


Safety Climate in a Ghanaian Industry:  
Its Measurement and Relative Influence on Employee Safety-Oriented Behaviour

by

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A thesis submitted in partial fulfilment of the requirements for the  
Master of Philosophy (MPhil) degree in  
Human Development

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June, 2010



## Preface

This thesis is written in an article-based format and comprises of two parts. The purpose of the first part is to provide an integrating overview of the two empirical papers which together forms the second part. As such Part I contains a detailed presentation of methodological and conceptual issues and may provide a reader with some extra information regarding the subject matter of the empirical papers. However it is worth mentioning that, each of the two empirical papers contains sufficient information that allow it to be read and understood separately without necessarily having to read the first part of the thesis. Also, a reader should note that there are some overlaps in the method sections of the papers in part II. The reason for this is that the papers are based on data collected in a single survey from the sample respondents.

Without the support of some individuals and institutions, this thesis and my whole education at NTNU that laid the foundation for the conduct of this work would not have been a success. I therefore wish to express my heartfelt gratitude to all these people and institutions. They include:

- 1) Professor Torbjørn Rundmo for sharing his safety attitude questionnaire with me and also for his guidance and comments on the two empirical papers.
- 2) The Norwegian State Educational Loan Fund for providing financial support for the conduct of this research as well as for my entire education at NTNU
- 3) Mr Owusu-Ansah and Ms Benedicta Fiave for reviewing the study questionnaire. Also not forgetting Mr Alia and his colleagues at the SHE department as well as all my respondents from the mining industry where this study was conducted. I salute all of you and say ‘‘*Safety! Yen kwa Nti!!!*’’
- 4) Messers Elijah Y. Amankwah and Kofi Agyei for serving as research assistants for the data collection.
- 5) The administrator, lecturers and students of the 2009/10 Human Development program most especially Professors Knizek Birthe Loa, Øyvind Eikrem, Danket Vedeler and Audrey van der Meer for their insightful lectures and discussions on the research methodology and theory of science.

- 6) And lastly the entire Ghanaians at NTNU as well as members of the Trondheim Adventist church for providing a home away from home for me during my two-year stay in Norway.

I say a big *TUSEN TAKK* to you all.

Trondheim, June 2010

Kofi Adutwum

## Summary

In recent times, creating and maintaining a positive safety climate is being promoted by organizational theorists as an efficient way to enhance occupational safety in industries such as the mining sector. However, very little is known about the extent to which the climate for safety within mining work units relates with the safety behaviours of technical workers. In view of this, the overriding aim of the research presented in the thesis was to explore the safety climate – safety behaviour relationship in a Ghanaian mining industry. Following a cross-sectional survey, data from 273 employees (representing a response rate of 92%) were analyzed with relevant statistical tests.

Culture has been found to influence the properties of safety climate scales. Due to this and the fact that no previously validated measure existed for the Ghanaian industrial context, the first empirical paper in the thesis focused on evaluating the inherent factor structure, reliability and discriminant validity of the safety climate scale used. Regarding structure, four dimensions were extracted through principal component analysis with oblimin rotation. Each of these dimensions demonstrated acceptable Cronbach's alpha reliability and also discriminated effectively among respondents on the basis of their work locations and job positions. As expected, no effect of either gender, age, years of experience or education on employees' perceptions of the four climate dimensions were observed. On the whole, these findings indicate that the safety climate scale had satisfactory psychometric properties; implying that it can be used in the mining industry to periodically map the state of safety as assessed by the identified dimensions. Also for the subsequent study reported in the thesis, the findings allow further analysis involving the four identified dimensions to be carried out with some degree of confidence.

As a result, the relative importance of each of the identified safety climate dimensions to predicting employees' safety behaviour was examined in Paper II. This was done together with two other factors - safety attitudes and risk perception also known to influence behaviour. Results from the data analysis reveal that for aspects of behaviour considered, global safety climate emerged as the strongest predictor over demographics, safety attitudes and risk perception. However, not all safety climate dimensions contributed significantly in predicting each of the behaviours. Rather different sets of climate dimensions were found to be more salient for different types of safety behaviour. The implications of these findings in terms of how safety climate assessment can be used to guide the development of intervention programs and for future research have been discussed.

## **List of Papers**

This thesis is based on the following papers:

- I. Reliability and Discriminant Validity of a Safety Climate Measure in a Ghanaian Mining Industry
- II. Safety Climate, Attitudes and Risk Perception as Predictors of Safety Behaviours among Mine Workers

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# **PART I**

## 1. INTRODUCTION

### *1.1. Statement of problem*

Occupational safety problems continue to remain common in mining industries despite substantial efforts to ensure safer operations. Huge economic and personnel costs are currently being incurred by industries especially those in developing countries as a result of work-related injuries and diseases (Camm & Girard-Dwyer, 2005; Seo et al, 2004). All the factors responsible for these safety problems can certainly not be identified. However, it is known that some are due to conditions in the physical work environment and others to the human component of the work system. An important human factor in the chain of events that lead to various safety mishaps is employee behaviour.

From Maslow's theory of needs (Geller, 2001), self preservation may be expected to override other motives so that mine workers will engage in practices that protect them from exposure to the hazards inherent in their workplace and hence from injuries. Contrary to this, the literature is stacked with evidence of recklessness, safety rule violations, indifferent attitudes toward hazards and other forms of unsafe behaviour among workers (Laurence, 2005; Hobbs & Williamson, 2002; Lawton, 1998). These unsafe practices have been noted to account for quite a greater percentage of occupational safety incidents. For instance, Zohar and Luria (2003) identified that about 40% of work accidents result from workers' failure to use protective equipments. Implicitly, this suggests that if mine workers can be influenced to engage in safer rather than at-risk work behaviours, then a possible decrease in the rate of work-related injuries and diseases shall be achieved.

To promote sustainable change in the safety situations in mining industries, insight from other industries that operate in similar hazardous conditions such as the offshore oil companies (Tharaldsen et al, 2008; Rundmo, 2000; Mearns et al, 1997) and nuclear reprocessing plants (Findley et al, 2007; Lee, 1998) suggests that, creating and maintaining a positive climate for safety will be required. The safety climate of an organization refers to perceptions shared by workers regarding the overall importance accorded safety in their organization as compared to other priorities like work speed (Kath et al, 2010; Zohar, 2003; Griffin & Neals, 2000). It represents the overall mental framework that workers' have about how safety is treated during the day to day activities in their organization (Wills et al, 2004). The research literature has shown that, employees pattern their safety related behaviours to be in harmony with the climate they

perceive. As such an anticipated benefit of maintaining a positive climate for safety stem from the ability of mines with such climate to be able to increase the value function of safe work behaviours (Zohar, 2008). This will make complying with safety standards and undertaking of safety initiatives more rewarding for workers as well as expected among themselves.

A key to maintaining a positive safety climate is however having a tool that is able to; indicate the state of the prevailing safety climate at any point in time, identify aspects of the safety management system that need improvement and that can be used to monitor the effectiveness of interventions applied. A number of such safety climate measures have been developed and tested in other industries (Cooper & Philips, 2004). But in spite of the crucial nature of safety in their operations, mining industries have not been a common place for such studies. Also, almost all of those studies have been carried out in industries found in the Western and Eastern countries of the world including Australia, China, India, USA and UK. There is a paucity of similar investigations in Africa and for that matter Ghana.

For Ghanaian mining industries to benefit from the use of safety climate assessment as a proactive means to manage safety, there is therefore the need to develop or explore the psychometric properties of safety climate measures in that context. This is essential because measures from different cultures and industries cannot be assumed to apply equally valid in those settings; at least not when culture and industrial differences have been reported in previous studies (Vinodkumar & Bhasi, 2009; Coyle et al. 1995; Dedobbeleer & Beland, 1991) to influence the factor structure of safety climate.

In another respect, majority of previous studies using sample of workers from the manufacturing, health and construction industries have shown that positive safety climate is associated with increased compliance with safety standards (Wills et al, 2006; Seo, 2005; Clarke, 2006a); workers' participation in non-mandatory safety enhancing activities (Griffin & Neal, 2000; Pousette et al, 2008) and improved safety reporting culture (Kath et al, 2010; Hofmann & Stetzer, 1998). These notwithstanding, a small number (e.g. Neitzel et al., 2008; Glendon & Litherland, 2001) have failed to support such relationships. This makes it necessary to examine these relationships again using a sample of mine workers in order to establish the validity of safety climate as an important influence of employee safety behaviours as well as a leading indicator of occupational safety in mining industries.

The above are mine specific safety climate issues that need to be explored. Besides, there are also some gaps in the general safety climate literature that require research attention. Among the

research community, safety climate is widely acknowledged as a multidimensional construct that influences total industrial safety via its impact on employees' behaviour (Kath et al, 2010; Wills et al, 2009). In principle, organizations' efforts to improve safety climate will be strongest when they can identify specific aspects on which to focus activities. However, most researchers in examining the safety climate-behaviour relationship have treated the construct as a global indicator without consideration of its multidimensional nature. The findings from previous studies have only indicated that safety climate affects behaviour; but have failed to tell which safety climate dimension is important for what kind of safety behaviour and in which context. Meaning, the sort of pertinent information necessary for developing interventions is lacking.

As a result, using safety climate assessments as a guide for developing appropriate and efficient behavioural change interventions has been difficult over the years (Morrow et al, in press). In many settings where it has been assessed, the concern of practitioners as highlighted by Fleming and Lardner (1999) has always been that, while the assessment may indicate that something is wrong, it rarely provides insight on how to improve the situation. Putting this in another way, Gundulmund (2000) argued that, it remains to be shown how an accurate assessment of safety climate could be use as a guide in developing intervention strategies to improve the safety of organizations.

In spite of the growing interest in safety climate echoed in the research literature, this problem has received little attention in previous empirical investigations. Rectifying it will imply 'unlocking' the global safety climate construct as it has been used previously and then analyzing how its specific facets relate to aspects of safety behaviour. Specifically, it will involve answering the question: which safety climate dimensions significantly and strongly predict what kind of safety behaviour among workers and in what industrial setting?

Such an approach will also help clarify another issue identified by Clarke (2006). She noted in a meta-analytic study that, though safety climate accounted for substantial variance in safety behaviours, there were considerable variations in the strength of the climate-behaviour relationships. Possibly this may be due to methodological differences; one of which is the fact that different studies have assessed different safety climate dimensions. The scores on these dimensions are usually combined to form a global safety climate factor which is used in the analysis concerning the relationship between climate and behaviour. It can then be argued that, the relative strength of the safety climate-behaviour relationship is possibly dependent on the

particular dimensions selected to capture safety climate and hence the variations observed by Clarke (2006a). However, this has not been explicitly examined in the literature.

Another issue that requires attention is the relative influence of safety climate and its dimensions on safety behaviour when considered together with other factors also known to affect how employees act in relation to safety. Employee safety behaviour like other complex organizational phenomena is rarely dependent on one factor. Understanding the relative impact of safety climate will thus give an idea of how to pursue climate-driven interventions alongside other behavioural change initiatives or even select one intervention strategy over the other depending on the kind of behaviour that needs to be modified.

