) have reported that job location has a significant positive association with job risk perception that influences employee safety behaviour based on evaluated risk. For high-risk work environments, stringent H&S regulations and work safety practices are often implemented to ensure reduced risks (Glendon & Litherland, 2001). Management commitment has been reported as an important predictor of H&S performance in high risk industries which could be attributed to perceptions that influence safe work behaviour by workers in these contexts (Cox & Cheyne, 2000; Mearns et al., 1998; Mearns, Whittaker & Flin, 2001). This finding indicates that equipping workers with the necessary skills to identify hazards and risks through H&S training and H&S management systems can be interventions that help reduce workplace injuries.

The finding of differences in injury reporting among the different work contract categories is consistent with studies that have investigated injuries amongst construction workers. According to James et al. (2012), casual workers are more likely to be injured on the construction site than permanent employees. This probability of injuries is attributed to the lack of H&S training amongst casual workers. To avoid the high economic and human cost of injuries, organisations would be advised to intervene by equipping workers on site with the necessary H&S knowledge, using toolbox talks as a mechanism for managing H&S relevant to specific hazards that are manifested at the current project stage. Knowledge of the current risks and hazards would enable workers to adjust behaviour accordingly to reduce injuries. This finding further reinforces the importance of H&S interventions that are targeted at the individual level to reduce the high incidence of injuries.

7.7 LIMITATIONS OF THE CURRENT STUDY

Although the findings obtained in the current study are presented with confidence, this is done against the perspective of the study's known limitations. Limitations in social science studies are a common aspect of doing research; this study was not exempted of such limitations, which are discussed in the next section.

A non-probability sample of organisations that hold affiliations with MBAWC was involved in the study. This might have resulted in selection bias, because organisations that are members of this association are expected to adhere to levels of H&S standards, as set out by the affiliating body, on their construction sites. The random selection of workers to participate in the study might have enhanced the generalizability of the study findings, although possible bias could have been present on account of participants who had already experienced injuries or incidents, which might have influenced their H&S behaviour, making them more aware of risks and hazards, and changing their behaviour based on previous experiences of injury.

The measure for injuries was a dichotomous scale, which required the study participant to respond with a yes or no.. This nature of this measure could have led to the weak predictive finding obtained in the current study. It is recommended that future studies use a nominal scale with multiple statements to measure injuries.

The third limitation was the use of a cross-sectional survey to collect data, which might have presented a threat to the validity of the study, as the survey excluded causal inferences to be made from the findings. Longitudinal study designs are considered to be suitable for assessing causality (Cook & Campbell, 1979); however, the nature of construction work and the mobility of work teams do not render this design suited to that population.

The fourth limitation refers to the use of the individual level of analysis in this study without considering the sub-contractor categories that are a feature of the construction industry sector. This is consistent with most previous studies of H&S climate(Zohar, 2010). This study attempted to address this limitation with grouping the sample according to construction sites. Future studies consider using a multi-level research design (Lingard et al., 2010), which would enable the researcher to examine the dynamics of H&S climate in a holistic manner across different levels of construction contractors. The absence of a significant predictive ability of supervisory H&S leadership expectations and H&S performance was surprising, and is not consistent with previous studies (e.g., Zohar & Luria, 2005). Although other studies failed to replicate the leadership scale with different samples in the North American work environment (Brown & Holmes's, 1986; Dedobbeleer & Beland, 1991). For this study this can be attributed to the individual being the unit of analysis and therefore workers not being able to report on varying levels of contractor grouping which can lead to inadequate separation of the different levels of management (Lingard, et al., 2010). This failure to replicate original findings was highlighted by Flin et al., (2000), who reported that previous studies on safety climate failed to replicate dimensions because of confounding levels of measurement. Future studies should make a distinction in the design of the study for differentiation of worker roles in terms of positions or contractor levels. This will enable the analysis to be conducted at different levels.

Another limitation was the deficiencies of measurement tools to investigate H&S climate in the local environment. In the case of H&S climate in organisations, measurement error could arise from moderating variables such as government-recognised inspections, audits by the MBAWC, and current incidents in the organisations surveyed. Although the current study established a starting point, there is still a need for the generation of more knowledge and understanding of the H&S climate by investigating other variables not included in this study, but which could have an effect on the construct, for example selection bias related to gender on building sites.

The current study did not assess any mediation or moderating. It is suggested that future studies on H&S climate in the South African environment include a consideration and n assessment of possible mediation and moderation effects.

Finally, the scales used for this study were developed mostly in work environments in Western countries, and they therefore need further development and validation in developing countries to evaluate the universal application of these variables in the context of developing countries.

7.8 RECOMMENDATIONS FOR FUTURE RESEARCH

It is hoped that this study will serve as a stimulus for studies that will investigate H&S climate relationships and develop measurement models applicable to H&S on construction sites and in a diverse range of industries, in the South African and broader African contexts, to contribute to the global discourse on the H&S climate construct.

Future studies should consider refining and generating the reported conceptual links and relationships from this study. The model, as described above and presented in Figure 6.1, should be investigated further in future studies, extending the injuries variable as a nominal scale to try to establish how organisations could reduce injuries and fatalities on industry sectors that have inherent risks and hazards. Further distinctions can be investigated between the constructs H&S performance and H&S behaviour to establish differences and to be able to define and distinguish each one as a separate independent variable.

Future studies in industry sectors such as construction will need to consider the effect of subcontracting on an organisation's H&S climate. In work environments where multiple work teams are from different organisations with varying H&S priorities, it is important to examine how the work teams adjust their behaviour when operating as subcontractors or main contractors. The study by Lingard et al. (2010) would form a useful source of guidance on how group level variables of safety climate subcontracting can be investigated. Future empirical studies could be conducted on other samples in South Africa and other countries on the African continent to be able to develop a knowledge base for the H&S climate construct, and also contribute to the global discourse of occupational health studies. This would enable inferences to be made about the occurrence of H&S incidents in the construction industry in this region. Further to this suggestion, future selection of sample organisations should take place randomly, using a member list such as one from the CIDB, which has a broad membership and which does not conduct H&S audits. This will enable the study to capture data from organisations that may not be adhering to legal H&S requirements due to the absence of affiliation audits.

7.9 CONTRIBUTION TO KNOWLEDGE

The value of the current study lies in its contribution in the form of the development and examination of a reliable and valid measurement scale for an H&S climate in the South African construction industry. The findings from this study reinforce the validity and reliability of commonly used H&S climate measures, which had been used in a diverse range of industries, by transporting these scales to the local construction environment and validating them. When subjected to EFA, the measurement tool returned similar factor structures as the original scales; however, comparatively, the current study recorded higher Cronbach's alphas for all scales than in the original studies from which the scales were drawn.

The use of multiple methods to collect data for the testing of this model enabled the researcher to study the phenomenon using different lenses: the use of content analysis for interview data, and bivariate relationships using standard and hierarchical multiple regressions. The use of multiple data analysis techniques allowed for differences in relationships between the variables to be exposed with the different methods used.

The finding of H&S motivation as a good predictor of H&S performance in this study was important, because, like in previous studies, this finding strengthens and emphasises the important role of the worker in contributing to H&S climate above and beyond existing organisational structures and processes. It is important for future research to examine further the high correlation between H&S training and incident reporting, because of previous studies that have indicated that incident reporting is an indication of a positive H&S climate. This finding will hopefully provide impetus for future studies to explore this link further, and to link it to H&S performance.

7.10 PRACTICAL IMPLICATIONS

The strongest practical implication arising from the current study is that of top management in organisations who initiate interventions targeting the improvement of workers' H&S motivation to enhance the H&S performance of the organisation and reduce injuries. This finding points to the development of strategies that will empower employees with skills and capacity to be motivated in terms of H&S behaviour. For the individual employee, this investment in his or her H&S behaviour capacity and skills will be an indication of the organisation's commitment to the wellbeing of workers, and this in turn will enhance workers' H&S behaviours and thus affect the organisation's H&S performance.

For organisations to reduce the costs that are associated with workplace injuries and fatalities, the individual employee is pivotal to the success of H&S initiatives and interventions through compliance. In a situation where the organisation is able to provide resources, and initiate procedures and processes to safeguard workers from injury, a lack of individual responsibility for H&S will render these initiatives void. Another practical implication of this study is that the leaders in organisations should realise that, beyond the provision of H&S resources and the establishment of H&S management systems and processes, the worker presents the biggest barrier to the successful implementation of these H&S initiatives. Therefore interventions targeting the worker to encourage individual responsibility from a perspective of self-preservation, rather than from a perspective of legal compliance, offer the best opportunity to reduce injuries and associated costs.

A further implication of the findings that emerged from this study is that organisations should be able to provide both managers and workers with ample opportunities for training and learning, so that H&S knowledge will be well grounded in the work ethic. This form of development may enhance the workers' H&S motivation, which in turn will translate into positive H&S performance, which may result in fewer injuries and therefore reduced associated costs.

A further implication for organisations providing training and learning opportunities is that the workforce will become acutely aware of their individual roles and responsibilities in reporting unsafe work practices and faulty machinery. As reported in Chapters Two and Four, incident reporting has a positive effect on the H&S climate in an organisation, although the current study did not corroborate this finding. Organisations and managers should therefore encourage workers to report incidents, faulty equipment and ‘near misses’, to create a positive work environment where workers feel safe to report these issues without fear of punitive repercussions.

From the findings of the current study, it is clear that the dimensions used could be applied to all workers, regardless of gender, race or age. This is encouraging, as the benefits of implementing H&S initiatives can be harnessed by every member of the organisation.

During the process of testing the developed H&S climate model, the researcher came to understand that the H&S climate construct was a complex phenomenon to investigate in one study. With this realisation, I acknowledge that it was not possible to create a generic universal H&S climate model that would be applicable to all construction sector organisations or situations. The developed model therefore applies to the construction industry in the Western Cape, with a focus on the particular building projects that were sampled in this study. This is an important realisation, because even the sample in this study manifested a diverse range of risks and hazards, depending on the phase of the building project.

7.11 FINAL NOTES

Workplace injuries and fatalities are costly to the organisation in which they occur, and to central government (in the form of compensation costs). Top management in organisations must be able to identify areas in the organisation where effective accident prevention strategies can be applied to minimise the incidence of these events. By initiating interventions that target individual worker behaviour and promote personal responsibility for H&S, organisations will be serving their H&S strategy, as well as retaining experienced workers, if injuries and fatalities can be reduced. This thesis is my contribution to the H&S climate discourse on an academic level and, on a practical level, a contribution for organisations to use the findings for studying the H&S climate phenomena further and to design interventions that will keep workers safe.

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APPENDIX A:

RESEARCH IN ETHICS COMMITTEE (COMMERCE)

APPROVAL LETTER

UNIVERSITY OF CAPE TOWN

Faculty of Commerce
Ethics in Research Committee

Courier: Room 2.21 Leslie Commerce Building Upper Campus University of Cape Town
Post: University of Cape Town • Private Bag • Rondebosch 7701
Email: Irwin.brown@uct.ac.za
Telephone: +27 21 650-2311
Fax No.: +27 21 689-7570

3 August 2010

Mrs Chao Mulenga
School of Management Studies
University of Cape Town
Chao.mulenga@uct.ac.za

Dear Mrs Mulenga

Project title: An explanatory model of health and safety performance in the South African construction industry

This letter serves to confirm that the project entitled, **"An explanatory model of health and safety performance in the South African construction industry"**, as described in your final submitted protocol dated 16 July 2010, has been approved subject to final confirmation by the Commerce Faculty Ethics in Research Committee. You may proceed with the research subject to the following conditions:

Written organizational consent from suitably authorized representative of each employer whose employees are to be surveyed, and permission from respective site managers.

Please note that if you make any substantial change in your research procedure that could affect the experiences of the participants, you must submit a revised protocol to the Committee for approval.

Best wishes for great success with your research.

Regards,

I BROWN

A/Prof Irwin Brown
Commerce Faculty Ethics in Research Committee

"OUR MISSION is to be outstanding teaching and research university, educating for life and addressing the challenges facing our society."

APPENDIX B:

LETTER OF APPROVAL

UNIVERSITY OF CAPE TOWN

School of Management Studies

University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

TO WHOM IT MAY CONCERN

Thank you for your willingness to permit Ms Chao Nkhungulu (student number NKHCHA001) to collect data from your organisation for her doctoral studies. We appreciate your contribution to the education of our students.