### ***1.2 Objectives and Research Questions***

In view of the above, this thesis aims to present the knowledge generated through research on how safety climate relates to the safety-oriented behaviours of employees in a Ghanaian mining industry; with special consideration of the limitations identified in the literature. The specific objectives of interest listed according to the constituent empirical papers were to;

#### **Paper I**

- 1) Assess the safety climate within a Ghanaian Mining industry
- 2) Determine the inherent dimensions (factor structure) of the safety climate scale used
- 3) Examine the reliability and discriminant validity of the identified dimensions of the safety climate scale

#### **Paper II**

- 4) Examine the relationship between global safety climate and safety behaviours among a sample of mine workers'.
- 5) Explore mine workers' attitudes toward safety as well as the level of risk perceived by them.
- 6) Investigate the relative strength of the relationships between safety climate dimensions and safety behaviour when examined together with safety attitudes and risk perception.

These aims were pursued to address questions such as;

- a) Will the psychometric properties of the safety climate scale employed be satisfactorily when used in a Ghanaian industrial context?

- b) Will the relationship observed between employees' safety climate perceptions and their safety behaviour be confirmed among a sample of mine workers from Ghana? Finding support for this relationship will somehow justify the use of safety climate as a leading indicator of safety conditions in the mining industry.
- c) How do specific dimensions of safety climate relate to employees safety behaviour? OR do the relative strength of the relationships between specific safety climate dimensions and aspects of safety behaviour differ? The answer to this question will help determine which climate dimension is more salient for which kind of behaviour and hence provide an idea of what to focus attention on during safety climate driven behavioural change initiatives.
- d) How does safety climate relate to safety behaviour in the context of other behavioural influences (i.e. safety attitudes and risk perception)?

## **2. THEORETICAL FRAMEWORK**

Over the years, various researchers have defined and assessed safety climate differently. In this section, the construct as conceptualized and operationalized in the two empirical papers of the thesis will be discussed. To begin, the broader theoretical framework - organizational climate from which the construct was derived will be examined briefly.

### ***2.1. Overview of Organizational Climate***

‘Climate’ is a meteorological term that refers to conditions of the atmosphere prevailing at a particular location over a period of time. According to Arvidsson (2006), this term was borrowed into psychology by Lewin and his colleagues to specify how certain psychological conditions influence the motivation and behaviour of individuals within a social unit. Following the initial application, other scholars within the social sciences adapted and over time formulated different conceptualizations of the term climate.

Currently, climate as it is used in organizational psychology refers to employees’ shared and enduring molar perceptions of the psychologically important aspects of their work environment (Parker et al, 2003; Ashworth, 1985). It pertains to the shared descriptions of what workers see happening to them in their workplace. Humans are not only active perceivers; but also interpreters who attach meanings to what they observe. With regards to climate perceptions, the attached meanings as argued by Schneider (1990) indicate to workers what it is that is valued within their organization and also channel their energies and competencies toward achieving those valued outcomes. By this, climate functions as a mediator between the work environment and workers responses. It is neither the objective environment itself nor an individual’s response to it.

### ***2.2. Formation of Organizational Climate***

As highlighted by the definition above, the foremost feature of the organizational climate construct is its ‘sharedness’. Thus climate is an emergent property characterizing group of individuals (Zohar, 2003). Within the literature, various theoretical explanations have been proposed regarding how these shared perceptions emerge among employees.

According to a structuralist perspective, climates emerge as a result of the objective features of an organization (Ashworth, 1985). Such features include the size of the organization, degree of centralization, the basis for subunit groupings and so on. It is believed that, these structures restrict the expression of individual differences in workers’ description of their organizational situation

such that the exposure to similar context leads to similarity in perceptions. Dejoy et al's (2004) observation of relationships between certain objective features of an organization and the climate perceptions of its members to some extent provide support for this perspective on climate formation.

From another angle Schneider and Reichers (1983) argue that, climate is formed through an attraction-selection-attrition (ASA) process. This implies that, individuals' attraction to an organization combined with the selection procedures of that specific organization and the attrition of employees who may not share the values of the organization results in the creation of a social unit with relatively homogenous membership. It is this similarity in the personality and values of members that cause their individual perceptions to be shared.

After proposing the ASA, Schneider as noted by Ashworth (1985) later extended it into what can be considered the third perspective on climate formation. The extension was that the similarity in members' characteristics leads to likening and then frequent interaction among themselves. From the concept of symbolic interactionism (Blumer, 1969), these daily interactions with each other actually involve the exchange of experiences as a result of which organizational members modify the meanings that they have individually attached to various organizational events. Over time shared meanings of the organizational attributes and events are believed to emerge. It is the shared meanings that create a consensual agreement among members regarding what it is that is valued in their organization. Thus according to the interactionist perspective, climate perceptions are 'socially construed' by individuals in their attempt to understand their organization and their roles within it (Zohar and Luria, 2005).

### ***2.3. Attributes of Climate***

The essence of conceptualizing climate as a shared or group level construct is that, though the source of data during research is the individual, the unit of analysis can be at levels higher than the individual level. Meaning, the climate scores of individuals can be aggregated to the level of the entire organization, departments or work group and the mean of the aggregated scores used to represent the climate for that chosen unit. This practice is very common throughout the literature even though some scholars also study climate perceptions at the individual level. When investigated at this lower level, the climate construct is qualified as *psychological climate*; a term considered as distinct from organizational climate which denotes a group-level phenomenon (Zohar, 2003).



To justify the aggregation of climate scores during empirical investigations, three validating criteria are expected to be satisfied. The first of these criteria as outlined by Zohar (2003) is the evidence of sufficient within-unit homogeneity. This implies there should be support based on the data to be aggregated that, members belonging to the same group of a chosen analytical unit share their climate perceptions. The degree of sharedness in most instances is determined using indexes of agreement such as interclass correlation (ICC) and within-group correlations ( $R_{wg}$ ; James et al, 1993). Regarding the within-group correlation which is commonly used, a heuristic coefficient of 0.70 and higher is considered sufficient evidence to warrant aggregation of individual responses.

The second validating criterion concerns the existence of between-group heterogeneity. With this, it is expected that the aggregated scores of two different groups of the analytical level of interest should differ to some extent. For example, if the chosen unit of analysis in a climate study is the organization, then it is expected that different organizations should differ in their aggregated scores. Lastly, to warrant aggregation it is argued that the chosen unit of analysis should correspond with naturally existing social units such as organizations, departments or work group (Zohar, 2003). Satisfying this last criterion upholds the interactionist explanation of how shared climate perceptions emerge. That is, there must be some form of interaction and exchange among members whose scores are to be aggregated.

From the ensuing discussion, organizational climate as a construct and any of its derivatives can be described with two parameters. The first is the value of the mean score obtained after aggregating the individual scores to the preferred level of analysis. This is known as *climate level* and can be high or low. The second index is known as *climate strength* and it concerns the degree of ‘sharedness’ of climate perceptions among members belonging to the same group or unit. It can vary from weak to strong.

#### ***2.4. General versus Facet Specific Climate***

Organizational climate as defined earlier also pertains to employees’ perceptions of the “psychologically important” aspects of their work environment. A good number of such aspects may exist in any workplace and are inferred from the policies and practices within the organization. In most cases, organizations pursue multiple goals and specific policies and practices are usually developed to outline the means of attaining each of them. As such, workers may develop multiple climate perceptions.

Considering this, Schneider (1975, 1990) proposed that instead of approaching climate research from a general perspective encompassing all possible aspects of the environment, investigations should be strategically focused. Thus, researchers were to focus on specific organizational goals and assess a *climate for something* rather than an all-inclusive climate construct. The impetus for approaching climate study this way is that each facet specific climate should be able to predict outcomes related to its domain better. For instance, a climate construct focusing on service is expected to be a better predictor of customer satisfaction than a more general one.

On the whole, the proposal seems to have received much acceptance among the research community and a lot of facet specific climates are now being reported in the literature. These include the climate for; service (Schneider, 1990; 2000), ethics (Grojean, 2004; Peterson, 2002), safety (Vinodkumar & Bhasi, 2009, Tharaldsen, Olsen & Rundmo, 2008; Zohar, 2000) and innovation (Arvidsson et al, 2006). Though some scholars continue to study climate in its general sense, the current prominence of the facet specific climates has made the term ‘organizational climate’ appear more as a concept or a research domain when used in the literature than as a construct.

### ***2.5. Safety climate***

Obviously, safety climate (Zohar, 1980) is a facet specific type of organizational climate strategically focused on occupational safety. As a derivative of organizational climate, it is group level variable and can be considered as employees’ shared perceptions of the safety policies, procedures and practices in their organization. These key safety elements according to Zohar (2003) may be present in two kinds – a) the formally declared types which are often in the form of explicit statements or written documents and b) the enacted types which are those actually enforced on the shop floor during the day to day activities of a company. From a functional perspective, safety climate as assessed in the empirical sections of this thesis pertains to the enacted or enforced safety policies and practices.

Workers get to know these enacted policies and practices by observing the ways in which other people in the workplace act in relation to safety. This includes how supervisors react to unsafe practices, the commitment of management to safety, the rate at which worn-out protective equipments are replaced and the state of safety inspection (Vinodkumar & Bhasi, 2009). Perceiving such attributes informs workers about the overall importance accorded safety in their workplace as compared to other priorities like work speed (Neal & Griffin, 2000). It cues them regarding the extent to which safe behaviours are supported, rewarded and hence expected;

thereby helping workers to discern the probably consequences of their own behaviours concerning safety.

## **2.6. Safety Climate Assessment**

### *2.6.1. Dimensions*

Assessing the safety climate within an industry gives a snap shot of the state of safety at a given point in time from the perspective of the workforce. For practitioners, such an indication may serve as a warning signal pointing out the need for a change in the way safety is operationalized and managed in the organization.

Safety climate is usually assessed by way of a questionnaire survey on which workers are asked to indicate the extent to which various items characterized how safety is been treated in their workplace. Zohar (1980) was the first to develop such a survey. Through a review of literature, he identified certain characteristics that differentiated between high and low accident rate industries. Based on that, a 49 item questionnaire was developed and administered to a pilot sample of 120 Israeli workers. Following factor analysis of the resulting data, eight dimensions of safety climate were identified. These were labelled perceived; importance of safety training programs, management attitudes toward safety, effects of safe conduct on promotion, level of risk at work place, effects of required work pace on safety, status of safety officer, effects of safe conduct on social status and status of safety committee.

Brown and Holmes (1986) tried to validate this structure among a sample of manufacturing workers in North America. Using the same instrument, they found support for only three dimensions which were identified as; management concern, management activity and risk perception. Among another North American sample, Dedobbeleer and Béland (1991) who used the same questionnaire found a two factor solution - management commitment and worker involvement as more appropriate.

Coyle et al (1995) also attempted to find consistency in safety climate dimensions by developing and administering the same measure to workers from two Australian health institutions. When each institution's data was factor analyzed, the results indicated that a seven factor structure was most appropriate for one hospital whiles for the other hospital a three factor structure was deemed appropriate.

Over the years, several other measures have been developed by various researchers. As evident in Table 1 on the next page, these instruments have produced significantly different number and kinds of safety climate dimensions. Some of the observed variations in the extracted dimensions have been attributed to the differences in the cultural and industrial background of the samples on which the measures were tested (Cooper & Philips, 2004). Also the developmental history of the measures – either through review of research literature, accident reports or through interviews have been argued to have an impact on the items included and hence the factors extracted (Flin et al., 2000).

These reasons notwithstanding, the conceptual ambiguity surrounding the safety climate construct may be responsible for a greater percentage of the discrepancies in safety climate dimensions reported over the years. A number of researchers failed to distinguish between the safety climate and other closely related constructs. As a result, safety climate has most often been operationalized with items that do not belong to it as a derivative of organizational climate (Zohar, 2003; 2008; Neal & Griffin, 2002). For instance, the construct has usually not been distinguished from its consequences or outcome variables. This has led to the inclusion of items pertaining to; safety satisfaction, workers' participation in safety activities and violations of safety rules (e.g. Cox & Cheyne, 2000) on scales designed to measure safety climate.

Also, in most studies safety climate has been treated as synonymous to safety culture. However, reviews by Neal and Griffin (2004) and Guldenmund, (2000) suggest that the two constructs are distinct even though they are closely related. Safety climate as considered earlier refers to employees shared perceptions of the overall importance accorded safety and it is a derivative of the organizational climate concept. On the other hand, safety culture stems from the concept of organizational culture which has its root in anthropology. This concept concerns why an organization operates the way it does; thus encompassing why certain behavioural safety norms may exist in the organization and not just the descriptive information about the norms (Patterson et al., 2005; Guldenmund, 2000).

That is, safety culture is a broader concept that incorporates safety climate in addition to other constructs like attitudes and values. Failure to distinguish between the two constructs has led to the operationalization of safety climate with items pertaining to the other aspects of safety culture. As a result, factors like scepticism and risk justification (Williamson et al., 1997) have been reported in the literature as dimensions of safety climate even though they pertain to safety attitudes. According to Clarke (2006b), most of what are considered as safety climate scales

**Table 1: Safety Climate Dimensions Identified in Previous Studies**

Research Team	Industry (country)	n	Item Source & number	Dimensions
Cox and Cheyne (2000)	Offshore Oil Industry - (UK)	221	Literature review, Focus group discussion 43 items	Management commitment, , Communication, Priority of safety Safety rules, Supportive environment, Involvement in safety, Personal Priorities and need for safety, Personal appreciation, Work environment
Glendon & Litherland (2001)	Construction, Maintenance (Australia)	198	Glendon et al (1994) 40 items	Communication and support, Work Pressure, Adequacy of procedures, Personal Protective Equipment, Relationships, Safety Rules (factors overlapped with those of the original scale)
Wills et al (2005)	Fleet safety (Australia)		Modified version of Glendon's (2001) scale 32 items	Management commitment , Communication & procedures, Work pressure, Relationships, Training, Safety rules (some factors overlapped with original scale)
Vinodkumar & Bhasi (2009)	Chemical Industry (India)	2536	Literature Review 82 items	Management commitment and actions for safety, Workers' knowledge and compliance, Worker safety attitude, Worker participation and commitment to safety, Safeness of work environment, Emergency preparadness, Priority for safety, Risk Justification
Varonen & Mattila (2000)	Sawmills, plywood Industry (Finland)	548	Seppala (1992) 32 items	Organization responsibility, Workers' safety attitudes, Safety supervision, Company safety precautions (factors were similar to those of the original questionnaire)
Lu & Shang (2005)	Shipping (Taiwan)	112	Literature review 37 items	Supervisor safety, Co-worker' safety actions, Job safety / risky, Safety management, Safety training, Safety rules, Job pressure

**Table 2 cont'd**

Research Team	Industry (country)	n	Item Source & number	Dimensions
Lee (1998)	Nuclear Reprocessing plant (UK)	5296	Literature review , Focus group 172 items	Procedures, Risk, Safety system, Job satisfaction, Rules, Competence, Participation, Safety system, Design
Cox and Cox (1991)	Gas company depots (Europe)	630	Literature review 18 items	Scepticism, Responsibility, Work environment, Safety system, Personal immunity
Mearns et al (1997)	Offshore Oil Industry UK	722	Literature review , Focus group 52 items	Communication, Supervision, Safety reporting, Violations, Rules / Regulations, Site management, Work pressure, Work clarity, Risk, Safety measures
Diaz and Cabrera (1997)	Airport (Spain)	166	Literature review, Brainstorming 40 items	Safety policy, Productivity & Safety, Group attitudes, Prevention strategies, Safety levels
Williamson et al (1997)	Manufacturing (Australia)	660	Literature Review 27 items	Personal motivation, Positive safe practice, Risk justification, Fatalism / optimism
Tharaldsen, Olsen & Rundmo (2008)	Offshore (Norway)	3310	NORSCI 32 items	Safety Prioritisation, Safety management and Involvement, Safety versus Production, Individual motivation, System comprehension
Lin et al (2008)	Electrical construction, Oil refinery (China)	1026	Literature review 21 items	Management support, Communication, Safety awareness, Organizational environment, Risk judgement, Safety Precautions, Safety training

actually assess safety attitudes or a mixture of attitudes and perception instead of assessing safety perceptions alone.

Theoretically, this has a negative implication for the validity of safety climate as a construct. Data obtained by using such measures have normally been reported to have lower criterion validity with safety outcome variables (Clarke, 2006b). Therefore on grounds of validity scholars like; Zohar (2003) as well as Neal and Griffin (2002) have advocated that instruments developed to measure safety climate should not be confounded with items pertaining to other aspects of safety culture. Rather such aspects of safety culture should be treated as independent factors that also influence occupational safety in their own right.

Consequently, the current research was designed with the distinction between safety climate and closely related constructs in mind. Safety climate as employed in the empirical sections is considered as distinct from safety attitudes, risk perception and safety behaviours. It refers to a situational factor which is external to the worker. Respondents to the safety climate measure were therefore considered as observers of what happens within their work area and were expected to report on what was normally done with regards to safety (or how safety issues were generally treated in their work area).

On the whole, there is currently no consensus regarding the definite primary dimensions which form the safety climate construct. However, it is worth noting that the multidimensional nature of the construct has always been supported. Across a large majority of the previous studies, some common themes seem to have reoccurred. These include aspects pertaining to management commitment (Vinodkumar & Bhasi, 2009; Lin et al, 2008; Wills et al, 2005; Cox & Cheyne, 2000; Zohar, 1980), supervisor safety (Lu & Shang, 2005; Hayes, et al. 1998; Mearns et al, 1997), co-worker safety (Varonen & Mattila, 2000; Hayes, et al. 1998; Diaz & Cabrera, 1997, Zohar, 1980) and communication (Wills et al, 2005; Glendon & Litherland, 2001; Mearns et al, 1997).

#### *2.6.2. Universal versus Industry Specific Indicators of Safety Climate*

According to Griffin and Neal (2000) the primary safety climate dimensions together form a high order construct – safety climate which gives an overall indication of the priority of safety in a work unit. However, like other organizational assessments, it is the purpose that determines whether specific first-order or a high order construct is appropriate (Griffin & Neal, 2000). In this thesis emphasis is laid on the specific first order factors and their relative impact on safety behaviour.

These first order factors as noted by Zohar (2008) can be subdivided into universal versus industry specific. Universal safety climate dimensions refer to those that cut across all industries or are applicable in all work sectors where safety is relevant. They include: management and supervisors value for safety. On the contrary, industry specific factors apply to particular industries because of the nature of the tasks being carried out in such workplaces. Example includes the emphasis on universal precautions against pathogens in health institutions (Dejoy, 2004). In determining whether an instrument should emphasize on universal or industry specific safety climate indicators, a researcher is often required to be guided by the nature of the target population in which the assessment is to be carried out and applied.

### ***2.7. Safety Behaviours***

Safety behaviour as conceptualized in this thesis encompasses all the activities undertaken by individuals in their workplace to ensure their personal safety, the safety of their co-workers and the safety of their organization at large. Referring to such activities as safety performance, Burke et al (2002) in two studies identified four components of safety behaviour. These components concerned workers'; use of personal protective equipments (PPE), engagement in workplace practices to reduce risk (PRR), dissemination or communication of health and safety information (CHS) and lastly exercise of their rights and responsibilities (ERR).

Marchand et al (1998) and Neal et al (2000) also conceptualized safety behaviour as comprising of two components which they termed safety compliance and safety participation (or initiatives). Safety compliance according to these models refers to the mandatory activities that workers need to perform to bring about workplace safety. Usually such activities offer direct personal protection for the worker. It includes activities like following safety standards and using the correct PPE.

Safety participation on the other hand, involves 'activities that may not directly contribute to an individual's personal safety, but which do help to develop an environment that supports safety' (Neal & Griffin, 2002). Such activities are usually not mandatory within a workplace and individuals perform them at their own discretion. They can thus be considered as 'safety specific citizenship' behaviours with examples being; identifying and reporting hazards, making suggestions to improve safety and correcting colleagues who engage in unsafe acts.

These two factor models of safety behaviour proposed by Neal et al (2000) and Marchand et al (1998) are similar to the distinction usually made in the job performance literature between task and contextual performance (e.g. Borman & Motowidlo, 1993). Also when considered carefully, it subsumes the components of Burke et al's (2002) four factor model of safety behaviour. The safety



compliance component is similar to PPE and PRR in the four factor model while safety participation overlaps with the other two components - CHS and ERR.

In all, it is considered that there are at least two dimensions of safety behaviour. Similar to job performance in general, Ford and Tetrick (2008) asserted that, workers' safety oriented behaviour can be scaled by the extent to which they engage in actions that promote safety and avoid those that decrease safety. In previous studies this frequency or rate of safety behaviours have been mapped through direct observation ( Glendon & Litherland, 2001) and by questionnaire assessment of near misses (Seo et al, 2004), unsafe practices (Hoffman & Stetzer, 1996; Brown et al, 2000), workers' safety compliance and safety participation (Cheyne et al, 1998; Neal et al., 2000) as well as workers' propensity to actively care about the safety of others (Geller et al, 1999).

## ***2.8. Antecedent of Safety Behaviour***

### *2.8.1. Safety Climate*

Irrespective of how safety behaviour is measured, there are more theoretical reasons to expect it to be affected by the climate for safety that exists in a particular workplace. Two of such reasons are derived from the social exchange theory (Blau, 1964) and the expectancy – valence theory (Vroom, 1964).