Please note that our students are required to work within the ethical framework of the Faculty of Commerce Ethics Committee when collecting information from research participants. This framework deals with confidentiality, sensitivity when requesting information from people and responsible reporting of results. Ms Nkhungulu has received ethical clearance from this Committee.

We also expect that the student will display professional behaviour at all times while working in your organisation.

In order to comply with the rules of the Faculty of Commerce Ethics Committee, we request you to sign below to indicate that the student will have access to employees on your building site.

Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	**ORGANISATION**	**DATE**

APPENDIX B1:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

TO WHOM IT MAY CONCERN

Thank you for your willingness to permit Ms Chao Mulenga to collect data from your organisation for her doctoral studies. We appreciate your contribution to the education of our students.

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In order to comply with the rules of the Faculty of Commerce Ethics Committee, we request you to sign below to indicate that the student will have access to employees on your building site.

Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	ORGANISATION	DATE
		22 · 07 · 2010

APPENDIX B2:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

	Beshard Construction	03/08/10
AUTHORISED PERSON	**ORGANISATION**	**DATE**
Assistant Site Supervisor		

APPENDIX B3:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	ORGANISATION	DATE
	Suparkway Construction.	10-8-2010.

APPENDIX B4:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

	PCCivils	7 Sep 2010
AUTHORISED PERSON	**ORGANISATION**	**DATE**

APPENDIX B5:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	ORGANISATION	DATE
	SUPARKWAY. CONSTRUCTION.	10-8-2010.

APPENDIX B6:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	ORGANISATION	DATE
	Power Construction A-Berth	20/09/2010

APPENDIX B7:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	ORGANISATION	DATE
	Power Construction A-Berth	20/09/2010

APPENDIX B8:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON **ORGANISATION** **DATE** 27/09/10

APPENDIX B9:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON **ORGANISATION** **DATE** 27/09/10

APPENDIX B10:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

	NMC (PTY) LTD	27 September 2010
AUTHORISED PERSON	**ORGANISATION**	**DATE**

APPENDIX B11:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
Rondebosch 7701
Telephone: +27 21 650-5218
Fax: +27 21 689-7570

<u>**TO WHOM IT MAY CONCERN**</u>

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Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	ORGANISATION	DATE
	Power Construction A - Berth	20/09/2010

APPENDIX B12:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
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Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

AUTHORISED PERSON	ORGANISATION	DATE
		22 · 07 · 2010

APPENDIX B13:

APPROVED SITE PERMISSION LETTER

UNIVERSITY OF CAPE TOWN

School of Management Studies
University of Cape Town. Private Bag.
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Thank you very much.

Yours sincerely

Dr Suki Goodman
HEAD: SECTION OF ORGANISATIONAL PSYCHOLOGY

PERMISSION TO COLLECT DATA FROM BUILDING SITE:

	NMC (PTY) LTD	27 September 2010
AUTHORISED PERSON	**ORGANISATION**	**DATE**

APPENDIX C:

STRUCTURED INTERVIEW SCHEDULE

Please indicate your:

Job role:

Age:

Gender:

1	How dangerous/risky is your job? Why?
2	What H&S problems are experienced on this site?
3	What is the role of immediate supervisors on H&S? Rectifying hazards, new safe ideas, what are the regular H&S problems experienced on site? Do supervisors discuss H&S issues with workers regularly, when?
4	What H&S procedures exist in your workplace? Are these followed at all times, are they updated regularly? How easy are the H&S procedures for workers to understand?
5	How often do you discuss H&S issues with workers on site? Does management request /accept suggestions/ideas from workers? Are you regularly informed of accidents that happen on site?
6	Are you trained/shown how to work safely?
7	Do workers encourage each other to work safely
8	How important is H&S for you? Why/why not?

General questions for model validation

1. What could improve H&S on this building site?
2. What do you think your firm can do to help improve H&S for the workers? Why/why not?
3. What should the workers do to improve their own H&S on building sites?
4. Is there anything that you would like to have done on site to make your work safer?
5. What makes your work safe at the moment?

APPENDIX D:

MEASUREMENT TOOL

About yourself
(Please do not put your name on any part of the questionnaire)

Gender	**M**
	F
Age	
Years working for same company	
Work status:	**Full time**
	Contract
	Casual
Education level	**Grade:**
	Past Grade 12:
Race (for statistical purposes only)	**Black**
	Coloured
	Indian
	White
	Other
Contractor type	**General contractor**
	Trade
	Labourer

Thank you for completing this questionnaire.

Company:
Site no:
Questionnaire no:

INSTRUCTIONS:

1. **PLEASE <u>DO NOT WRITE</u> YOUR NAME ANYWHERE.**
2. **PARTICIPATION IS VOLUNTARY.**
3. **INFORMATION YOU PROVIDE IS CONFIDENTIAL.**

THANK YOU

School of Management Studies
Section: Organisational Psychology
Contact: Chao Mulenga
083 955 7005/021 650 4243
Email: Chao.mulenga@uct.ac.za

	H&S Management systems **(Msys)**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1	H&S procedures and practices are enough to prevent incidents from happening	1	2	3	4	5
2	There are H&S systems and procedures in place for preventing breakdowns in workplace H&S	1	2	3	4	5
3	The safety procedures and practices in this organisation are useful and effective	1	2	3	4	5
	Toolbox talk **(tbt)**					
4	We have regular toolbox talks on our building site	1	2	3	4	5
5	Our toolbox talks are relevant to H&S issues I face on site	1	2	3	4	5
6	Toolbox talks help me to work and behave more safely	1	2	3	4	5
	H&S Communication **(hsco)**					
7	On this site there is <u>confusion</u> about who to speak to regarding H&S	1	2	3	4	5
8	We <u>do not</u> discuss H&S statistics on this site	1	2	3	4	5
9	We <u>do not</u> discuss H&S hazards openly on this site	1	2	3	4	5
10	When you report an H&S hazard you <u>don't get</u> a quick answer	1	2	3	4	5
11	We have <u>very few</u> H&S signs or posters on this site	1	2	3	4	5
12	Employee ideas and opinion about H&S <u>are not</u> requested	1	2	3	4	5

13	We do not have regular meetings about H&S	1	2	3	4	5
14	We are not informed about all accidents that happen on this site	1	2	3	4	5

	Personal Protection Equipment (PPE) **PLEASE TICK OPTIONS APPLICABLE**	**Hard hat**	**Safety boots**	**Safety goggles**	**Safety gloves**	**Work overalls**	**Company coat**
15	The company provides me with free PPE						
16	I pay for PPE provided by my company						

	H&S Motivation **(hsmo)**					
21	I believe that workplace H&S is an important issue	1	2	3	4	5
22	I feel that it is worthwhile to put in effort to maintain or improve my personal H&S	1	2	3	4	5
23	I feel that it is important to maintain H&S at all times	1	2	3	4	5
24	I believe that it is important to reduce the risk of incidents in the workplace	1	2	3	4	5
	Individual H&S responsibility (hsir)					
25	Personal protection equipment should always be worn	1	2	3	4	5
26	I should encourage colleagues to work safely	1	2	3	4	5
27	I share responsibility for H&S	1	2	3	4	5

	Top management commitment to H&S **(mgco)**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
28	Where I work top management gets personally involved in H&S activities	1	2	3	4	5
29	Top management views H&S regulation violations very seriously even when they don't result in any apparent damage	1	2	3	4	5
30	Our top management acts quickly to correct H&S issues	1	2	3	4	5
31	Top management is presently acting to make the work environment healthier and safer	1	2	3	4	5
32	Our top management is well informed about H&S issues on this site	1	2	3	4	5
33	Top management in this organisation is willing to invest money and effort to improve the level of H&S in the workplace	1	2	3	4	5
34	The protection of workers from exposure to hazards is a high priority with top management	1	2	3	4	5
	Supervisory H&S leadership **(shsl)**					
35	My supervisor says a good word whenever he sees a job done according to the H&S rules	1	2	3	4	5
36	My supervisor seriously considers any workers' suggestions for improving safety	1	2	3	4	5
37	My supervisor approaches workers during work to discuss H&S issues	1	2	3	4	5
38	My supervisor gets annoyed with any worker ignoring H&S rules, even minor rules	1	2	3	4	5

	Working safely **(hspf)** **Over the past one week, I**	**Never**	**Rarely**	**Sometimes**	**Usually**	**Always**
43	Carried out my work in a safe manner	1	2	3	4	5
44	Used all the necessary H&S equipment to do my job	1	2	3	4	5
45	Used the correct H&S procedures to carrying out my job	1	2	3	4	5
46	Ensured the highest levels of H&S when I carried out my job	1	2	3	4	5
47	Promoted H&S programmes within the organisation	1	2	3	4	5
48	Put in extra effort to improve the H&S of the workplace	1	2	3	4	5
49	Helped my co-workers when they were working under risky or hazardous conditions	1	2	3	4	5
50	Voluntarily carried out tasks or activities that help to improve workplace H&S	1	2	3	4	5

	H&S work pressure **(wlhs)** **On this building site**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
51	Production is given higher priority than H&S	1	2	3	4	5
52	We are usually in such a hurry that H&S is often overlooked	1	2	3	4	5
53	I take H&S shortcuts when I need to get the job done in a timely manner	1	2	3	4	5
54	It is difficult to finish a job while following all the H&S rules	1	2	3	4	5
55	Risk-taking and shortcuts are common due to the heavy workload	1	2	3	4	5
56	There is a lot of pressure to complete jobs quickly	1	2	3	4	5
57	We often do not have time to do things safely	1	2	3	4	5

	Work environment H&S **(wdng)**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
58	Working on a building site is dangerous	1	2	3	4	5
59	My work environment is not safe	1	2	3	4	5
60	I am exposed to dangerous situations at work	1	2	3	4	5
	H&S incident reporting **(irep)**					
61	Why mention an H&S mistake when it is not obvious?	1	2	3	4	5
62	It is bad to make one's H&S mistakes public	1	2	3	4	5
63	It is not useful to discuss my H&S mistakes	1	2	3	4	5
64	It can be useful to cover up H&S mistakes	1	2	3	4	5
65	I would rather keep my H&S mistakes to myself	1	2	3	4	5
66	Employees who admit their H&S errors make a big mistake	1	2	3	4	5
	H&S training **(trng)**					
67	In my work I have been shown how to do my work safely	1	2	3	4	5
68	H&S issues are given a high priority in training programmes	1	2	3	4	5
69	Workplace H&S training covers the types of situations that I experience in my job	1	2	3	4	5
70	I have received comprehensive training in H&S issues	1	2	3	4	5

	Observed safety **(hsab)** **Over the past one week, I**	**Never**	**Rarely**	**Sometimes**	**Usually**	**Always**
71	Talked to fellow employees about H&S	1	2	3	4	5
72	Used H&S equipment whenever I was on site	1	2	3	4	5
73	Did <u>not work</u> on scaffolds with <u>missing guard</u> rails	1	2	3	4	5
74	Did <u>not climb</u> up or down scaffolding when a ladder was <u>not provided</u>	1	2	3	4	5
75	Did <u>not use</u> a ladder not tied or secured	1	2	3	4	5
76	Did <u>not use</u> a ladder which <u>was broken</u> or somehow not safe	1	2	3	4	5
77	Made sure colleagues were <u>wearing personal protective equipment</u> as required	1	2	3	4	5
78	Did <u>not work</u> on scaffolds <u>not totally boarded</u>	1	2	3	4	5
79	Asked <u>colleagues</u> for <u>suggestions</u> on safe ways to do our work	1	2	3	4	5
80	Made <u>sure</u> there was clear access to exits and fire extinguishers	1	2	3	4	5

Injuries – **(Inju)** **Over the past one month I have**	**Yes**	**No**
Injured myself on building site but did not need medical attention	1	2
Injured myself on building site and needed medical attention	1	2

APPENDIX E:

ORGANISATION RESEARCH SITE LIST

Site no.	Name of organisation
1	Steffanutti & Stocks Khayelitsha
2	NMC Observatory
3	RCCivils Grassy Park
4	Power Construction Mowbray
5	GVK Oudtshoorn
6	GVK Stellenbosch
7	WBHO UCT middle campus
8	NMC Stellenbosch
9	Safecon
10	Cape Town Station
11	Borschard
12	Steffanutti & Stocks Brackenfell
13	Power Construction Brooklyn
14	Power waterfront
15	NMC Stellenbosch

APPENDIX F:

RETURNED QUESTIONNAIRE LIST – MAIN STUDY

Organisation name	Contact person	No. delivered	Collected
RCCivils Grassy Park	Asanda	30	23
NMC Observatory	Lwandile/ Warren	270	238
Steffanutti & Stocks Khayelitsha	Faried Rinquist	100	77
Power Construction Brooklyn	Ebrahim Rinquist/Roger	100	82
Power Construction Mowbray	Xolile Mr X.	50	41
GVK Oondshorn	Craig Laskey/ Kristina Miller	200+	165
GVK Stellenbosch	Benni	30	22
Power waterfront	Sivu	75	17
NMC Stellenbosch	Happy	300	51
WBHO UCT	Felicia/Michelle(accident)	400	18
Steffanutti & Stocks Brackenfell	Faried Rinquist	90	60
TOTAL		**1 200**	**794**

Note: Table does not include pilot study sites

APPENDIX G:

PATH ANALYSIS COMPOSITE RELIABILITY OVERVIEW

Variable name	AVE	Composite reliability	R square	Cronbach's alpha	Communality	Redundancy
HSco	0.6957	0.948	0	0.937	0.6957	0
HSmo	0.7369	0.9514	0.489	0.9404	0.7369	0.0527
HspfA	0.6061	0.9321	0.4219	0.9176	0.6061	0.2331
Inju	1	1	0.0276	1	1	0.008
Irep	0.6549	0.9191	0.376	0.8946	0.6549	0.2017
Mgco	0.6928	0.9403	0	0.9259	0.6928	0
Msys	0.6569	0.9197	0	0.8965	0.6569	0
Shsle	0.716	0.9093	0	0.867	0.716	0
Trng	0.7372	0.918	0	0.8811	0.7372	0
Wlhs	0.6061	0.9131	0	0.8924	0.6061	0

APPENDIX H

PATH ANALYSIS FACTOR STRUCTURE/ITEM ANALYSIS

	HSco	HSmo	HspfA	Inju	Irep	Mgco	Msys	Shsle	Trng	Wlhs
Inju	0.2027	0.1937	0.0994	1	0.2265	0.1238	0.1052	0.1246	0.0412	-0.1572
hsco1r	**0.7451**	0.255	0.1927	0.1702	0.4719	0.2352	0.068	0.4806	0.1494	-0.5014
hsco2r	**0.843**	0.3136	0.3156	0.109	0.4345	0.2366	0.1575	0.4652	0.2127	-0.4648
hsco3r	**0.8671**	0.3456	0.3093	0.128	0.5112	0.2613	0.2078	0.4587	0.2221	-0.4838
hsco4r	**0.8743**	0.3276	0.3037	0.2132	0.4908	0.2615	0.187	0.4628	0.2178	-0.4846
hsco5r	**0.796**	0.2437	0.217	0.1485	0.4626	0.2358	0.1329	0.3616	0.151	-0.4078
hsco6r	**0.8685**	0.3211	0.343	0.1608	0.4849	0.3155	0.2074	0.4236	0.2214	-0.4657
hsco7r	**0.846**	0.3385	0.3567	0.2114	0.4853	0.3042	0.2321	0.4503	0.2381	-0.4902
hsco8r	**0.8245**	0.3064	0.3026	0.2086	0.4597	0.2584	0.1829	0.429	0.183	-0.4864
hsir1	0.333	**0.864**	0.5541	0.1793	0.2762	0.4889	0.5011	0.2784	0.4678	-0.2124
hsir2	0.2995	**0.8647**	0.5696	0.1592	0.2241	0.5085	0.4576	0.2386	0.4889	-0.1594
hsir3	0.3445	**0.8302**	0.5365	0.1814	0.3025	0.5347	0.4656	0.1773	0.4653	-0.2118
hsmo1	0.3045	**0.8727**	0.5547	0.1874	0.2213	0.4696	0.5265	0.1993	0.45	-0.1799
hsmo2	0.3212	**0.8543**	0.492	0.1877	0.2571	0.4552	0.43	0.1778	0.4186	-0.2097
hsmo3	0.3402	**0.8722**	0.5378	0.1737	0.2733	0.4661	0.4713	0.2138	0.445	-0.2323
hsmo4	0.2748	**0.8499**	0.5196	0.0947	0.2682	0.4696	0.4891	0.1729	0.4814	-0.1659
hspf1	0.3343	0.5655	**0.8033**	0.0857	0.3095	0.4642	0.436	0.3019	0.4602	-0.314
hspf3	0.2726	0.5531	**0.8493**	0.1406	0.2377	0.4784	0.447	0.2388	0.4795	-0.278
hspf4	0.3112	0.5807	**0.8723**	0.1277	0.2572	0.51	0.4497	0.2372	0.4928	-0.2591
hspf5	0.2726	0.447	**0.7864**	0.1146	0.1516	0.4729	0.4171	0.1935	0.4055	-0.1843
hspf6	0.2934	0.4506	**0.8072**	0.0354	0.1793	0.4716	0.419	0.2271	0.4189	-0.2347
hspf7	0.2425	0.4684	**0.7632**	0.033	0.1709	0.4548	0.4147	0.2166	0.4025	-0.1891
hspf8	0.2366	0.3947	**0.7419**	0.0841	0.0903	0.4751	0.3988	0.1525	0.3606	-0.1084
irep1r	0.4453	0.2104	0.1884	0.1426	**0.7922**	0.1714	0.1509	0.3573	0.0719	-0.4661
irep2r	0.3647	0.1438	0.0794	0.1536	**0.7315**	0.1462	0.0285	0.2816	-0.0015	-0.3768
irep3r	0.4701	0.2727	0.2219	0.1701	**0.8246**	0.1924	0.123	0.3844	0.0793	-0.4656
irep4r	0.4164	0.2002	0.1731	0.2353	**0.8076**	0.2144	0.094	0.3864	0.0218	-0.5044
irep5r	0.5533	0.3099	0.3265	0.184	**0.8727**	0.2554	0.1837	0.4641	0.103	-0.595

	HSco	HSmo	HspfA	Inju	Irep	Mgco	Msys	Shsle	Trng	Wlhs
irep6r	0.4856	0.2943	0.2387	0.2123	**0.8203**	0.2324	0.1769	0.4252	0.0881	-0.4951
mgco1	0.3003	0.434	0.5284	0.1011	0.2349	**0.8107**	0.4364	0.1985	0.3761	-0.2046
mgco2	0.3192	0.489	0.4775	0.1346	0.271	**0.8383**	0.4199	0.2239	0.3588	-0.2559
mgco3	0.2705	0.4674	0.4706	0.057	0.2	**0.8534**	0.4576	0.1878	0.4296	-0.2185
mgco4	0.2289	0.463	0.5193	0.0476	0.1469	**0.8673**	0.5189	0.1661	0.4803	-0.1578
mgco5	0.247	0.5273	0.518	0.1196	0.2192	**0.8315**	0.4984	0.2262	0.4642	-0.2231
mgco6	0.2177	0.3786	0.3731	0.0966	0.1895	**0.7611**	0.4034	0.0834	0.3471	-0.1227
mgco7	0.2607	0.5101	0.5337	0.1562	0.2153	**0.8595**	0.5296	0.2013	0.4988	-0.2013
msys1	0.076	0.362	0.3387	0.0957	0.0676	0.4282	**0.74**	0.158	0.3141	-0.065
msys2	0.1252	0.3596	0.3958	0.0938	0.1222	0.4113	**0.7675**	0.1673	0.3098	-0.0964
msys3	0.0985	0.3884	0.3861	0.0437	0.1011	0.4288	**0.8028**	0.1123	0.3346	-0.0764
hsab2	0.3333	0.5164	**0.7516**	0.0168	0.3122	0.445	0.4633	0.276	0.4815	-0.3297
hsab9	0.119	0.3393	**0.5994**	0.0338	0.0324	0.3629	0.3151	0.1215	0.3967	-0.1841
shsl5r	0.3318	0.0499	0.1129	0.0331	0.3017	0.0851	0.0852	**0.7299**	0.0798	-0.4277
shsl6r	0.4702	0.2417	0.2394	0.1589	0.4107	0.2033	0.1768	**0.8788**	0.1827	-0.4965
shsl7r	0.4995	0.2773	0.2964	0.1125	0.4257	0.2489	0.1772	**0.8861**	0.2297	-0.5257
shsl8r	0.4697	0.2164	0.2922	0.1015	0.4649	0.1992	0.2123	**0.8798**	0.1906	-0.5361
tbt1	0.2635	0.5076	0.4876	0.0873	0.1583	0.4945	**0.8504**	0.1715	0.4528	-0.1655
tbt2	0.2501	0.539	0.492	0.1466	0.2037	0.5032	**0.8566**	0.2271	0.4329	-0.2024
tbt3	0.1455	0.4963	0.486	0.0384	0.1141	0.4567	**0.8388**	0.1229	0.4335	-0.1118
trng1	0.1866	0.4898	0.4167	0.0356	0.0448	0.4095	0.4207	0.168	**0.8357**	-0.1189
trng2	0.1986	0.4619	0.5302	0.0293	0.0485	0.459	0.4181	0.201	**0.8935**	-0.1997
trng3	0.2538	0.4963	0.5231	0.0454	0.144	0.4796	0.4518	0.1971	**0.8933**	-0.2507
trng4	0.1809	0.3764	0.4532	0.0292	0.0249	0.3999	0.3328	0.1451	**0.8087**	-0.1682
wlhs1	-0.466	-0.1549	-0.2354	-0.1234	-0.4626	-0.226	-0.1291	-0.5031	-0.202	**0.7945**
wlhs2	-0.513	-0.216	-0.2542	-0.1755	-0.5573	-0.212	-0.1613	-0.5435	-0.1714	**0.8678**
wlhs3	-0.4944	-0.223	-0.3036	-0.1214	-0.5134	-0.2211	-0.1582	-0.5171	-0.2626	**0.8656**
wlhs4	-0.4958	-0.243	-0.2631	-0.1384	-0.5381	-0.2032	-0.0869	-0.4908	-0.1826	**0.8498**
wlhs5	-0.4308	-0.1406	-0.1997	-0.1234	-0.4825	-0.1476	-0.1105	-0.4243	-0.0839	**0.7818**
wlhs6	-0.227	0.1568	0.0047	-0.0318	-0.2857	0.0426	0.0828	-0.2134	0.0871	**0.4916**
wlhs7	-0.3682	-0.1268	-0.2386	-0.0832	-0.3967	-0.1636	-0.1149	-0.3952	-0.1353	**0.7307**

APPENDIX I

INTERRATER CORRELATION TABLES

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tmsys	Pearson Correlation	.[a]	.[a]	.[a]	.[a]	.[a]
		N	0	0	0	0	0
	Tmgco	Pearson Correlation	.[a]	1	-0.437	0.308	.133
		N	0	54	51	53	45
	Tshsl	Pearson Correlation	.[a]	-0.437	1	-0.286	-0.351
		N	0	51	54	52	46
	Ttrng	Pearson Correlation	.[a]	0.308	-0.286	1	.027
		N	0	53	52	55	46
	Thsco	Pearson Correlation	.[a]	.133	-0.351	.027	1
		N	0	45	46	46	48
1	Tmsys	Pearson Correlation	1	0.721	-.019	0.782	.059
		N	29	25	25	28	29
	Tmgco	Pearson Correlation	0.721	1	0.444	0.748	.248
		N	25	30	27	30	29
	Tshsl	Pearson Correlation	-.019	0.444	1	.136	0.697
		N	25	27	30	30	28
	Ttrng	Pearson Correlation	0.782	0.748	.136	1	.159
		N	28	30	30	34	32
	Thsco	Pearson Correlation	.059	.248	0.697	.159	1
		N	29	29	28	32	33
2	Tmsys	Pearson Correlation	1	0.49	0.533	.080	0.581
		N	57	56	56	57	53
	Tmgco	Pearson Correlation	0.49	1	0.293	0.325	0.504
		N	56	61	60	61	57
	Tshsl	Pearson Correlation	0.533	0.293	1	0.359	0.566
		N	56	60	61	61	57
	Ttrng	Pearson Correlation	.080	0.325	0.359	1	0.461
		N	57	61	61	62	58
	Thsco	Pearson Correlation	0.581	0.504	0.566	0.461	1
		N	53	57	57	58	58