Social exchange theory has it that, if one party acts in a way that benefits another, an implicit obligation to reciprocate is created. This implicit obligation overtime results in actions undertaken to benefit the initiating partner. Within the workplace, Tsui et al (1997) reported that employees may reciprocate the benefits they enjoy by performing their core tasks at a high standard and also by carrying out citizenship activities.

While no organization enters into business because of safety, it is expected that safety of workers are given at least the same priority as other issues. Safety climate as already noted is anchored in enacted safety policies and practices. By perceiving these attributes, workers get to know the extent to which their safety is of value to their managers, supervisors and co-workers. Based on the principle of social exchange therefore, workers who perceive that other people in their organization are concerned about their safety would reciprocate in safety related exchanges like complying with established safety standards as well as actively caring for the safety of their colleagues

In another sense, safety climate influences behaviour – outcome expectancies. Workers through their climate perceptions are informed of the overall importance place on safety in comparison to other priorities like work speed. This provides them with cues regarding behaviours and outcomes that are deemed acceptable and expected in their workplace. Also, it informs them of the possible

consequences of their own actions; as to how others will react in response to those actions and whether such actions will contribute to realizing the outcomes valued in the workplace.

Based on expectancy – valence theory (Vroom, 1964), it can be anticipated that workers will be more motivated to comply with safety standards and engage in safety promoting activities if they believe that these behaviours will be valued and will contribute to achieving the outcomes considered as important in their workplace. By this workers within settings with higher levels of safety climate are more likely to engage in safety oriented behaviours than those who are not. Thus, safety climate levels are expected to positively correlate with safety oriented behaviours and vice versa.

Among a sample of hospital workers, Neal, Griffin and Hart (2000) found support for a positive and significant relationship between perceptions of overall safety climate and workers motivation to act safe as well as learn about safety. Climate perceptions were also found to be related to self reported participation in safety activities like voluntarily carrying out tasks to improve safety. Similarly, Cheyne et al (1998) reported a positive relationship between climate perceptions and employee safety involvement.

Using a more direct measure of behaviour Glendon and Litherland (2001) found a weak non-significant relationship between safety climate factors and the observed safety compliance among maintenance and construction workers (explaining 5.9% of the variance). Other studies (e.g. Morrow et al, in press; Wills et al, 2006; Clarke, 2006a) have however reported a significant positive relationship between safety climate and safety compliance. Also climate has been found to influence the propensity of workers to report injuries as well as to voice out their safety concerns (Kath et al, 2010; Hofmann & Stetzer, 1998). Safety climate has also been reported to correlate negatively with safety outcomes like accident and injury rates (Clarke, 2006; Johnson, 2007; Zohar, 2000, Hoffman & Stretzer, 1996). These linkages may be moderated by behaviour and they provide support for the validity of safety climate as a construct that is able to reflect and influence the level of industrial safety.

### *2.8.2. Attitudes and Risk Perception*

Like other complex organizational phenomena, safety behaviour is hardly influenced by a single factor. This is evident in models like the theory of planned behaviour (Ajzen, 1991) proposed to examine the various factors that possibly influence behaviour. In order to examine the relative importance of safety climate, other factors already linked to safety behaviour were incorporated into the model explored in this study. Based on the theory of planned behaviour (Ajzen, 1991) and the

protection motivation theory (Glendon & Mckenna, 1995), attitude towards safety and risk perception respectively were inculcated as the other behavioural influences.

It must be mentioned that some previous studies have considered safety attitudes and risk perception as dimensions of safety climate. However as argued by Zohar (2003) as well as Neal and Griffin (2004), these are person related variables that needs to be considered as separate antecedents of safety behaviour in their own right. Safety climate as conceptualized in this thesis is a situational factor that pertains to workers report of how safety is treated in their workplace or what is considered the normal safety practices in their workplace. It is thus external to the worker who responds to the safety climate survey. On the other hand risk perception captures the extent to which workers see their physical work environment as dangerous. Safety attitudes is also distinct from safety climate in that it pertains to a workers' own belief and feelings about safety related practices, policies and procedures. On the whole, the overriding aim of determining the impact of safety climate on technical mine workers' safety behaviours in the context of other known behavioural influences can be summarized in a heuristic model as;

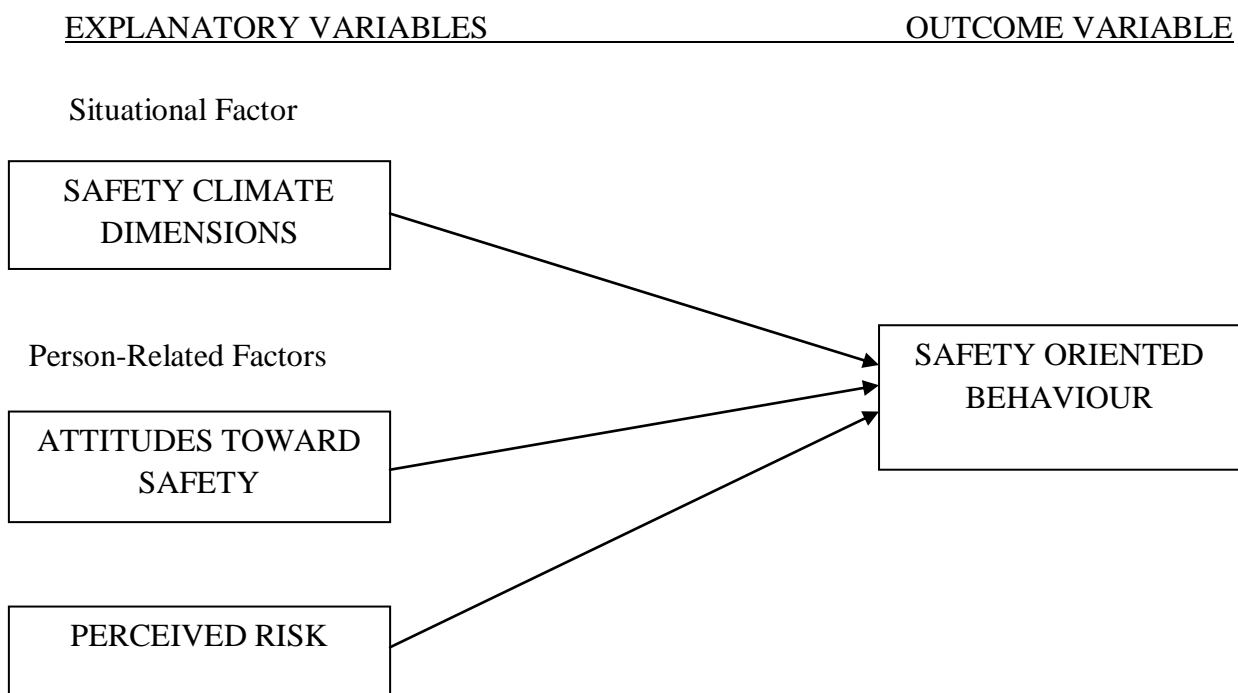


Fig. 1 A heuristic model for examining the relative influence of safety climate on safety behaviour

### 3. METHODOLOGY

The research presented in this thesis is of a cross sectional survey design in which structured questionnaire was used to collect data from respondents. Being quantitative in nature, its general epistemology is rooted in the psychometric theory of measurement. As such a brief presentation of the theory would be provided before discussing issues pertaining to the research setting, characteristics of respondents and ethics.

#### *3.1. Psychometric theory of measurement*

The basic concern of the theory is to make sense and derive knowledge about psychological and social phenomena by quantifying them. Psycho-social phenomena like safety climate are abstractions that do not exist in observable forms. These abstractions (also known as latent variables) are usually attributes of a person, group or an organization and are believed to have the capacity to vary. Considering the point that these phenomena can change, the major task during psychometric assessment is therefore to determine the level of the phenomenon present at a particular point in time. The focus is usually not on why the phenomenon is present. As such before assessing any variable, a researcher is required to theoretically specify the ‘why’ of the phenomenon and how it may be related to other latent variables. That is, the phenomenon to be assessed should be embedded in a theoretical model (Netemeyer et al, 2003).

Psycho-social phenomena by their abstract nature can only be assessed indirectly. Such indirect assessment in psychometrics is accomplished via self report measures with multiple items, indicators or descriptions pertaining to a phenomenon of interest (Netemeyer et al, 2003). The collection of items is referred to as a scale and people’s responses to the items are called scores. A scale is thus supposed to reflect the latent variable of interest. It is this variable that is considered to be the cause of the item scores. Meaning, the response option a person selects on a scale is as a result of the level of the psychosocial phenomenon experienced. This also implies that the latent variables explain the variance in item scores.

In that respect, the numbers that are used in psychometrics as Stiles (2006) puts it are signs; which like all other signs point to something besides themselves. The ‘something’ in this case is the latent variable of interest during assessment. By being stable, precise and manipulable (able to be manipulated), numbers when employed in studying phenomena in an organizational context allow for easy comparison, mapping of trends as well as establishing of relationships

between latent variables. In a sense they help to extrapolate how aspects of the work environment may influence say employee functioning.

In developing a scale to measure a psycho-social construct, psychometrics require such a construct to be precisely defined and distinguished from other constructs (Netemeyer et al, 2003). Precisely operationalizing a construct helps to specify the kind of items that qualify to be included in the scale and hence improve the adequacy of the scale to reflect the targeted latent variable.

Generally, the extent to which a scale is adequate is determined by how valid and reliable it is. The validity of a scale concerns the extent to which the scale measures what it is supposed to measure (Coolican, 1999). There are a number of validities including content validity and discriminant validity. Content validity captures the extent to which items of a scale are relevant to the targeted variable while discriminant validity requires that scales do not correlate too highly with other scales from which it is supposed to differ.

On the other hand, reliability refers to the ‘degree of interrelatedness among a set of items designed to measure a latent variable’ (Netemeyer et al, 2003). It is usually assessed with Cronbach’s coefficient of alpha and can range from 0.0 to 1.0. A higher reliability indicates that items on a scale are consistent with each other and might be assessing the same latent variable. And a lower reliability signifies the items on a scale may be assessing multiple latent variables. Normally scales are expected to have high reliability value as well as good discriminant validity as initial justification of its usefulness. In view of this, various statistical tests were performed in this thesis to ensure that the scales used were psychometrically sound.

### ***3.2. Research Setting, Population and Sample***

The setting for the research project was a mining industry situated in the Ashanti region of Ghana. The employees in this mine cut across a broad spectrum of job categories. However for the purposes of the research, the group of interest were the technical mine workers which include;

- a) Individuals who perform more traditional mining-related duties such as surveying, blasting, drilling and processing as well as
- b) Individuals employed in the mine to repair and maintain equipments. Examples of such workers are; machinists, electrical workers and sheet metal workers.

It must be noted that administrators, clerical staff, security personnel, caterers and hospital staff were not part of the targeted population.