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
3	Tmsys	Pearson Correlation	1	0.655	0.717	0.684	.247
		N	16	15	16	16	15
	Tmgco	Pearson Correlation	0.655	1	.364	.445	.281
		N	15	18	18	18	17
	Tshsl	Pearson Correlation	0.717	.364	1	.024	0.615
		N	16	18	19	19	18
	Ttrng	Pearson Correlation	0.684	.445	.024	1	-.229
		N	16	18	19	19	18
	Thsco	Pearson Correlation	.247	.281	0.615	-.229	1
		N	15	17	18	18	18
4	Tmsys	Pearson Correlation	1	0.355	.042	0.181	-.092
		N	234	228	230	231	227
	Tmgco	Pearson Correlation	0.355	1	.110	0.191	0.218
		N	228	233	229	230	226
	Tshsl	Pearson Correlation	.042	.110	1	.050	0.525
		N	230	229	234	232	227
	Ttrng	Pearson Correlation	0.181	0.191	.050	1	.030
		N	231	230	232	236	229
	Thsco	Pearson Correlation	-.092	0.218	0.525	.030	1
		N	227	226	227	229	232
5	Tmsys	Pearson Correlation	1	0.671	-0.344	0.734	-.121
		N	77	74	75	75	72
	Tmgco	Pearson Correlation	0.671	1	-0.524	0.699	-.173
		N	74	74	72	72	69
	Tshsl	Pearson Correlation	-0.344	-0.524	1	-0.618	0.274
		N	75	72	75	73	70
	Ttrng	Pearson Correlation	0.734	0.699	-0.618	1	-.141
		N	75	72	73	75	71
	Thsco	Pearson Correlation	-.121	-.173	0.274	-.141	1
		N	72	69	70	71	72
6	Tmsys	Pearson Correlation	1	.111	0.206	0.499	.114
		N	142	138	137	141	142
	Tmgco	Pearson Correlation	.111	1	.133	0.312	0.297
		N	138	144	140	143	144

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
	Tshsl	Pearson Correlation	0.206	.133	1	0.221	.124
		N	137	140	143	142	143
	Ttrng	Pearson Correlation	0.499	0.312	0.221	1	.014
		N	141	143	142	147	147
	Thsco	Pearson Correlation	.114	0.297	.124	.014	1
		N	142	144	143	147	148
7	Tmsys	Pearson Correlation	1	.093	.286	.209	.370
		N	24	21	22	23	23
	Tmgco	Pearson Correlation	.093	1	0.934	0.722	0.512
		N	21	21	21	20	21
	Tshsl	Pearson Correlation	.286	0.934	1	0.732	0.509
		N	22	21	22	21	21
	Ttrng	Pearson Correlation	.209	0.722	0.732	1	.376
		N	23	20	21	23	22
	Thsco	Pearson Correlation	.370	0.512	0.509	.376	1
		N	23	21	21	22	23
8	Tmsys	Pearson Correlation	1	.245	-.218	-.013	.331
		N	18	17	18	17	16
	Tmgco	Pearson Correlation	.245	1	-0.517	0.831	0.652
		N	17	18	17	17	15
	Tshsl	Pearson Correlation	-.218	-0.517	1	-.323	.029
		N	18	17	18	17	16
	Ttrng	Pearson Correlation	-.013	0.831	-.323	1	0.667
		N	17	17	17	18	15
	Thsco	Pearson Correlation	.331	0.652	.029	0.667	1
		N	16	15	16	15	16
9	Tmsys	Pearson Correlation	1	0.703	.476	0.566	0.575
		N	20	16	16	16	20
	Tmgco	Pearson Correlation	0.703	1	0.642	0.864	0.755
		N	16	16	16	16	16
	Tshsl	Pearson Correlation	.476	0.642	1	0.688	0.763
		N	16	16	16	16	16
	Ttrng	Pearson Correlation	0.566	0.864	0.688	1	0.676
		N	16	16	16	16	16

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
	Thsco	Pearson Correlation	0.575	0.755	0.763	0.676	1
		N	20	16	16	16	21
10	Tmsys	Pearson Correlation	1	0.332	.173	0.334	0.312
		N	49	47	48	48	46
	Tmgco	Pearson Correlation	0.332	1	0.737	0.871	0.535
		N	47	48	48	48	47
	Tshsl	Pearson Correlation	.173	0.737	1	0.71	0.826
		N	48	48	49	49	47
	Ttrng	Pearson Correlation	0.334	0.871	0.71	1	0.486
		N	48	48	49	49	47
	Thsco	Pearson Correlation	0.312	0.535	0.826	0.486	1
		N	46	47	47	47	47
11	Tmsys	Pearson Correlation	1	0.355	0.248	.213	.109
		N	87	79	78	84	80
	Tmgco	Pearson Correlation	0.355	1	0.284	.130	0.253
		N	79	83	76	82	81
	Tshsl	Pearson Correlation	0.248	0.284	1	0.497	0.359
		N	78	76	80	80	76
	Ttrng	Pearson Correlation	.213	.130	0.497	1	.128
		N	84	82	80	89	82
	Thsco	Pearson Correlation	.109	0.253	0.359	.128	1
		N	80	81	76	82	84

Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tmsys	Z Score					
.	Tmsys	N	0	0	0	0	0
.	Tmgco	Z Score			-0.46852	0.318334	0.133796
.	Tmgco	N	0	54	51	53	45
.	Tshsl	Z Score		-0.46852		-0.2942	-0.36658
.	Tshsl	N	0	51	54	52	46
.	Ttrng	Z Score		0.318334	-0.2942		0.027227
.	Ttrng	N	0	53	52	55	46
.	Thsco	Z Score		0.133796	-0.36658	0.027227	
.	Thsco	N	0	45	46	46	48
1	Tmsys	Z Score		0.909725	-0.01867	1.050498	0.059037
1	Tmsys	N	29	25	25	28	29

Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
1	Tmgco	Z Score	0.909725		0.477202	0.968399	0.253802
1	Tmgco	N	25	30	27	30	29
1	Tshsl	Z Score	-0.01867	0.477202		0.136351	0.861442
1	Tshsl	N	25	27	30	30	28
1	Ttrng	Z Score	1.050498	0.968399	0.136351		0.16051
1	Ttrng	N	28	30	30	34	32
1	Thsco	Z Score	0.059037	0.253802	0.861442	0.16051	
1	Thsco	N	29	29	28	32	33
2	Tmsys	Z Score		0.53606	0.594326	0.080263	0.663971
2	Tmsys	N	57	56	56	57	53
2	Tmgco	Z Score	0.53606		0.301845	0.337228	0.554654
2	Tmgco	N	56	61	60	61	57
2	Tshsl	Z Score	0.594326	0.301845		0.375737	0.641618
2	Tshsl	N	56	60	61	61	57
2	Ttrng	Z Score	0.080263	0.337228	0.375737		0.49858
2	Ttrng	N	57	61	61	62	58
2	Thsco	Z Score	0.663971	0.554654	0.641618	0.49858	
2	Thsco	N	53	57	57	58	58
3	Tmsys	Z Score		0.784006	0.901443	0.836592	0.252585
3	Tmsys	N	16	15	16	16	15
3	Tmgco	Z Score	0.784006		0.381999	0.478353	0.288813
3	Tmgco	N	15	18	18	18	17
3	Tshsl	Z Score	0.901443	0.381999		0.023837	0.716923
3	Tshsl	N	16	18	19	19	18
3	Ttrng	Z Score	0.836592	0.478353	0.023837		-0.23285
3	Ttrng	N	16	18	19	19	18
3	Thsco	Z Score	0.252585	0.288813	0.716923	-0.23285	
3	Thsco	N	15	17	18	18	18
4	Tmsys	Z Score		0.371153	0.042016	0.183016	-0.09231
4	Tmsys	N	234	228	230	231	227
4	Tmgco	Z Score	0.371153		0.110007	0.193375	0.221555
4	Tmgco	N	228	233	229	230	226
4	Tshsl	Z Score	0.042016	0.110007		0.049819	0.583217
4	Tshsl	N	230	229	234	232	227
4	Ttrng	Z Score	0.183016	0.193375	0.049819		0.029528
4	Ttrng	N	231	230	232	236	229
4	Thsco	Z Score	-0.09231	0.221555	0.583217	0.029528	
4	Thsco	N	227	226	227	229	232
5	Tmsys	Z Score		0.81256	-0.35862	0.937345	-0.12184
5	Tmsys	N	77	74	75	75	72
5	Tmgco	Z Score	0.81256		-0.58184	0.865342	-0.17477
5	Tmgco	N	74	74	72	72	69
5	Tshsl	Z Score	-0.35862	-0.58184		-0.72176	0.281183
5	Tshsl	N	75	72	75	73	70

Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
5	Ttrng	Z Score	0.937345	0.865342	-0.72176		-0.14153
5	Ttrng	N	75	72	73	75	71
5	Thsco	Z Score	-0.12184	-0.17477	0.281183	-0.14153	
5	Thsco	N	72	69	70	71	72
6	Tmsys	Z Score		0.111426	0.20899	0.547974	0.114044
6	Tmsys	N	142	138	137	141	142
6	Tmgco	Z Score	0.111426		0.133729	0.32276	0.306226
6	Tmgco	N	138	144	140	143	144
6	Tshsl	Z Score	0.20899	0.133729		0.224707	0.12414
6	Tshsl	N	137	140	143	142	143
6	Ttrng	Z Score	0.547974	0.32276	0.224707		0.01394
6	Ttrng	N	141	143	142	147	147
6	Thsco	Z Score	0.114044	0.306226	0.12414	0.01394	
6	Thsco	N	142	144	143	147	148
7	Tmsys	Z Score		0.09318	0.294453	0.2123	0.388547
7	Tmsys	N	24	21	22	23	23
7	Tmgco	Z Score	0.09318		1.688845	0.91181	0.565437
7	Tmgco	N	21	21	21	20	21
7	Tshsl	Z Score	0.294453	1.688845		0.933023	0.561379
7	Tshsl	N	22	21	22	21	21
7	Ttrng	Z Score	0.2123	0.91181	0.933023		0.394899
7	Ttrng	N	23	20	21	23	22
7	Thsco	Z Score	0.388547	0.565437	0.561379	0.394899	
7	Thsco	N	23	21	21	22	23
8	Tmsys	Z Score		0.250148	-0.22208	-0.01257	0.344494
8	Tmsys	N	18	17	18	17	16
8	Tmgco	Z Score	0.250148		-0.57224	1.191359	0.77877
8	Tmgco	N	17	18	17	17	15
8	Tshsl	Z Score	-0.22208	-0.57224		-0.33488	0.029433
8	Tshsl	N	18	17	18	17	16
8	Ttrng	Z Score	-0.01257	1.191359	-0.33488		0.805319
8	Ttrng	N	17	17	17	18	15
8	Thsco	Z Score	0.344494	0.77877	0.029433	0.805319	
8	Thsco	N	16	15	16	15	16
9	Tmsys	Z Score		0.873207	0.517857	0.641618	0.654961
9	Tmsys	N	20	16	16	16	20
9	Tmgco	Z Score	0.873207		0.761569	1.308913	0.984483
9	Tmgco	N	16	16	16	16	16
9	Tshsl	Z Score	0.517857	0.761569		0.844148	1.003356
9	Tshsl	N	16	16	16	16	16
9	Ttrng	Z Score	0.641618	1.308913	0.844148		0.821711
9	Ttrng	N	16	16	16	16	16
9	Thsco	Z Score	0.654961	0.984483	1.003356	0.821711	
9	Thsco	N	20	16	16	16	21

Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
10	Tmsys	Z Score		0.345074	0.175172	0.347324	0.32276
10	Tmsys	N	49	47	48	48	46
10	Tmgco	Z Score	0.345074		0.94388	1.337208	0.597124
10	Tmgco	N	47	48	48	48	47
10	Tshsl	Z Score	0.175172	0.94388		0.887184	1.175414
10	Tshsl	N	48	48	49	49	47
10	Ttrng	Z Score	0.347324	1.337208	0.887184		0.53081
10	Ttrng	N	48	48	49	49	47
10	Thsco	Z Score	0.32276	0.597124	1.175414	0.53081	
10	Thsco	N	46	47	47	47	47
11	Tmsys	Z Score		0.371153	0.253281	0.21652	0.10949
11	Tmsys	N	87	79	78	84	80
11	Tmgco	Z Score	0.371153		0.292028	0.130442	0.258615
11	Tmgco	N	79	83	76	82	81
11	Tshsl	Z Score	0.253281	0.292028		0.545314	0.375737
11	Tshsl	N	78	76	80	80	76
11	Ttrng	Z Score	0.21652	0.130442	0.545314		0.128334
11	Ttrng	N	84	82	80	89	82
11	Thsco	Z Score	0.10949	0.258615	0.375737	0.128334	
11	Thsco	N	80	81	76	82	84