Within the industry, the typical locations for the technical workers are the shafts, workshops and the processing plants. Fifteen of such locations were selected such that the major professions classified as technical work group were represented. Each of these work locations was headed by a manger (hereafter referred to as supervisor) responsible for all the tasks carried out within the work location. They were also in charge of forming teams or crews to carry out various projects. Among the workforce another group of individuals known as foremen also performed the role of crew leaders. Specifically, the targeted population for this research were all the technical workers (foremen and frontline operators) present in the 15 selected work locations at the period of data collection.

In all three hundred (300) questionnaires were given out and 277 representing a response rate of 92% were retrieved. The questionnaires completed by ticking the same response option in all questions or completed by non-technical workers such as clerical staff were discarded. As a result, the sample size for the data analyses was reduced to 273 workers. Of this, the maximally and minimally represented work units had 38 and 7 respondents respectively. Table 1 and 2 depict the number of respondents from each work area and the demographic characteristics of the respondents respectively.

Table 3: Distribution of the 273 Respondents by Work Area

Work Area	Number of Respondents
1. Adansi Shaft*	24
2. CIC	11
3. Electrical Workshop	38
4. Equipment Rebuild	8
5. Engineering Training	11
6. George C. Shaft*	20
7. Kwasi Mensah Shaft*	31
8. Machine Shop	16
9. MBC*	14
10. Geological Survey/MRM	21
11. Plate shop	12
12. Mining Training	10
13. Sansu Shaft*	13
14. SHE**	7
15. Sulphide Treatment Plant	37

\* Respondents from the various shafts are those who perform the more traditional mining related duties. They include blast men, jack hammer operators and drillers.

\*\* The workers from the SHE department included in this study were those who conduct safety inspection in the various workshops and underground mines during every shift

Table 2: Demographic characteristics of respondents

Demographics	N	% of respondents
<b>Gender</b>		
Male	264	96.7
Female	9	3.3
<b>Age</b>		
18-29	73	26.7
30-39	90	33.0
40-49	87	31.9
50+	23	8.4
<b>Educational Level</b>		
Basic	79	28.9
Secondary	69	25.3
Professional	66	24.2
Tertiary	59	2.6
<b>Years at Current Unit</b>		
Less than 1 year	43	15.8
1-5yrs	53	19.4
6-10yrs	67	24.5
11-20years	76	27.8
21 <sup>+</sup>	34	12.5
<b>Position</b>		
Foreman	32	11.7
Frontline Operator	241	88.3

### 3.3. Instrument

A five sectioned questionnaire was used in the research process to collect data regarding safety climate, safety attitude, risk perception, safety behaviour and demographics. In constructing this questionnaire, both new items as well as items from previous surveys by other researchers were used. Items adapted from previously validated surveys were either used verbatim or rephrased in a more simple language to clarify their meaning.

Owing to the fact that the study questionnaire was new, no previous studies had examined its reliability or validity. Hence its reliability and validity assessment formed a key component of the data analysis. It must however be stated that before using the questionnaire two safety officers from the industry where the study was conducted reviewed it to assess its face and content validity. The various sections of the study questionnaire with their descriptions are;

- *Safety Climate*

Section A of the study questionnaire consisted of 21 items assessing respondents' safety climate perceptions. Some items on this scale were selected from the group level safety climate scales by

Zohar (2000, 2003) as well as Burt et al's (2008) CARE scale. With the work area as the unit of assessment, the selection and rewriting of items for inclusion on this scale was guided by some principles such that organizational level items like those pertaining to top management commitment to safety were not included.

Also, only items measuring respondents' perceptions rather than their own attitudes or behaviours were added. This was because as noted by Neal & Griffin (2000) previous scales have confounded the safety climate construct with items pertaining to employees' personal attributes. Such scales in essence measure employees' actions, feelings and beliefs about safety; all of which reflects constructs different from safety climate whose essence is to capture the descriptive norms about safety in a work place. Respondents in this study were thus considered as observers of what happens within the work area and the items were structured to elicit their report on what was normally done with regards to safety (or how safety issues are generally treated in their work area). Also, due to the nature of the target population, the scale only consisted of universal safety climate indicators (see section 2.5).

All the 21 items on the scale were rated on a 5-point Likert response scale ranging from 1 (strongly disagree) to 5 (strongly agree) and were scored in such a way that higher values corresponded to a higher level of positive safety climate.

- *Safety Attitudes and Risk Perception*

Items from Rundmo's (1998) Health, Safety and Environment scale were adopted to assess safety attitudes and risk perception. Safety attitudes which concern respondents' personal beliefs and feelings about accident prevention, safety activities and safety rules were assessed by seven (7) items. Responses to these items were made on a five point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Majority of the items were negatively worded and as such disagreement with any of them was considered an idea attitude and hence attracted a higher score.

Regarding risk perception, only the cognitive aspect but not the emotional component was of interest. Four items were used to measure respondents' assessment of the probability of themselves or their co-workers being injured at the workplace, the severity of such injuries should they occur and how dangerous their work area is compared to other sections of the Mine. Responses were made on a five point Likert scale with higher scores indicating a greater degree of perceived risk.



- *Safety Behaviour*

This was assessed by eight (8) items that asked respondents to indicate the extent to which they engaged in various safety-related practices such as wearing PPE, reporting colleagues who break safety rules to supervisor etc. Ratings were done on a four point Likert scale ranging from Never (1) to Very Often (4).

**Scoring:** For each of the variables considered in this study, a respondent's score was represented by the mean score of the various items making up that specific variable.

### ***3.4. Procedure and Ethical consideration***

Approval to conduct the study in the selected setting was granted by the industry through its Safety, Health and Environment (SHE) department. Following this, the supervisors of the selected work areas were contacted and specific periods agreed upon for the data collection. Within the Mine, units hold safety meetings at the beginning of each day's work. So on the designated survey day for a particular work area, potential respondents were met at the end of their units' safety meeting. A brief introduction of the study (i.e. its aims, what was expected of participants and the voluntary nature of participation) was made and questions from the workers were answered accordingly. The study questionnaire and pens were then distributed to workers who were willing to participate.

Each questionnaire had a cover sheet that again reiterated all ethical conditions under which the survey was being conducted. It was stated that participation was completely voluntary and that workers decision to participate or not will have no influence on their employment. The anonymity as well as confidentiality of respondents was assured. To this end, there was no requirement for the respondents to put their name or ID number on the questionnaire. Also, demographic information was collected using aggregated (continuous) scales in order to maximise participants' anonymity. Collecting demographic information this way contributed positively to the response rate because workers who were initially reluctant to participate later decided to complete the survey upon realizing that it was not easy to identify them by their completed questionnaires.

Respondents who were proficient in English language filled the questionnaire on their own whiles the few with poor literacy skills responded to a questionnaire interview in which the local dialect (Twi) was used. The time allotted for the completion of the questionnaire varied from 15 to 20 minutes depending on the work area and respondents' level of education. The research

team (two assistants and I) stayed with respondents throughout this period to clarify issues as well as collect completed questionnaires. In situations where respondents in a unit could not complete questionnaires within the stipulated time, they were allowed to keep and complete it. Such questionnaires were given to a specific person within the unit for retrieval by the research team later on the same day.

### 3.5. Data Analysis

The collected data was prepared for statistical analysis by coding them into SPSS 16.0 data file. Reverse-worded items on the questionnaire were re-coded. The means, standard deviations and ranges of reported values were then examined to ensure that all the data were appropriately entered. Missing data analysis was also performed to determine the percentage and pattern of missing data. The analysis revealed that none of the items in the study had more than 5% missing values and also the pattern of missing data was completely random. As such missing data were excluded list wise throughout the analysis as recommended by Peng et al (2003).

Following this, separate principal component analyses (PCA) were conducted to explore the dimensional structures of the major study variables. this helped to reduce the large number of items into small more manageable factors. Internal consistency reliability of each identified factor was determined by calculating for Cronbach's alpha ( $\alpha$ ).

#### *Additional analysis*

In Paper 1, scores on the safety climate dimensions identified were aggregated at the working unit/location level. Estimates of inter-rater agreement  $r_{WG(J)}$  (James et al. 1993) were calculated for each work area per climate dimension to test within unit homogeneity in climate perceptions. The formula used to estimate the inter-rater agreement was:

$$R_{WG(J)} = \frac{J [1 - (\overline{s_{xj}^2} / \sigma_{EU}^2)]}{J [1 - (\overline{s_{xj}^2} / \sigma_{EU}^2)] + (\overline{s_{xj}^2} / \sigma_{EU}^2)}$$

Where:  $R_{WG(J)}$  represents the within-group inter-rater agreement,

$\overline{s_{xj}^2}$  - the mean of the observed unit variances on the J items, and

$\sigma_{EU}^2$  - the variance that would be expected if all judgments have been due exclusively on measurement error,

The variance due to error was estimated using the following formula:

$$\sigma_{EU}^2 = (A^2 - 1) / 12$$

Where **A** corresponds to the number of alternatives in the response scale for  $X_j$ , which was presumed to vary from 1 to A. For the safety climate measure, A = 5.

One aim pursued in paper 1 was to examine the discriminant validity of the safety climate scale used in this study. Discriminant validity refers to the ability of the scale to differentiate between groups that are theoretically expected to be distinct (Murphy, 2003). Theoretically, the safety climate scale was expected to discriminate between respondents based on their work location and position. To avoid confounding the comparison among respondents according to these two demographics (position and work location), a MANOVA was performed to analyze the groups on the other demographic characteristics to determine whether they differ significantly in terms of age, gender, education and years of experience. The independent variables were the work area and position of respondents.

The result of the MANOVA revealed that respondents differed significantly in terms of gender. As such gender was entered as covariate in a MANCOVA to determine the discriminant validity of the scale. The four safety climate dimensions were treated as dependent variable; with the respondents' work location and position as independent variables. ANOVAs were used as a post hoc test.

In paper 2, Pearson correlation coefficients were calculated for all the study variables and key demographic variables. Hierarchical multiple regressions were then conducted to examine the abilities of the various independent variables to predict aspects of safety behaviour. Key demographic variables like age and position at the workplace were entered into the regression model as controls in the first step. In step 2, the dimensions of safety attitudes and risk perception were entered. This was followed by either the global safety climate variables or the four specific safety climate dimensions in step 3. The unique contribution made by each of the factors that significantly predicted safety behaviour was calculated using the formula:

$$sr^2 = r * \beta * 100$$

Where  $sr^2$ - unique contribution

r – Pearson coefficient of correlation between the specific independent variable and the predicted behaviour

$\beta$  – Standardized coefficient of the independent variable in the final regression model

## 4. RESULTS

The section summarises each of the two articles included in this thesis with special emphasis on the results obtained from the various statistical analyses carried out.

### *4.1. Summary of paper I*

The major aim pursued in this paper was to determine the factor structure, reliability and the discriminant validity of the safety climate scale used among a sample of Ghanaian mine workers. The scale was developed based on an extension of Zohar's (2000) model of unit level safety climate to include aspects of co-worker safety related attitudes, values and actions. The study setting was selected because there have been very few researches on safety climate and a total lack of studies examining the psychometric properties of safety climate measures in Ghana.

Principal component analysis was performed on the data from 273 respondents. In all, a four factor solution which accounted for 51.09% of the overall variance was deemed appropriate. The extracted dimensions were labelled safety communication, co-worker value for safety, supervisory monitoring and recognition and production versus safety pressure. The dimensions loaded in the order in which they have been listed; meaning the items forming the safety communication dimension loaded onto the first factor.

Through computation of Cronbach's alpha coefficients it was found that each of the four identified dimensions had satisfactorily internal consistency reliability. The obtained alpha values were 0.78, 0.65, 0.60, and 0.58 respectively. Regarding within group homogeneity of climate perception, the inter-rater agreement  $r_{WG(J)}$  values computed indicated that there was a higher degree of 'sharedness' in safety climate perceptions among respondents within the same work location,. The obtained values ranged from 0.83 to 0.98 for each work unit per dimension. The average of these values was 0.95. All the obtained values thus exceeded the required threshold of 0.70 (Zohar, 2003).

MANCOVA analysis also revealed significant difference in safety climate perceptions among workers according to their work location (Wilk's Lambda = 0.61,  $F_{(56, 877)} = 2.06$ ,  $p < 0.01$ ,  $\eta^2 = 0.11$ ) and also on the basis of their positions (Wilk's Lambda = 0.93,  $F_{(4,225)} = 4.23$ ,  $p < 0.01$ ,  $\eta^2 = 0.07$ ). It was observed that the scale discriminated among respondents better on the basis of work area than according to position ( $\eta^2 = 0.11 > \eta^2 = 0.07$ ). With regards to other demographics, no significant effect of gender, age, education or experience on respondents' safety climate

perceptions was observed. Together these results suggest that the scale is discriminately valid and is able to reflect changes in safety climate levels.

In another regards, item by item analysis revealed that items pertaining to supervisor and co-workers expectations when safety conflict with production and those concerned with workers been given feedbacks on their complaints or been praised for acting safe had very low scores below 50%; implying they were problem areas that required attention.

#### ***4.2. Summary of paper II***

Using samples from diverse industries, previous studies have reported that employees' safety climate perceptions are positively correlated with their safety related behaviours. One aim of this study was to examine the observed climate - behaviour relationship among a sample of mine workers. In addition the study extended existing literature by exploring how specific safety climate dimensions contributed to predicting employees' safety behaviour when considered together with employees' safety attitudes and the level of risk perceived.

Based on the analysis of data from 273 mine workers, support was found for the safety climate – behaviour relationship. It was observed that safety climate as a global indicator emerged as the strongest significant predictor of both employee's safety compliance and safety initiatives over and above demographics, attitudes and risk perception. Uniquely it accounted for 13% and 8% of the total variance explained for safety compliance and safety initiative respectively.

When the global safety climate variable was decomposed into its specific dimensions, regression analyses revealed that certain dimensions were strongly related to specific kinds of safety behaviours than others. Relatively the dimension labelled co-worker value for safety emerged as the strongest significant predictor [ $sr^2 = 16.6\%$ ,  $p < 0.01$ ] of employees' safety compliance whiles supervisory monitoring strongly predicted safety initiatives [ $sr^2 = 14.6\%$ ,  $p < 0.01$ ] over the other climate dimensions, attitudes and risk perception.

Also different set of safety climate dimensions were observed to significantly predict different aspects of safety behaviours. Co-worker safety and supervisor monitoring were the significant predictors of safety compliance in addition to fatalism (5.1%) and risk perception (6.3%). Also, two safety climate dimensions – supervisor monitoring and safety communication contributed significantly to predicting employees' propensity to take safety related initiatives. The other significant predictor of initiative was risk perception accounting for 4.5% of the total explained variance.

## 5. DISCUSSION AND CONCLUSION

Safety climate is a situational factor that has in recent times emerged to the forefront of discussions about how to improve occupational safety. As a construct that reflects and affects the level of safety in industries, a number of empirical investigations have focused on its measurement and relationship with employee safety behaviour. However, almost all of these studies were conducted in industries other than the mining sector. Also there has been a paucity of such researches from African. Exploring the measurement and influence of safety climate within a Ghanaian mining industry is thus one unique contribution of this thesis to the occupational safety literature. In addition, by addressing some limitations in the existing literature, the findings of the current research project have implications not only for the industry where it was conducted but also for future research and safety management in general. This section of the thesis discusses some of the implications of the findings and takes certain methodological issues into consideration.

### *5.1. Implications for Safety Management*

The research project explored how safety climate relates to safety behaviour when considered together with two person-related factors – attitude towards safety and risk perception. As a result, it was possible to show that perceived safety climate, risk perception and fatalism (i.e. respondents' belief about the controllability of work-related accidents, injuries and diseases) were significantly associated with safety behaviour. Together these factors explained larger amount of variance in workers' reported safety compliance and propensity to undertake safety initiatives.

For general safety management, the above observation suggests that to modify workers safety behaviour, it is necessary to focus on both situational (organizational practices) and person-related factors. Developing multi-pronged programs that combine interventions aimed at the two dimensions of behavioural influence is thus required for maximum and sustainable change in the way industrial workers act in relation to safety. For instance to enhance compliance, a person-related approach like training workers' to perceive risk correctly should be complimented with a corresponding enhancement of organizational safety practices like safety inspection and monitoring.

In the industry where the current study was conducted, safety climate should certainly be a key factor of concern when taking a multi-pronged approach to improve safety behaviour. This is

because perceived safety climate was strongly associated with workers' safety compliance and initiatives than all the other factors considered. Practitioners should therefore consider assessing and modifying the climate for safety prevailing within the various work locations for an improvement in the safe work behaviours of technical workers.

To effectively and efficiently carry out a safety climate-driven intervention in any industry, the study suggests that practitioners should first investigate which safety climate dimension is most salient for the behaviour of interest. This is to help focus much attention and resource on improving that dimension. For example, given that perception of co-workers value for safety was the strongest predictor of safety compliance among the technical mine workers studied, practitioners should can focused more on restructuring the safety descriptive norms in the various mine units; as workers' within the same unit can become one another's behavioural model.

Within the mining sector, introducing a safety buddy system in which workers observe colleagues' safety behaviour in routine tasks or establishing a forum for peer communication about their safety practices can be very helpful in enhancing safety compliance among technical workers. This kind of informal social control and information exchange have been found to be effective in improving pro-environmental (Cialdini, 2007) and health (Real and Rimal, 2007) behaviours and can have similar effect with regards to safe work behaviours. Further, insight from the "Hawthorne study" show that when workers recognize that others pay attention to their work behaviour, and that they are important than they thought (concerning the effect of their behaviour on others), it is possible for them to control and improve their safety behaviour, which in turn, can improve colleagues' safety behaviour and hence the overall safety in a work area.

### ***5.2. Implications for Research***

The observation that specific safety climate dimensions are more salient for specific safety behaviours has an important research implication. It suggests that, future investigations should take into consideration the multidimensional nature of the construct and emphasize more on identifying the specific dimensions that are more salient for various aspects of safety behaviour in different industrial settings.

In Paper 1, it also was found that the identified safety climate dimensions discriminated more effectively among workers on the basis of their work locations than by job position. The scale employed in the study consisted of only perceptual items. As such it can be inferred that

operationalizing safety climate in terms of employees' perceptions alone will enhance the discriminant validity of the construct. Over the years, various researchers have assessed the construct with measures that comprise of a mixture of attitudinal and perceptual items. However, safety climate as a derivative of organizational climate is a situational factor concerned with employees' report of how safety is treated in a particular workplace and not their own safety attitudes. As such the current finding adds onto the recommendation by Zohar (2008) as well as Griffin and Neal (2000) that on grounds of validity, measures developed to assess safety climate should not be confounded with items pertaining to other factors that may independently affect workplace safety like attitudes.

### **5.3. Methodological Issues**

The study was conducted by way of a cross sectional survey in which structured questionnaire was used to collect data from respondents. In addition to being time efficient, the nature of this method allowed for the quantification of data and hence the ease of exploring differences among employee groups as well as analyzing relationships with respect to the various phenomena (variables) that were of interest. These notwithstanding, cross sectional surveys always raise some methodological concerns regarding sampling and response biases.

People usually have the tendency to respond in a slightly more favourable manner. As such one factor that might have impacted the current results is social desirability. The safety climate measure scale used in this study was not to assess workers' personal abilities or preferences but rather they were to report on how others in their workplace treat safety. The risk of bias due to social desirability may therefore be reduced for the safety climate assessment. However, the safety attitude and the safety behaviour measures might be more sensitive to this kind of bias since respondents were to report on their personal attributes.

A second issue concerns the fact that the data were collected in a single survey and from the same set of respondents; indicating the potential for the observed relationships to have been inflated or deflated by common method variance (Podsakoff et al., 2003). In order to examine whether the bias accounted for all the relationships among the variables, Harman's single factor test (Podsakoff et al., 2003) was followed. This involved checking if all the items assessed belong to one factor; if it is the case, then significant relationships could be attributed to the bias or it can be concluded that the significant relationships are real to some extent. The unrotated principal component showed that one general factor cannot account for most of the variance in the study variables. Thus, common method bias might not have accounted for all



the relationships among the variables. Also, the bivariate correlations did not indicate consistently high coefficients, which would have been the case if the relationships were due to common method variance. Beside these, the magnitude of the variance explained by safety climate in the current study is similar to that found by Clarke (2006) in her meta-analytic studies (i.e. 13% and 8% as compared to 22% in the meta-analysis). These notwithstanding, it will be desirable for future studies to use data from multiple sources to examine and validate the relationships observed in the present study. For example safety behaviour can be measured through observation.

Another issue of concern is the extent to which the results can be applied to the target population and beyond. The population of interest were technical mine workers and it includes people who perform more traditional mining duties like drilling and blasting as well as individuals employed to basically maintain and repair mining equipments. The sample for the study was representative of this population in terms of gender, age and job categories. As such the current findings can be generalized to the population to a greater extent.

However, one needs to be mindful of extending the findings to other group of workers. As per the nature of the industry, the current sample is male dominated. In addition, mining industries tend to be more hazardous than other working environments. Most often the safety hazards that mine workers may encounter can be life or death situations which are rarely the case in an office working environment. Therefore, the results may be less extendable to working environments where workers are not confronted with such serious hazards on a daily basis and where the gender distribution is not similar to that of the mining industry. Having noted this, it is worth noting that certain comparisons and relationships were examined of which the knowledge gained may be valuable in other industries. For instances, respondents were found to differ in their risk perception on the basis of age and work experience and this may provide some insight in developing training in other industries to enhance workers risk perception.