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tmsys	Pearson Correlation	.a	.a	.a	.a	.a
.	Tmsys	N	0	0	0	0	0
.	Tmgco	Pearson Correlation	.a	1	-0.437	0.308	0.133003
.	Tmgco	N	0	54	51	53	45
.	Tshsl	Pearson Correlation	.a	-0.437	1	-0.286	-0.351
.	Tshsl	N	0	51	54	52	46
.	Ttrng	Pearson Correlation	.a	0.308	-0.286	1	0.027221
.	Ttrng	N	0	53	52	55	46
.	Thsco	Pearson Correlation	.a	0.133003	-0.351	0.027221	1
.	Thsco	N	0	45	46	46	48
1	Tmsys	Pearson Correlation	1	0.721	-0.01867	0.782	0.058969
1	Tmsys	N	29	25	25	28	29
1	Tmgco	Pearson Correlation	0.721	1	0.444	0.748	0.248489
1	Tmgco	N	25	30	27	30	29
1	Tshsl	Pearson Correlation	-0.01867	0.444	1	0.135513	0.697
1	Tshsl	N	25	27	30	30	28
1	Ttrng	Pearson Correlation	0.782	0.748	0.135513	1	0.159146
1	Ttrng	N	28	30	30	34	32
1	Thsco	Pearson Correlation	0.058969	0.248489	0.697	0.159146	1
1	Thsco	N	29	29	28	32	33
2	Tmsys	Pearson Correlation	1	0.49	0.533	0.080091	0.581
2	Tmsys	N	57	56	56	57	53
2	Tmgco	Pearson Correlation	0.49	1	0.293	0.325	0.504
2	Tmgco	N	56	61	60	61	57
2	Tshsl	Pearson Correlation	0.533	0.293	1	0.359	0.566
2	Tshsl	N	56	60	61	61	57
2	Ttrng	Pearson Correlation	0.080091	0.325	0.359	1	0.461
2	Ttrng	N	57	61	61	62	58
2	Thsco	Pearson Correlation	0.581	0.504	0.566	0.461	1
2	Thsco	N	53	57	57	58	58
3	Tmsys	Pearson Correlation	1	0.655	0.717	0.684	0.247347
3	Tmsys	N	16	15	16	16	15
3	Tmgco	Pearson Correlation	0.655	1	0.364442	0.444924	0.281042
3	Tmgco	N	15	18	18	18	17
3	Tshsl	Pearson Correlation	0.717	0.364442	1	0.023832	0.615
3	Tshsl	N	16	18	19	19	18
3	Ttrng	Pearson Correlation	0.684	0.444924	0.023832	1	-0.22873
3	Ttrng	N	16	18	19	19	18
3	Thsco	Pearson Correlation	0.247347	0.281042	0.615	-0.22873	1
3	Thsco	N	15	17	18	18	18
4	Tmsys	Pearson Correlation	1	0.355	0.041992	0.181	-0.09205
4	Tmsys	N	234	228	230	231	227

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
4	Tmgco	Pearson Correlation	0.355	1	0.109565	0.191	0.218
4	Tmgco	N	228	233	229	230	226
4	Tshsl	Pearson Correlation	0.041992	0.109565	1	0.049778	0.525
4	Tshsl	N	230	229	234	232	227
4	Ttrng	Pearson Correlation	0.181	0.191	0.049778	1	0.029519
4	Ttrng	N	231	230	232	236	229
4	Thsco	Pearson Correlation	-0.09205	0.218	0.525	0.029519	1
4	Thsco	N	227	226	227	229	232
5	Tmsys	Pearson Correlation	1	0.671	-0.344	0.734	-0.12124
5	Tmsys	N	77	74	75	75	72
5	Tmgco	Pearson Correlation	0.671	1	-0.524	0.699	-0.17301
5	Tmgco	N	74	74	72	72	69
5	Tshsl	Pearson Correlation	-0.344	-0.524	1	-0.618	0.274
5	Tshsl	N	75	72	75	73	70
5	Ttrng	Pearson Correlation	0.734	0.699	-0.618	1	-0.14059
5	Ttrng	N	75	72	73	75	71
5	Thsco	Pearson Correlation	-0.12124	-0.17301	0.274	-0.14059	1
5	Thsco	N	72	69	70	71	72
6	Tmsys	Pearson Correlation	1	0.110967	0.206	0.499	0.113552
6	Tmsys	N	142	138	137	141	142
6	Tmgco	Pearson Correlation	0.110967	1	0.132938	0.312	0.297
6	Tmgco	N	138	144	140	143	144
6	Tshsl	Pearson Correlation	0.206	0.132938	1	0.221	0.123506
6	Tshsl	N	137	140	143	142	143
6	Ttrng	Pearson Correlation	0.499	0.312	0.221	1	0.013939
6	Ttrng	N	141	143	142	147	147
6	Thsco	Pearson Correlation	0.113552	0.297	0.123506	0.013939	1
6	Thsco	N	142	144	143	147	148
7	Tmsys	Pearson Correlation	1	0.092911	0.286228	0.209167	0.370107
7	Tmsys	N	24	21	22	23	23
7	Tmgco	Pearson Correlation	0.092911	1	0.934	0.722	0.512
7	Tmgco	N	21	21	21	20	21
7	Tshsl	Pearson Correlation	0.286228	0.934	1	0.732	0.509
7	Tshsl	N	22	21	22	21	21
7	Ttrng	Pearson Correlation	0.209167	0.722	0.732	1	0.375576
7	Ttrng	N	23	20	21	23	22
7	Thsco	Pearson Correlation	0.370107	0.512	0.509	0.375576	1
7	Thsco	N	23	21	21	22	23
8	Tmsys	Pearson Correlation	1	0.245057	-0.2185	-0.01257	0.331483
8	Tmsys	N	18	17	18	17	16
8	Tmgco	Pearson Correlation	0.245057	1	-0.517	0.831	0.652
8	Tmgco	N	17	18	17	17	15
8	Tshsl	Pearson Correlation	-0.2185	-0.517	1	-0.3229	0.029424

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
8	Tshsl	N	18	17	18	17	16
8	Ttrng	Pearson Correlation	-0.01257	0.831	-0.3229	1	0.667
8	Ttrng	N	17	17	17	18	15
8	Thsco	Pearson Correlation	0.331483	0.652	0.029424	0.667	1
8	Thsco	N	16	15	16	15	16
9	Tmsys	Pearson Correlation	1	0.703	0.476044	0.566	0.575
9	Tmsys	N	20	16	16	16	20
9	Tmgco	Pearson Correlation	0.703	1	0.642	0.864	0.755
9	Tmgco	N	16	16	16	16	16
9	Tshsl	Pearson Correlation	0.476044	0.642	1	0.688	0.763
9	Tshsl	N	16	16	16	16	16
9	Ttrng	Pearson Correlation	0.566	0.864	0.688	1	0.676
9	Ttrng	N	16	16	16	16	16
9	Thsco	Pearson Correlation	0.575	0.755	0.763	0.676	1
9	Thsco	N	20	16	16	16	21
10	Tmsys	Pearson Correlation	1	0.332	0.173402	0.334	0.312
10	Tmsys	N	49	47	48	48	46
10	Tmgco	Pearson Correlation	0.332	1	0.737	0.871	0.535
10	Tmgco	N	47	48	48	48	47
10	Tshsl	Pearson Correlation	0.173402	0.737	1	0.71	0.826
10	Tshsl	N	48	48	49	49	47
10	Ttrng	Pearson Correlation	0.334	0.871	0.71	1	0.486
10	Ttrng	N	48	48	49	49	47
10	Thsco	Pearson Correlation	0.312	0.535	0.826	0.486	1
10	Thsco	N	46	47	47	47	47
11	Tmsys	Pearson Correlation	1	0.355	0.248	0.213199	0.109055
11	Tmsys	N	87	79	78	84	80
11	Tmgco	Pearson Correlation	0.355	1	0.284	0.129707	0.253
11	Tmgco	N	79	83	76	82	81
11	Tshsl	Pearson Correlation	0.248	0.284	1	0.497	0.359
11	Tshsl	N	78	76	80	80	76
11	Ttrng	Pearson Correlation	0.213199	0.129707	0.497	1	0.127634
11	Ttrng	N	84	82	80	89	82
11	Thsco	Pearson Correlation	0.109055	0.253	0.359	0.127634	1
11	Thsco	N	80	81	76	82	84

TMSYS

	Z_{obs} Tmsys Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	$N_{.}$ = 0	NA										
Site 2	$N_{.}$ = 0	-2.50	NA									
Site 3	$N_{.}$ = 0	N_3 <20	N_3 <20	NA								
Site 4	$N_{.}$ = 0	0.73	4.84	N_3 <20	NA							
Site 5	$N_{.}$ = 0	0.79	4.23	N_3 <20	0.21	NA						
Site 6	$N_{.}$ = 0	-0.26	3.33	N_3 <20	-1.91	-1.60	NA					
Site 7	$N_{.}$ = 0	-1.11	1.04	N_3 <20	-2.06	-2.01	-1.15	NA				
Site 8	$N_{.}$ = 0	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	$N_{.}$ = 0	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	$N_{.}$ = 0	-1.06	1.64	N_3 <20	-2.49	-2.29	-1.20	0.24	N_8 <20	N_9 <20	NA	
Site 11	$N_{.}$ = 0	-0.22	3.05	N_3 <20	-1.53	-1.40	0.03	1.11	N_8 <20	N_9 <20	1.12	NA

	Z_{obs} Tmsys Vs Tmgco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	$N_{.}$ = 0	NA										
Site 2	$N_{.}$ = 0	1.47	NA									
Site 3	$N_{.}$ = 0	N_3 <20	N_3 <20	NA								
Site 4	$N_{.}$ = 0	2.41	1.08	N_3 <20	NA							
Site 5	$N_{.}$ = 0	0.40	1.52	N_3 <20	-3.24	NA						
Site 6	$N_{.}$ = 0	3.47	2.62	N_3 <20	2.39	4.78	NA					
Site 7	$N_{.}$ = 0	2.57	1.62	N_3 <20	1.13	2.73	0.07	NA				
Site 8	$N_{.}$ = 0	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	$N_{.}$ = 0	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	$N_{.}$ = 0	2.16	0.94	N_3 <20	0.16	2.44	-1.35	-0.90	N_8 <20	N_9 <20	NA	
Site 11	$N_{.}$ = 0	2.22	0.92	N_3 <20	0.00	2.67	-1.81	-1.06	N_8 <20	N_9 <20	-0.14	NA

	Z_{obs} Tmsys Vs Ttrng											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	$N_{.} = 0$	NA										
Site 2	$N_{.} = 0$	4.01	NA									
Site 3	$N_{.} = 0$	N_3 <20	N_3 <20	NA								
Site 4	$N_{.} = 0$	0.63	-0.68	N_3 <20	NA							
Site 5	$N_{.} = 0$	0.49	-4.76	N_3 <20	-5.58	NA						
Site 6	$N_{.} = 0$	2.31	-2.91	N_3 <20	-3.38	2.68	NA					
Site 7	$N_{.} = 0$	2.79	-0.50	N_3 <20	-0.13	2.87	1.40	NA				
Site 8	$N_{.} = 0$	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	$N_{.} = 0$	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	$N_{.} = 0$	2.82	-1.32	N_3 <20	-1.01	3.10	1.17	-0.50	N_8 <20	N_9 <20	NA	
Site 11	$N_{.} = 0$	3.65	-0.78	N_3 <20	-0.26	4.45	2.37	-0.02	N_8 <20	N_9 <20	0.70	NA

	Z_{obs} Tmsys Vs Tshsl											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	$N_{.}$ = 0	NA										
Site 2	$N_{.}$ = 0	-2.42	NA									
Site 3	$N_{.}$ = 0	N_3 <20	N_3 <20	NA								
Site 4	$N_{.}$ = 0	-0.27	-0.99	N_3 <20	NA							
Site 5	$N_{.}$ = 0	1.40	5.27	N_3 <20	2.96	NA						
Site 6	$N_{.}$ = 0	-0.99	2.37	N_3 <20	-1.53	-3.88	NA					
Site 7	$N_{.}$ = 0	-1.00	1.12	N_3 <20	-1.06	-2.53	-0.35	NA				
Site 8	$N_{.}$ = 0	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	$N_{.}$ = 0	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	$N_{.}$ = 0	-0.75	2.07	N_3 <20	-0.82	-2.81	0.20	0.44	N_8 <20	N_9 <20	NA	
Site 11	$N_{.}$ = 0	-1.12	1.90	N_3 <20	-1.59	-3.71	-0.31	0.16	N_8 <20	N_9 <20	-0.41	NA