Another limitation of this study is that, the nature of the research design makes it impossible to investigate causal relationships. This means that it cannot be claimed that the various explanatory variables actually cause employees to exhibit higher levels of safety behaviours. But it can only be stated that they are related to each other. Collecting data at multiple points in time could allow for causal inferences to be made about the relationships and it is suggested that in future longitudinal studies of how safety climate affects mine workers behaviour should be carried out.

Response rate and sample size are two methodological issues that have been problematic in most survey researches. However in the current study they were not. The response rate was excellent (92%), mainly due to the data collection approach used in which the research team distributed the study questionnaire and stayed with the respondents throughout the time of completion to clarify issues and retrieve the filled questionnaires. The sample size of 273 was also appropriate for the various statistical analysis carried out. For example in all the principal component analysis, the case to variable ratio exceeded the 10:1 recommended by Field (2008).

### ***5.5. CONCLUSION***

On the whole, this research has shown that perceived safety climate is strongly associated with the safety-oriented behaviours of technical mine workers. Thus confirming the observations from other industries and suggesting that safety practitioners in mining industries can shape the safety behaviours of technical workers and hence the overall level of workplace safety through a modification of the climate for safety within work units. Co-worker value for safety was the safety climate dimension most salient for safety compliance. As such it is suggested that promoting active caring or modifying the descriptive safety norm through interventions like the establishment of 'safety buddy systems' may help improve employees' compliance with safety standards during routine work. This may also be helpful in improving compliance in other sectors where workers are organized in crews. Further, for technical mine workers to go beyond compliance and engage in non-mandatory safety activities, the study recommends that interventions aimed at enhancing supervisory practices (i.e. monitoring and recognition of safe work behaviours) may be beneficial.

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## **PART TWO**

**Reliability and Discriminant Validity of a Safety Climate Measure in a Ghanaian Mining Industry**

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**Abstract**

In this study, a cross sectional safety climate survey was carried out within a Ghanaian mining industry and the psychometric properties of the scale used were examined. The study scale was developed by extending Zohar's (2000) model of unit level safety climate to incorporate aspects of both supervisor and co-worker value for safety. This scale was then administered to a sample of technical mine workers out of which 273 (representing a response rate of 92%) returned their completed scale. Principal component analysis revealed four underlying safety climate dimensions; each of which had an acceptable Cronbach's alpha reliability. Further, all the identified dimensions discriminated effectively among workers on the basis of their work locations and positions on the organizational hierarchy.

*Key Words: Safety Climate; Reliability; Validity; Mining Industry; Ghana*

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**1. Introduction**

Preventing work related injuries and diseases is necessary to reduce the economic and psychosocial consequences associated with them. These consequences are enormous; some of which are difficult to assess. The most direct ones may include; costs related to medical care, workers' compensation claims, decreased productivity and sometimes the development of permanent disabilities and even death of injured workers (Landers & Maguie, 2004; Hockey & Miles, 1999). For these reasons, occupational safety has attracted much attention from practitioners and researchers in diverse fields including: psychology, sociology, management and engineering.

An interdisciplinary literature search reveals that the concept of safety climate is at the forefront of discussions about ways to improve workplace safety. Though it has been conceptualized in several ways, safety climate has consistently been referred to as employees' perceptions of safety related policies, procedures and practices enacted in their workplace (Neals & Griffin, 2002; Zohar, 1980). Put in another way, it refers to the experiential based descriptions of what employees see happening at their workplace in relation to safety (Wallace

et al., 2006). These perceptions signal employees as to the overall importance accorded safety in the workplace and hence provide the context for their own safety behaviours which in turn impact on their propensity to be injured (Krause, 2005; Reason, 1997; Hayos, 1995).

Aside predicting employees' safety behaviours (Pousette et al., 2008; Rundmo, 2000; Griffin & Neal, 2000), part of the interest in safety climate is due to its function as a leading indicator of workplace safety. Mearns (2009) describes a leading indicator as 'something that provides information that helps the user to respond to changing circumstances and take actions to achieve desired outcomes or avoid unwanted outcomes' (p. 491). Regarding safety climate, employees derived their perceptions from attributes within the work environments. These attributes include the attitudes and actions of others (managers, supervisors and co-workers) towards safety, the state of safety inspection and the amount of resources allocated for safety issues (Jiang, in press; Zohar, 2003; Griffin & Neals, 2000). Assessing safety climate therefore provides practitioners with information about the aspects of the safety system that needs improvement and base on these preventive actions can be taken (Lee, 1998; Coyle et al., 1995).

The validity of safety climate as a leading indicator can also be further ascertain from studies reporting significant relationships between it and various safety outcomes such as accidents and injuries rates (Clarke, 2006; Johnson, 2007; Zohar, 2000, Hoffman & Stretzer, 1996). In all, assessing the climate for safety within an industry may be likened to taken the 'safety temperature' of that organization which will give a 'snapshot' of the state of safety at a particular point in time (Vinodkumar & Bhasi, 2009). Consequently a valid and reliable safety climate scale will be a valuable tool for practitioners and researchers.

In the western and eastern countries, a number of these instruments have been developed and tested. On the contrary, there is a paucity of such studies in Africa and for that matter Ghana. The only few safety climate studies (mainly by Gyekye, 2005, 2008) that have been conducted in the Ghana made use of measures from other cultures with no report on the factor structure when the scale was used in this new context. However, measures from the western and eastern countries cannot be assumed to apply equally valid in Ghanaian industrial settings; at least not when previous studies have shown that different factor structures emerge even when the same instrument is used across countries (Vinodkumar & Bhasi, 2009; Coyle et al. 1995; Dedobbeleer & Beland, 1991). Implying, safety factors may be assigned different meanings or degree of importance in different cultural contexts.

## **2. Aims of study**

In view of the above, the core aims of the current study are to: (a) assess the safety climate in a Ghanaian mining industry and (b) examine the factor structure, reliability and discriminant validity of the measure used. The reliability and validity are important psychometric properties of any scale. Identifying that the scale used in this study is reliable and valid will therefore give practitioners and researchers a certain degree of confidence in employing it as a tool for periodically mapping the state of safety within industries.

## **3. Safety Climate Measurement issues**

Organizational theorists (e.g. Zohar & Luria, 2005; Griffin & Neal, 2000) have proposed a multilevel approach to safety climate assessment. According to this perspective, two climates levels coexist within the same industry. One of which is the company level climate and the other is the unit level climate. The impetus for such a distinction is that, modern day organizations are complex and usually comprise of several semi-autonomous but interdependent departments. As a result, the same safety policies and procedures established by the top management of a company might vary in their implementation across departments due to differences in group processes and functions (Neal & Griffin, 2006) as well as according to the discretion of departmental managers (Zohar, 2008). The priority given to safety at the company level by management may thus differ from that at the department level.

As members of the organization as well as a subunit within it, workers are assumed to develop concurrent perceptions of the two climates. Of these, the company level climate is expected to be shared by all members of the industry. Its assessment therefore concerns what workers see regarding top managers' commitment to safety. As noted by Griffin and Neal (2000), this managerial commitment is reflected in features like allocation of resources (e.g. investment in safety devices and safety education), effectiveness of emergency response strategies and quality of incident investigations.

On the other hand, unit level climate is expected to be shared by only members within the same subunit. Zohar (2000; 2003; 2008) conceptualized this kind of climate in terms of employees' perceptions of their supervisors' commitment to safety. An assessment scale was then developed base on this conceptualization. By virtue of their proximity to and authority over workers, supervisors would in no doubt be an important social referent at the work unit level. Nonetheless, they may not be the only referent for workers' climate perception.

A worker may as well determine the extent to which safety is valued at the shop floor by observing the behavioural patterns of his co-workers. This is a group which they consider as similar, desirable and majority. Based on the principle of social influence (Lisa, 2007) such group would be an important referent for their climate perceptions. In relational cultures like Ghana where people are known to attach more importance to group membership (Markus & Kitayama, 1991; Oyserman et al., 2002), the influence of peer safety actions may even be greater. Consequently to be a true reflection of a unit- level safety climate, theoretical models and their associated measures need to take into consideration aspects of co-worker safety attitudes, values and practices.

However in attempt to do this, care should be taken not to confound scales with items that may not belong to safety climate. The climate for safety as described above (refer to introduction) is a situational factor external to workers. During its assessment workers are thus considered as observers of life in their workplace who report on what they see happening with regards to how safety issues are dealt with. Zohar (2003) noted that over the years some researchers have failed to differentiate safety climate from closely related construct like its outcome variables and safety culture. As a result, items pertaining to these related constructs such as workers' personal safety attitudes and their perception of the degree of risk inherent in their physical work environment have all been assessed as dimensions of safety climate. This practice according to Clarke (2006) has negative implications for the validity of safety climate as a construct that reflects and affects the level of industrial safety. On grounds of validity therefore it has been argued that such items should not be included in safety climate scales.

Zohar (2008) observed that most previous studies failed to distinguish between company and unit level safety climate and also a number of them did not specify the referent of items included on scales. As mentioned earlier, even in instances where this distinction between the two climates has been made, unit level safety climate has often been operationalized with only items relating to supervisory priority for safety. The present study will make use of a unit level safety climate scale. Whiles this scale will consists of only items pertaining to workers perception and **not** their personal attitudes, it will incorporate aspects of both supervisory and co-worker priority for safety. Based on psychometrics and previous studies, it is expected that the scale;

**HI:** Demonstrates satisfactory internal consistency reliability when used to assess the safety climate perceptions of mine workers in Ghana.

**H2:** Discriminate among workers based on their respective work units in the Mine (Lingard et al, 2009; Tharaldsen et al, 2008; Glendon & Litherland, 2001)

**H3:** Differentiate between workers according to their job positions as either foremen or frontline operators (Findley et al, 2006; Clarke, 1999). Finding support for H2 and H3 would imply that the scale possesses the psychometric property of being discriminantly valid.

## **4. Methods**

### *4.1. Sample*

The study is a cross sectional survey conducted within a mining industry situated in the Ashanti region of Ghana. Fifteen work areas in the Mine were selected for the purpose of data collection such that workers performing various technical jobs (such as drilling, refilling, processing, electrical works, etc) were represented. All the technical mine workers present in the selected work areas at the time of the data collection thus formed the population for the study. In all, three hundred questionnaires were administered and 277 of them were retrieved; representing a response rate of 92%. The questionnaires completed by ticking the same response option in all questions or completed by non-industrial workers such as clerical staff were discarded to avoid distortion of the results. This reduced the sample size for further analysis to 273 workers. The maximally and minimally represented work areas had 38 and 7 respondents respectively. Males dominated the sample as expected, forming 96.7%. Thirty two respondents were foremen while the rest were frontline operators. By age distribution; 26.7% were between 18-29 years, 33% (30-39 years), 31.9% (40-49 years) and 8.4% were 50 years and above. The majority of respondents had some form of basic education only (28.9%) while others had attained secondary (25.3%), technical (24.2%) and tertiary (2.6%) education. Regarding number of years at current workplace, respondents working for less than 1 year were 15.8%, 1-5 years (19.4%), 6-10 years (24.5%), 11-20 years (27.8%) and 21<sup>+</sup> years (12.5%).