TMGCO

	Z_{obs} Tmgco Vs Tshsl											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-3.78	NA										
Site 2	-3.93	0.72	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-3.64	1.71	5.03	N_3 <20	NA							
Site 5	0.60	4.47	0.13	N_3 <20	5.03	NA						
Site 6	-3.59	1.55	-6.45	N_3 <20	-0.22	-4.85	NA					
Site 7	-7.81	-3.89	-6.45	N_3 <20	-6.45	-8.58	-6.20	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-6.81	-1.85	-5.11	N_3 <20	-5.11	-7.96	-4.72	2.67	N_8 <20	N_9 <20	NA	
Site 11	-4.09	0.79	-1.35	N_3 <20	-1.35	-5.20	-1.09	5.31	N_8 <20	N_9 <20	3.44	NA

	Z_{obs} Tmgco Vs Ttrng											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-2.72	NA										
Site 2	-0.10	2.71	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	0.80	3.81	0.98	N_3 <20	NA							
Site 5	-2.95	0.45	-2.96	N_3 <20	-4.89	NA						
Site 6	-0.03	3.07	0.09	N_3 <20	-1.20	3.69	NA					
Site 7	-2.11	0.18	-2.08	N_3 <20	-2.86	-0.17	2.29	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-4.96	-1.52	-5.03	N_3 <20	-7.01	-2.46	-5.92	-1.49	N_8 <20	N_9 <20	NA	
Site 11	1.04	3.76	1.20	N_3 <20	0.48	4.46	1.37	2.92	N_8 <20	N_9 <20	6.46	NA

	Z_{obs} Tmgco Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-0.48	NA										
Site 2	-2.05	-1.26	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-0.52	0.16	2.20	N_3 <20	NA							
Site 5	1.56	1.85	3.98	N_3 <20	2.83	NA						
Site 6	-0.98	-0.25	1.55	N_3 <20	-0.79	-3.23	NA					
Site 7	-1.53	-1.02	-0.04	N_3 <20	-1.40	-2.78	-1.04	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-2.15	-1.39	-0.21	N_3 <20	-2.28	-3.97	-1.68	-0.11	N_8 <20	N_9 <20	NA	
Site 11	-0.65	-0.02	1.67	N_3 <20	-0.28	-2.59	0.34	1.17	N_8 <20	N_9 <20	1.80	NA

	Z_{obs} Tmsys Vs Tmgco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	$N_{.}$ = 0	NA										
Site 2	$N_{.}$ = 0	1.47	NA									
Site 3	$N_{.}$ = 0	N_3 <20	N_3 <20	NA								
Site 4	$N_{.}$ = 0	2.41	1.08	N_3 <20	NA							
Site 5	$N_{.}$ = 0	0.40	1.52	N_3 <20	-3.24	NA						
Site 6	$N_{.}$ = 0	3.47	2.62	N_3 <20	2.39	4.78	NA					
Site 7	$N_{.}$ = 0	2.57	1.62	N_3 <20	1.13	2.73	0.07	NA				
Site 8	$N_{.}$ = 0	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	$N_{.}$ = 0	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	$N_{.}$ = 0	2.16	0.94	N_3 <20	0.16	2.44	-1.35	-0.90	N_8 <20	N_9 <20	NA	
Site 11	$N_{.}$ = 0	2.22	0.92	N_3 <20	0.00	2.67	-1.81	-1.06	N_8 <20	N_9 <20	-0.14	NA

THSCO

	Z_{obs} Tshsl Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-4.88	NA										
Site 2	-4.93	0.91	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-5.70	1.32	-0.26	N_3 <20	NA							
Site 5	-3.32	2.48	1.97	N_3 <20	2.17	NA						
Site 6	-2.81	3.40	3.23	N_3 <20	4.26	1.06	NA					
Site 7	-3.31	0.97	0.29	N_3 <20	0.09	-1.06	-1.75	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-7.19	-1.25	-2.63	N_3 <20	-3.59	-4.61	-6.08	-2.19	N_8 <20	N_9 <20	NA	
Site 11	-3.86	2.10	1.48	N_3 <20	1.54	-0.56	-1.74	0.71	N_8 <20	N_9 <20	4.19	NA

	Z_{obs} Ttrng Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-0.55	NA										
Site 2	-2.32	-1.47	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-0.01	0.66	2.51	N_3 <20	NA							
Site 5	0.87	1.36	3.53	N_3 <20	1.24	NA						
Site 6	0.08	0.72	3.06	N_3 <20	0.15	-1.06	NA					
Site 7	-1.33	-0.79	0.39	N_3 <20	-1.53	-2.07	-1.56	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-2.35	-1.55	-0.16	N_3 <20	-3.04	-3.48	-3.00	-0.50	N_8 <20	N_9 <20	NA	
Site 11	-0.53	0.15	2.11	N_3 <20	-0.76	-1.63	-0.82	1.04	N_8 <20	N_9 <20	2.14	NA

	Z_{obs} Tmgco Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-0.48	NA										
Site 2	-2.05	-1.26	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-0.52	0.16	2.20	N_3 <20	NA							
Site 5	1.56	1.85	3.98	N_3 <20	2.83	NA						
Site 6	-0.98	-0.25	1.55	N_3 <20	-0.79	-3.23	NA					
Site 7	-1.53	-1.02	-0.04	N_3 <20	-1.40	-2.78	-1.04	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-2.15	-1.39	-0.21	N_3 <20	-2.28	-3.97	-1.68	-0.11	N_8 <20	N_9 <20	NA	
Site 11	-0.65	-0.02	1.67	N_3 <20	-0.28	-2.59	0.34	1.17	N_8 <20	N_9 <20	1.80	NA

	Z_{obs} Tmsys Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	$N_{.} = 0$	NA										
Site 2	$N_{.} = 0$	-2.50	NA									
Site 3	$N_{.} = 0$	$N_3 <20$	$N_3 <20$	NA								
Site 4	$N_{.} = 0$	0.73	4.84	$N_3 <20$	NA							
Site 5	$N_{.} = 0$	0.79	4.23	$N_3 <20$	0.21	NA						
Site 6	$N_{.} = 0$	-0.26	3.33	$N_3 <20$	-1.91	-1.60	NA					
Site 7	$N_{.} = 0$	-1.11	1.04	$N_3 <20$	-2.06	-2.01	-1.15	NA				
Site 8	$N_{.} = 0$	$N_8 <20$	$N_8 <20$	$N_8 <20$	$N_8 <20$	$N_8 <20$	$N_8 <20$	$N_8 <20$	NA			
Site 9	$N_{.} = 0$	$N_9 <20$	$N_9 <20$	$N_9 <20$	$N_9 <20$	$N_9 <20$	$N_9 <20$	$N_9 <20$	$N_8 <20$	NA		
Site 10	$N_{.} = 0$	-1.06	1.64	$N_3 <20$	-2.49	-2.29	-1.20	0.24	$N_8 <20$	$N_9 <20$	NA	
Site 11	$N_{.} = 0$	-0.22	3.05	$N_3 <20$	-1.53	-1.40	0.03	1.11	$N_8 <20$	$N_9 <20$	1.12	NA

TSHSL

	Z_{obs} Tshsl Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-4.88	NA										
Site 2	-4.93	0.91	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-5.70	1.32	-0.26	N_3 <20	NA							
Site 5	-3.32	2.48	1.97	N_3 <20	2.17	NA						
Site 6	-2.81	3.40	3.23	N_3 <20	4.26	1.06	NA					
Site 7	-3.31	0.97	0.29	N_3 <20	0.09	-1.06	-1.75	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-7.19	-1.25	-2.63	N_3 <20	-3.59	-4.61	-6.08	-2.19	N_8 <20	N_9 <20	NA	
Site 11	-3.86	2.10	1.48	N_3 <20	1.54	-0.56	-1.74	0.71	N_8 <20	N_9 <20	4.19	NA

	Z_{obs} Tmsys Vs Tshsl											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	$N_{.} = 0$	NA										
Site 2	$N_{.} = 0$	-2.42	NA									
Site 3	$N_{.} = 0$	N_3 <20	N_3 <20	NA								
Site 4	$N_{.} = 0$	-0.27	-0.99	N_3 <20	NA							
Site 5	$N_{.} = 0$	1.40	5.27	N_3 <20	2.96	NA						
Site 6	$N_{.} = 0$	-0.99	2.37	N_3 <20	-1.53	-3.88	NA					
Site 7	$N_{.} = 0$	-1.00	1.12	N_3 <20	-1.06	-2.53	-0.35	NA				
Site 8	$N_{.} = 0$	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	$N_{.} = 0$	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	$N_{.} = 0$	-0.75	2.07	N_3 <20	-0.82	-2.81	0.20	0.44	N_8 <20	N_9 <20	NA	
Site 11	$N_{.} = 0$	-1.12	1.90	N_3 <20	-1.59	-3.71	-0.31	0.16	N_8 <20	N_9 <20	-0.41	NA

	Z_{obs} Tmgco Vs Tshsl											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-3.78	NA										
Site 2	-3.93	0.72	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-3.64	1.71	5.03	N_3 <20	NA							
Site 5	0.60	4.47	0.13	N_3 <20	5.03	NA						
Site 6	-3.59	1.55	-6.45	N_3 <20	-0.22	-4.85	NA					
Site 7	-7.81	-3.89	-6.45	N_3 <20	-6.45	-8.58	-6.20	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-6.81	-1.85	-5.11	N_3 <20	-5.11	-7.96	-4.72	2.67	N_8 <20	N_9 <20	NA	
Site 11	-4.09	0.79	-1.35	N_3 <20	-1.35	-5.20	-1.09	5.31	N_8 <20	N_9 <20	3.44	NA

	Z_{obs} Tshsl Vs Ttrng											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-1.80	NA										
Site 2	-3.45	-1.03	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-2.19	0.43	2.22	N_3 <20	NA							
Site 5	2.30	3.79	6.18	N_3 <20	-3.76	NA						
Site 6	-3.12	-0.42	0.97	N_3 <20	-1.63	-6.46	NA					
Site 7	-4.45	-2.62	-2.07	N_3 <20	-3.61	-6.26	-2.83	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-5.75	-3.10	-2.59	N_3 <20	-5.18	-8.48	-3.89	0.16	N_8 <20	N_9 <20	NA	
Site 11	-4.59	-1.83	-0.98	N_3 <20	-3.76	-7.67	-2.26	1.48	N_8 <20	N_9 <20	1.83	NA

TTRNG

	Z_{obs} Tshsl Vs Ttrng											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-1.80	NA										
Site 2	-3.45	-1.03	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-2.19	0.43	2.22	N_3 <20	NA							
Site 5	2.30	3.79	6.18	N_3 <20	-3.76	NA						
Site 6	-3.12	-0.42	0.97	N_3 <20	-1.63	-6.46	NA					
Site 7	-4.45	-2.62	-2.07	N_3 <20	-3.61	-6.26	-2.83	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-5.75	-3.10	-2.59	N_3 <20	-5.18	-8.48	-3.89	0.16	N_8 <20	N_9 <20	NA	
Site 11	-4.59	-1.83	-0.98	N_3 <20	-3.76	-7.67	-2.26	1.48	N_8 <20	N_9 <20	1.83	NA

	Z_{obs} Ttrng Vs Thsco											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-0.55	NA										
Site 2	-2.32	-1.47	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	-0.01	0.66	2.51	N_3 <20	NA							
Site 5	0.87	1.36	3.53	N_3 <20	1.24	NA						
Site 6	0.08	0.72	3.06	N_3 <20	0.15	-1.06	NA					
Site 7	-1.33	-0.79	0.39	N_3 <20	-1.53	-2.07	-1.56	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-2.35	-1.55	-0.16	N_3 <20	-3.04	-3.48	-3.00	-0.50	N_8 <20	N_9 <20	NA	
Site 11	-0.53	0.15	2.11	N_3 <20	-0.76	-1.63	-0.82	1.04	N_8 <20	N_9 <20	2.14	NA

	Z_{obs} Tmgco Vs Ttrng											
	Site .	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Site .	NA											
Site 1	-2.72	NA										
Site 2	-0.10	2.71	NA									
Site 3	N_3 <20	N_3 <20	N_3 <20	NA								
Site 4	0.80	3.81	0.98	N_3 <20	NA							
Site 5	-2.95	0.45	-2.96	N_3 <20	-4.89	NA						
Site 6	-0.03	3.07	0.09	N_3 <20	-1.20	3.69	NA					
Site 7	-2.11	0.18	-2.08	N_3 <20	-2.86	-0.17	2.29	NA				
Site 8	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	N_8 <20	NA			
Site 9	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_9 <20	N_8 <20	NA		
Site 10	-4.96	-1.52	-5.03	N_3 <20	-7.01	-2.46	-5.92	-1.49	N_8 <20	N_9 <20	NA	
Site 11	1.04	3.76	1.20	N_3 <20	0.48	4.46	1.37	2.92	N_8 <20	N_9 <20	6.46	NA

Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tmsys	Z Score					
.	Tmsys	N	0	0	0	0	0
.	Tmgco	Z Score			-0.46852	0.318334	0.133796
.	Tmgco	N	0	54	51	53	45
.	Tshsl	Z Score		-0.46852		-0.2942	-0.36658
.	Tshsl	N	0	51	54	52	46
.	Ttrng	Z Score		0.318334	-0.2942		0.027227
.	Ttrng	N	0	53	52	55	46
.	Thsco	Z Score		0.133796	-0.36658	0.027227	
.	Thsco	N	0	45	46	46	48
1	Tmsys	Z Score		0.909725	-0.01867	1.050498	0.059037
1	Tmsys	N	29	25	25	28	29
1	Tmgco	Z Score	0.909725		0.477202	0.968399	0.253802
1	Tmgco	N	25	30	27	30	29
1	Tshsl	Z Score	-0.01867	0.477202		0.136351	0.861442
1	Tshsl	N	25	27	30	30	28
1	Ttrng	Z Score	1.050498	0.968399	0.136351		0.16051
1	Ttrng	N	28	30	30	34	32
1	Thsco	Z Score	0.059037	0.253802	0.861442	0.16051	
1	Thsco	N	29	29	28	32	33
2	Tmsys	Z Score		0.53606	0.594326	0.080263	0.663971
2	Tmsys	N	57	56	56	57	53
2	Tmgco	Z Score	0.53606		0.301845	0.337228	0.554654
2	Tmgco	N	56	61	60	61	57
2	Tshsl	Z Score	0.594326	0.301845		0.375737	0.641618
2	Tshsl	N	56	60	61	61	57

2	Ttrng	Z Score	0.080263	0.337228	0.375737		0.49858
2	Ttrng	N	57	61	61	62	58
Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
2	Thsco	Z Score	0.663971	0.554654	0.641618	0.49858	
2	Thsco	N	53	57	57	58	58
3	Tmsys	Z Score		0.784006	0.901443	0.836592	0.252585
3	Tmsys	N	16	15	16	16	15
3	Tmgco	Z Score	0.784006		0.381999	0.478353	0.288813
3	Tmgco	N	15	18	18	18	17
3	Tshsl	Z Score	0.901443	0.381999		0.023837	0.716923
3	Tshsl	N	16	18	19	19	18
3	Ttrng	Z Score	0.836592	0.478353	0.023837		-0.23285
3	Ttrng	N	16	18	19	19	18
3	Thsco	Z Score	0.252585	0.288813	0.716923	-0.23285	
3	Thsco	N	15	17	18	18	18
4	Tmsys	Z Score		0.371153	0.042016	0.183016	-0.09231
4	Tmsys	N	234	228	230	231	227
4	Tmgco	Z Score	0.371153		0.110007	0.193375	0.221555
4	Tmgco	N	228	233	229	230	226
4	Tshsl	Z Score	0.042016	0.110007		0.049819	0.583217
4	Tshsl	N	230	229	234	232	227
4	Ttrng	Z Score	0.183016	0.193375	0.049819		0.029528
4	Ttrng	N	231	230	232	236	229
4	Thsco	Z Score	-0.09231	0.221555	0.583217	0.029528	
4	Thsco	N	227	226	227	229	232
5	Tmsys	Z Score		0.81256	-0.35862	0.937345	-0.12184
5	Tmsys	N	77	74	75	75	72
5	Tmgco	Z Score	0.81256		-0.58184	0.865342	-0.17477
5	Tmgco	N	74	74	72	72	69

5	Tshsl	Z Score	-0.35862	-0.58184		-0.72176	0.281183
5	Tshsl	N	75	72	75	73	70
Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
5	Ttrng	Z Score	0.937345	0.865342	-0.72176		-0.14153
5	Ttrng	N	75	72	73	75	71
5	Thsco	Z Score	-0.12184	-0.17477	0.281183	-0.14153	
5	Thsco	N	72	69	70	71	72
6	Tmsys	Z Score		0.111426	0.20899	0.547974	0.114044
6	Tmsys	N	142	138	137	141	142
6	Tmgco	Z Score	0.111426		0.133729	0.32276	0.306226
6	Tmgco	N	138	144	140	143	144
6	Tshsl	Z Score	0.20899	0.133729		0.224707	0.12414
6	Tshsl	N	137	140	143	142	143
6	Ttrng	Z Score	0.547974	0.32276	0.224707		0.01394
6	Ttrng	N	141	143	142	147	147
6	Thsco	Z Score	0.114044	0.306226	0.12414	0.01394	
6	Thsco	N	142	144	143	147	148
7	Tmsys	Z Score		0.09318	0.294453	0.2123	0.388547
7	Tmsys	N	24	21	22	23	23
7	Tmgco	Z Score	0.09318		1.688845	0.91181	0.565437
7	Tmgco	N	21	21	21	20	21
7	Tshsl	Z Score	0.294453	1.688845		0.933023	0.561379
7	Tshsl	N	22	21	22	21	21
7	Ttrng	Z Score	0.2123	0.91181	0.933023		0.394899
7	Ttrng	N	23	20	21	23	22
7	Thsco	Z Score	0.388547	0.565437	0.561379	0.394899	
7	Thsco	N	23	21	21	22	23
8	Tmsys	Z Score		0.250148	-0.22208	-0.01257	0.344494
8	Tmsys	N	18	17	18	17	16

8	Tmgco	Z Score	0.250148		-0.57224	1.191359	0.77877
8	Tmgco	N	17	18	17	17	15
Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
8	Tshsl	Z Score	-0.22208	-0.57224		-0.33488	0.029433
8	Tshsl	N	18	17	18	17	16
8	Ttrng	Z Score	-0.01257	1.191359	-0.33488		0.805319
8	Ttrng	N	17	17	17	18	15
8	Thsco	Z Score	0.344494	0.77877	0.029433	0.805319	
8	Thsco	N	16	15	16	15	16
9	Tmsys	Z Score		0.873207	0.517857	0.641618	0.654961
9	Tmsys	N	20	16	16	16	20
9	Tmgco	Z Score	0.873207		0.761569	1.308913	0.984483
9	Tmgco	N	16	16	16	16	16
9	Tshsl	Z Score	0.517857	0.761569		0.844148	1.003356
9	Tshsl	N	16	16	16	16	16
9	Ttrng	Z Score	0.641618	1.308913	0.844148		0.821711
9	Ttrng	N	16	16	16	16	16
9	Thsco	Z Score	0.654961	0.984483	1.003356	0.821711	
9	Thsco	N	20	16	16	16	21
10	Tmsys	Z Score		0.345074	0.175172	0.347324	0.32276
10	Tmsys	N	49	47	48	48	46
10	Tmgco	Z Score	0.345074		0.94388	1.337208	0.597124
10	Tmgco	N	47	48	48	48	47
10	Tshsl	Z Score	0.175172	0.94388		0.887184	1.175414
10	Tshsl	N	48	48	49	49	47
10	Ttrng	Z Score	0.347324	1.337208	0.887184		0.53081
10	Ttrng	N	48	48	49	49	47
10	Thsco	Z Score	0.32276	0.597124	1.175414	0.53081	
10	Thsco	N	46	47	47	47	47

11	Tmsys	Z Score		0.371153	0.253281	0.21652	0.10949
11	Tmsys	N	87	79	78	84	80
Site			Tmsys	Tmgco	Tshsl	Ttrng	Thsco
11	Tmgco	Z Score	0.371153		0.292028	0.130442	0.258615
11	Tmgco	N	79	83	76	82	81
11	Tshsl	Z Score	0.253281	0.292028		0.545314	0.375737
11	Tshsl	N	78	76	80	80	76
11	Ttrng	Z Score	0.21652	0.130442	0.545314		0.128334
11	Ttrng	N	84	82	80	89	82
11	Thsco	Z Score	0.10949	0.258615	0.375737	0.128334	
11	Thsco	N	80	81	76	82	84

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tmsys	Pearson Correlation	.a	.a	.a	.a	.a
.	Tmsys	N	0	0	0	0	0
.	Tmgco	Pearson Correlation	.a	1	-0.437	0.308	0.133003
.	Tmgco	N	0	54	51	53	45
.	Tshsl	Pearson Correlation	.a	-0.437	1	-0.286	-0.351
.	Tshsl	N	0	51	54	52	46
.	Ttrng	Pearson Correlation	.a	0.308	-0.286	1	0.027221
.	Ttrng	N	0	53	52	55	46
.	Thsco	Pearson Correlation	.a	0.133003	-0.351	0.027221	1
.	Thsco	N	0	45	46	46	48
1	Tmsys	Pearson Correlation	1	0.721	-0.01867	0.782	0.058969
1	Tmsys	N	29	25	25	28	29
1	Tmgco	Pearson Correlation	0.721	1	0.444	0.748	0.248489
1	Tmgco	N	25	30	27	30	29
1	Tshsl	Pearson Correlation	-0.01867	0.444	1	0.135513	0.697
1	Tshsl	N	25	27	30	30	28
1	Ttrng	Pearson Correlation	0.782	0.748	0.135513	1	0.159146
1	Ttrng	N	28	30	30	34	32
1	Thsco	Pearson Correlation	0.058969	0.248489	0.697	0.159146	1
1	Thsco	N	29	29	28	32	33
2	Tmsys	Pearson Correlation	1	0.49	0.533	0.080091	0.581
2	Tmsys	N	57	56	56	57	53
2	Tmgco	Pearson Correlation	0.49	1	0.293	0.325	0.504
2	Tmgco	N	56	61	60	61	57
2	Tshsl	Pearson Correlation	0.533	0.293	1	0.359	0.566
2	Tshsl	N	56	60	61	61	57
2	Ttrng	Pearson Correlation	0.080091	0.325	0.359	1	0.461

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
2	Thsco	N	53	57	57	58	58
3	Tmsys	Pearson Correlation	1	0.655	0.717	0.684	0.247347
3	Tmsys	N	16	15	16	16	15
3	Tmgco	Pearson Correlation	0.655	1	0.364442	0.444924	0.281042
3	Tmgco	N	15	18	18	18	17
3	Tshsl	Pearson Correlation	0.717	0.364442	1	0.023832	0.615
3	Tshsl	N	16	18	19	19	18
3	Ttrng	Pearson Correlation	0.684	0.444924	0.023832	1	-0.22873
3	Ttrng	N	16	18	19	19	18
3	Thsco	Pearson Correlation	0.247347	0.281042	0.615	-0.22873	1
3	Thsco	N	15	17	18	18	18
4	Tmsys	Pearson Correlation	1	0.355	0.041992	0.181	-0.09205
4	Tmsys	N	234	228	230	231	227
4	Tmgco	Pearson Correlation	0.355	1	0.109565	0.191	0.218
4	Tmgco	N	228	233	229	230	226
4	Tshsl	Pearson Correlation	0.041992	0.109565	1	0.049778	0.525
4	Tshsl	N	230	229	234	232	227
4	Ttrng	Pearson Correlation	0.181	0.191	0.049778	1	0.029519
4	Ttrng	N	231	230	232	236	229
4	Thsco	Pearson Correlation	-0.09205	0.218	0.525	0.029519	1
4	Thsco	N	227	226	227	229	232
5	Tmsys	Pearson Correlation	1	0.671	-0.344	0.734	-0.12124
5	Tmsys	N	77	74	75	75	72
5	Tmgco	Pearson Correlation	0.671	1	-0.524	0.699	-0.17301
5	Tmgco	N	74	74	72	72	69
5	Tshsl	Pearson Correlation	-0.344	-0.524	1	-0.618	0.274
5	Tshsl	N	75	72	75	73	70

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
5	Thsco	Pearson Correlation	-0.12124	-0.17301	0.274	-0.14059	1
5	Thsco	N	72	69	70	71	72
6	Tmsys	Pearson Correlation	1	0.110967	0.206	0.499	0.113552
6	Tmsys	N	142	138	137	141	142
6	Tmgco	Pearson Correlation	0.110967	1	0.132938	0.312	0.297
6	Tmgco	N	138	144	140	143	144
6	Tshsl	Pearson Correlation	0.206	0.132938	1	0.221	0.123506
6	Tshsl	N	137	140	143	142	143
6	Ttrng	Pearson Correlation	0.499	0.312	0.221	1	0.013939
6	Ttrng	N	141	143	142	147	147
6	Thsco	Pearson Correlation	0.113552	0.297	0.123506	0.013939	1
6	Thsco	N	142	144	143	147	148
7	Tmsys	Pearson Correlation	1	0.092911	0.286228	0.209167	0.370107
7	Tmsys	N	24	21	22	23	23
7	Tmgco	Pearson Correlation	0.092911	1	0.934	0.722	0.512
7	Tmgco	N	21	21	21	20	21
7	Tshsl	Pearson Correlation	0.286228	0.934	1	0.732	0.509
7	Tshsl	N	22	21	22	21	21
7	Ttrng	Pearson Correlation	0.209167	0.722	0.732	1	0.375576
7	Ttrng	N	23	20	21	23	22
7	Thsco	Pearson Correlation	0.370107	0.512	0.509	0.375576	1
7	Thsco	N	23	21	21	22	23
8	Tmsys	Pearson Correlation	1	0.245057	-0.2185	-0.01257	0.331483
8	Tmsys	N	18	17	18	17	16
8	Tmgco	Pearson Correlation	0.245057	1	-0.517	0.831	0.652
8	Tmgco	N	17	18	17	17	15
8	Tshsl	Pearson Correlation	-0.2185	-0.517	1	-0.3229	0.029424

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
8	Ttrng	N	17	17	17	18	15
8	Thsco	Pearson Correlation	0.331483	0.652	0.029424	0.667	1
8	Thsco	N	16	15	16	15	16
9	Tmsys	Pearson Correlation	1	0.703	0.476044	0.566	0.575
9	Tmsys	N	20	16	16	16	20
9	Tmgco	Pearson Correlation	0.703	1	0.642	0.864	0.755
9	Tmgco	N	16	16	16	16	16
9	Tshsl	Pearson Correlation	0.476044	0.642	1	0.688	0.763
9	Tshsl	N	16	16	16	16	16
9	Ttrng	Pearson Correlation	0.566	0.864	0.688	1	0.676
9	Ttrng	N	16	16	16	16	16
9	Thsco	Pearson Correlation	0.575	0.755	0.763	0.676	1
9	Thsco	N	20	16	16	16	21
10	Tmsys	Pearson Correlation	1	0.332	0.173402	0.334	0.312
10	Tmsys	N	49	47	48	48	46
10	Tmgco	Pearson Correlation	0.332	1	0.737	0.871	0.535
10	Tmgco	N	47	48	48	48	47
10	Tshsl	Pearson Correlation	0.173402	0.737	1	0.71	0.826
10	Tshsl	N	48	48	49	49	47
10	Ttrng	Pearson Correlation	0.334	0.871	0.71	1	0.486
10	Ttrng	N	48	48	49	49	47
10	Thsco	Pearson Correlation	0.312	0.535	0.826	0.486	1
10	Thsco	N	46	47	47	47	47
11	Tmsys	Pearson Correlation	1	0.355	0.248	0.213199	0.109055
11	Tmsys	N	87	79	78	84	80
11	Tmgco	Pearson Correlation	0.355	1	0.284	0.129707	0.253
11	Tmgco	N	79	83	76	82	81

Correlations							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
11	Ttrng	Pearson Correlation	0.213199	0.129707	0.497	1	0.127634
11	Ttrng	N	84	82	80	89	82
11	Thsco	Pearson Correlation	0.109055	0.253	0.359	0.127634	1
11	Thsco	N	80	81	76	82	84

Correlations TMGCO							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tmgco	Pearson Correlation	.a	1	-0.437	0.308	0.133003
.	Tmgco	N	0	54	51	53	45
1	Tmgco	Pearson Correlation	0.721	1	0.444	0.748	0.248489
1	Tmgco	N	25	30	27	30	29
2	Tmgco	Pearson Correlation	0.49	1	0.293	0.325	0.504
2	Tmgco	N	56	61	60	61	57
3	Tmgco	Pearson Correlation	0.655	1	0.364442	0.444924	0.281042
3	Tmgco	N	15	18	18	18	17
4	Tmgco	Pearson Correlation	0.355	1	0.109565	0.191	0.218
4	Tmgco	N	228	233	229	230	226
5	Tmgco	Pearson Correlation	0.671	1	-0.524	0.699	-0.17301
5	Tmgco	N	74	74	72	72	69
6	Tmgco	Pearson Correlation	0.110967	1	0.132938	0.312	0.297
6	Tmgco	N	138	144	140	143	144
7	Tmgco	Pearson Correlation	0.092911	1	0.934	0.722	0.512
7	Tmgco	N	21	21	21	20	21
8	Tmgco	Pearson Correlation	0.245057	1	-0.517	0.831	0.652
8	Tmgco	N	17	18	17	17	15
9	Tmgco	Pearson Correlation	0.703	1	0.642	0.864	0.755
9	Tmgco	N	16	16	16	16	16
10	Tmgco	Pearson	0.332	1	0.737	0.871	0.535

		Correlation					
10	Tmgco	N	47	48	48	48	47
11	Tmgco	Pearson Correlation	0.355	1	0.284	0.129707	0.253
11	Tmgco	N	79	83	76	82	81

Correlations THSCO							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Thsco	Pearson Correlation	.a	0.133003	-0.351	0.027221	1
.	Thsco	N	0	45	46	46	48
1	Thsco	Pearson Correlation	0.058969	0.248489	0.697	0.159146	1
1	Thsco	N	29	29	28	32	33
2	Thsco	Pearson Correlation	0.581	0.504	0.566	0.461	1
2	Thsco	N	53	57	57	58	58
3	Thsco	Pearson Correlation	0.247347	0.281042	0.615	-0.22873	1
3	Thsco	N	15	17	18	18	18
4	Thsco	Pearson Correlation	-0.09205	0.218	0.525	0.029519	1
4	Thsco	N	227	226	227	229	232
5	Thsco	Pearson Correlation	-0.12124	-0.17301	0.274	-0.14059	1
5	Thsco	N	72	69	70	71	72
6	Thsco	Pearson Correlation	0.113552	0.297	0.123506	0.013939	1
6	Thsco	N	142	144	143	147	148
7	Thsco	Pearson Correlation	0.370107	0.512	0.509	0.375576	1
7	Thsco	N	23	21	21	22	23
8	Thsco	Pearson Correlation	0.331483	0.652	0.029424	0.667	1
8	Thsco	N	16	15	16	15	16
9	Thsco	Pearson Correlation	0.575	0.755	0.763	0.676	1
9	Thsco	N	20	16	16	16	21
10	Thsco	Pearson	0.312	0.535	0.826	0.486	1

		Correlation					
10	Thsco	N	46	47	47	47	47
11	Thsco	Pearson Correlation	0.109055	0.253	0.359	0.127634	1
11	Thsco	N	80	81	76	82	84

Correlations							
TMSYS correlations	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tmsys	Pearson Correlation	.a	.a	.a	.a	.a
.	Tmsys	N	0	0	0	0	0
1	Tmsys	Pearson Correlation	1	0.721	-0.01867	0.782	0.058969
1	Tmsys	N	29	25	25	28	29
2	Tmsys	Pearson Correlation	1	0.49	0.533	0.080091	0.581
2	Tmsys	N	57	56	56	57	53
3	Tmsys	Pearson Correlation	1	0.655	0.717	0.684	0.247347
3	Tmsys	N	16	15	16	16	15
4	Tmsys	Pearson Correlation	1	0.355	0.041992	0.181	-0.09205
4	Tmsys	N	234	228	230	231	227
5	Tmsys	Pearson Correlation	1	0.671	-0.344	0.734	-0.12124
5	Tmsys	N	77	74	75	75	72
6	Tmsys	Pearson Correlation	1	0.110967	0.206	0.499	0.113552
6	Tmsys	N	142	138	137	141	142
7	Tmsys	Pearson Correlation	1	0.092911	0.286228	0.209167	0.370107
7	Tmsys	N	24	21	22	23	23
8	Tmsys	Pearson Correlation	1	0.245057	-0.2185	-0.01257	0.331483
8	Tmsys	N	18	17	18	17	16
9	Tmsys	Pearson Correlation	1	0.703	0.476044	0.566	0.575
9	Tmsys	N	20	16	16	16	20
10	Tmsys	Pearson	1	0.332	0.173402	0.334	0.312

		Correlation					
10	Tmsys	N	49	47	48	48	46
11	Tmsys	Pearson Correlation	1	0.355	0.248	0.213199	0.109055
11	Tmsys	N	87	79	78	84	80

Correlations TSHSL							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Tshsl	Pearson Correlation	.a	-0.437	1	-0.286	-0.351
.	Tshsl	N	0	51	54	52	46
1	Tshsl	Pearson Correlation	-0.01867	0.444	1	0.135513	0.697
1	Tshsl	N	25	27	30	30	28
2	Tshsl	Pearson Correlation	0.533	0.293	1	0.359	0.566
2	Tshsl	N	56	60	61	61	57
3	Tshsl	Pearson Correlation	0.717	0.364442	1	0.023832	0.615
3	Tshsl	N	16	18	19	19	18
4	Tshsl	Pearson Correlation	0.041992	0.109565	1	0.049778	0.525
4	Tshsl	N	230	229	234	232	227
5	Tshsl	Pearson Correlation	-0.344	-0.524	1	-0.618	0.274
5	Tshsl	N	75	72	75	73	70
6	Tshsl	Pearson Correlation	0.206	0.132938	1	0.221	0.123506
6	Tshsl	N	137	140	143	142	143
7	Tshsl	Pearson Correlation	0.286228	0.934	1	0.732	0.509
7	Tshsl	N	22	21	22	21	21
8	Tshsl	Pearson Correlation	-0.2185	-0.517	1	-0.3229	0.029424
8	Tshsl	N	18	17	18	17	16
9	Tshsl	Pearson Correlation	0.476044	0.642	1	0.688	0.763
9	Tshsl	N	16	16	16	16	16
10	Tshsl	Pearson	0.173402	0.737	1	0.71	0.826

		Correlation					
10	Tshsl	N	48	48	49	49	47
11	Tshsl	Pearson Correlation	0.248	0.284	1	0.497	0.359
11	Tshsl	N	78	76	80	80	76

Correlations TTRNG							
Site	Var		Tmsys	Tmgco	Tshsl	Ttrng	Thsco
.	Ttrng	Pearson Correlation	.a	0.308	-0.286	1	0.027221
.	Ttrng	N	0	53	52	55	46
1	Ttrng	Pearson Correlation	0.782	0.748	0.135513	1	0.159146
1	Ttrng	N	28	30	30	34	32
2	Ttrng	Pearson Correlation	0.080091	0.325	0.359	1	0.461
2	Ttrng	N	57	61	61	62	58
3	Ttrng	Pearson Correlation	0.684	0.444924	0.023832	1	-0.22873
3	Ttrng	N	16	18	19	19	18
4	Ttrng	Pearson Correlation	0.181	0.191	0.049778	1	0.029519
4	Ttrng	N	231	230	232	236	229
5	Ttrng	Pearson Correlation	0.734	0.699	-0.618	1	-0.14059
5	Ttrng	N	75	72	73	75	71
6	Ttrng	Pearson Correlation	0.499	0.312	0.221	1	0.013939
6	Ttrng	N	141	143	142	147	147
7	Ttrng	Pearson Correlation	0.209167	0.722	0.732	1	0.375576
7	Ttrng	N	23	20	21	23	22
8	Ttrng	Pearson Correlation	-0.01257	0.831	-0.3229	1	0.667
8	Ttrng	N	17	17	17	18	15
9	Ttrng	Pearson Correlation	0.566	0.864	0.688	1	0.676
9	Ttrng	N	16	16	16	16	16
10	Ttrng	Pearson	0.334	0.871	0.71	1	0.486

		Correlation					
10	Ttrng	N	48	48	49	49	47
11	Ttrng	Pearson Correlation	0.213199	0.129707	0.497	1	0.127634
11	Ttrng	N	84	82	80	89	82

Z_{obs} Calculator		
	Group 1	Group 2
Pearson Correlation, r	0.497	0.71
Population Size	80	49
Z Score	0.545	0.887
Z_{obs}	-1.83	