### *4.2. Questionnaire*

An initial version of the safety climate scale employed in this study was developed by adapting items from previously tested and validated survey. Majority of the items were from Zohar's (2000; 2005) group level safety climate scales and Burt et al's (2008) CARE scale. These items were either used verbatim or rephrased to clarify the meaning. A review of the scale was done by two safety officers from the mining industry where the study was conducted. Based on this, some items were deleted and others modified.



The resulting 25 item scale was then piloted on 10 workers in the Mine. These workers commented on the length and language used as well as identified items that to them appeared duplicated. Based on the comments made, a final version of the questionnaire was prepared. On this 21 items were used to assess safety climate; all of which used a 5-point Likert response scale ranging from 1 (strongly disagree) to 5 (strongly agree) with midpoint labelled neither agree nor disagree.

### *4.3 Procedure*

After permission was granted by the authorities of the industry to conduct the survey, the managers (hereafter known as supervisors) of the selected work areas were contacted and specific periods agreed upon for the data collection. Throughout the Mine, safety meetings are held at the beginning of each day's work. So on the designated survey day for a particular work area, potential respondents were met at the end of the unit's safety meeting and were briefed about the study. Questions from workers were then addressed before the study questionnaires were distributed to qualified workers who were willing to participate. Each questionnaire had a cover sheet that again reiterated all conditions under which the survey was being conducted. It was stated that participation was completely voluntary and thus workers decision to participate or not will have no influence on their employment. To assure respondents of their anonymity and confidentiality of the information they provide, there was no requirement for their names or ID numbers on the questionnaire.

With respect to filling out the questionnaire, workers who were proficient in English language did it on their own whiles the few with poor literacy skills responded to a questionnaire interview in which the local dialect – Twi was used. The time allowed for the completion of the questionnaire ranged between 15 to 20 minutes. The researcher stayed with respondents throughout this time period to clarify issues as well as collect completed questionnaires.

## **5. Data Analysis and Results**

The data collected was prepared for statistical analysis by coding them into SPSS 16.0 data file. Items that were reverse-worded were coded such that higher scores reflected a more positive climate for safety. The means, SDs and ranges of reported values were examined to ensure that all the data were appropriately entered. Missing data analysis revealed that none of the items had more than 5% missing values and also the pattern of missing data was completely at random. As such missing data were excluded list wise throughout the analysis as recommended by Peng et al (2003).

### *5.1. Factor Structure*

To determine the underlying dimensions of the safety climate questionnaire, principal component analysis (PCA) was performed on the 21 items for the 273 cases. The case to variable ratio (13: 1) exceeded that recommended by Field (2008). Also the data was considered appropriate for analysis as evident by KMO measure of sampling adequacy of 0.74. This value is above the acceptable threshold of 0.6 (Worthington & Whittaker, 2006). The population correlation matrix obtained was not an identity matrix as indicated by a significant Bartlett's Test of Sphericity [ $\chi^2 = 1120$ ,  $df= 153$ ,  $p = .000$ ]. The extracted communalities were between 0.40 – 0.81 and as such all the 21 items were kept for factor rotation. Safety climate dimensions are theoretically expected to be related. Due to this, direct oblimin (delta = 0) which is a type of oblique rotation was selected during the PCA.

Initial rotation based on Kaiser's criterion of eigenvalues > 1 yielded five factors accounting for 52.49% of the total variance. However, it was noticed that most of the items loaded above 0.4 on the first four factors with only one item loading on the fifth factor. Upon inspection, a break was also found on the fourth component of the scree plot. As recommended by Field (2008) a four factor solution was thus deemed appropriate. Consequently, a forced four factor solution was tested. This cumulatively accounted for 51.09% of the explained variance and the resulting factor loadings are shown in Table 1. Items included are those that loaded on a single factor and had a loading greater than 0.4 (Hair et al, 1995).

The identified factors were labelled based on the theme conveyed by all or most of the items that loaded on them. The labels given to the four factors in the order they occur during PCA were: Safety communication, Co-worker value for safety, Supervisory monitoring and recognition and lastly Production versus safety pressure.

The first factor - safety communication consisted of six items; three of which concern the extent to which workers were provided with safety information within the unit and about safety happenings elsewhere in the mines. The other two concerned whether workers were consulted for safety suggestions and what the consequence was for a worker who voices out safety concerns in the unit. This factor alone accounted for 16.89% of the total variance explained. The second factor concerned the extent to which respondents perceive their colleagues as actively caring for each other's safety; hence its name co-worker care for safety.

Table 1: Rotated Factor Structure of Unit Safety Climate Scale with Items Rearranged by Factor

Items	Factor Loadings			
	F1	F2	F3	F4
1. My supervisor often reminds workers of the potential risks and hazards in our workplace	<b>.89</b>	.07	.01	.12
2. Workers in this unit are usually consulted for suggestions about how to improve safety	<b>.83</b>	.07	.00	.12
3. In this unit workers are given sufficient feedback about their safety complaints	<b>.62</b>	.03	.27	.05
4. In this unit workers receive regular updates on technical aspects of their job that will help them to work safely	<b>.59</b>	.07	.19	-.02
5. Workers in this unit are given sufficient information about safety incidents that occur throughout the mine	<b>.52</b>	.16	-.08	.13
6. Reporting a safety problem in this unit will not result in negative repercussions for the person reporting it	<b>.51</b>	.20	-.18	.13
7. My co-workers take immediate actions to correct safety hazards/risks they notice in this units	.06	<b>.74</b>	-.07	.05
8. Workers in this unit openly discuss near misses and share experiences of past injuries with each other	.16	<b>.71</b>	.06	.06
9. Workers in this unit strictly warn any colleague who acts unsafely	.03	<b>.65</b>	.02	.10
10. Workers in this unit almost always wear their safety protective equipment when they are supposed to	.10	<b>.52</b>	.19	-.02
11. Workers in this unit usually discuss about changes that could improve safety	.15	<b>.51</b>	.28	-.03
12. My supervisor frequently checks to see if workers are all following safety rules	-.12	.18	<b>.72</b>	.13
13. My supervisor often praises or says a good word to workers who pay attention to safety when working	.37	-.07	<b>.64</b>	.06
14. My supervisor insists on wearing of personal protective equipments (PPE) even if it is uncomfortable	.15	.21	<b>.61</b>	-.32
15. My supervisor usually gets annoyed with any worker who ignores safety rules and regulations, even minor rules	.16	.04	<b>.60</b>	.16
16. As long as daily targets are achieved, my supervisor does not care whether we worked by the safety rules or not (R)	.10	.07	.11	<b>.75</b>
17. Taking short cut to get a work done quickly is accepted among members of my work crew as long as everything goes well and nothing happens (R)	.11	.07	.03	<b>.72</b>
18. Whenever we fall behind schedule and we are not achieving daily targets, my supervisor wants us to work faster rather than by the rules (R)	.03	.10	.05	<b>.71</b>
<i>% Variance explained</i>	16.89	13.81	10.40	9.99
<i>Cronbach's Alpha</i>	0.78	0.65	0.60	0.58

*Extraction method: Principal Component Analysis; Rotation Method: oblimin (delta = 0) with Kaiser Normalization; Rotation conveyed in 7 iterations*

Respondents' perception of how their supervisor monitors safety behaviours as well as acknowledges workers who adopt safe practices was reflected in the four items that loaded on

to the third factor. On the other hand, items on the last factor which together explained 9.99% of the total variance convey a sense of how others in the work unit expects respondents to act when safety seems to be in conflict with production.

### *5.2. Reliability*

The internal consistency reliability of the scale was assessed using estimates of Cronbach's alpha. Since safety climate is considered a higher order construct (Griffin & Neal, 2000), first all the 18 items elicited from PCA were used in calculating the reliability of the safety climate scale as a whole. The Cronbach's alpha value obtained was 0.76; signifying a satisfactorily internal consistency reliability. Following this, the reliability of each of the identified safety climate dimensions was also calculated. As evident from Table 1, each of the four dimensions had acceptable internal consistency reliability with Cronbach's alpha values ranging from 0.58 – 0.78. Together these results support the first hypothesis (H1) of the study that the scale would be reliable when used to assess the safety climate within the Ghanaian mine.

### *5.3. Group Differences in Safety Climate Perception*

From hypotheses H2 and H3, it was expected that respondents' climate perceptions would differ on the basis of work location and job position. To avoid confounding the comparison between these groups, MANOVA was performed to analyze the groups on their demographic characteristics to determine whether they differ significantly in terms of age, gender, education and years of experience. The independent variables were the work area and position of respondents.

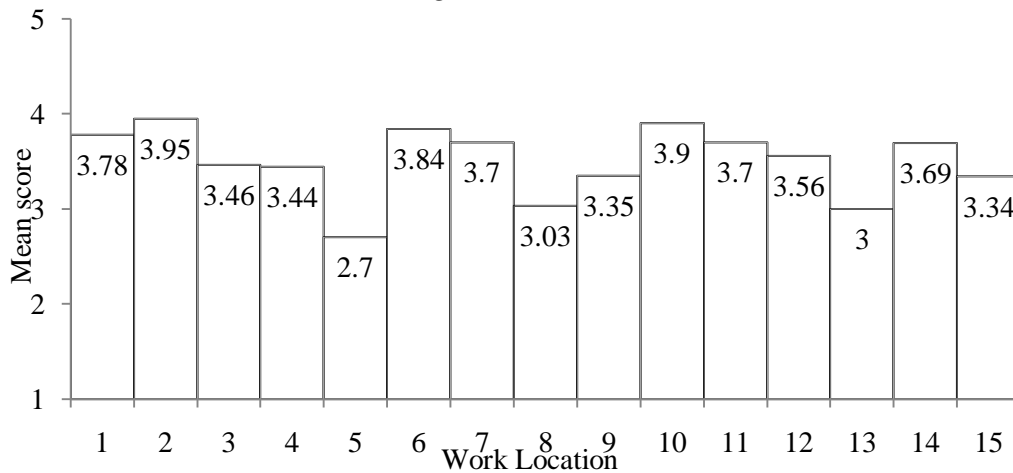
From the results, no main effect was found for position, Wilk's Lambda = 0.97 [ $F_{(4, 241)} = 1.90$ ,  $p = ns$ ] implying that workers in different positions did not differ significantly in gender, age, education and years of experience. On the other hand, a significant main effect was observed for work location, Wilk's Lambda = 0.47 [ $F_{(56, 241)} = 3.56$ ,  $p < 0.01$ ]. ANOVA analysis indicated that workers in the various work areas differed significantly ( $p < 0.05$ ) only in terms of their gender. In view of this, gender was dummy coded and entered as covariate in a MANCOVA performed to determine the discriminant validity of the scale. The four safety climate dimensions were treated as dependent variables; with the respondents' work location and position as independent variables.

The results demonstrated a significant main effect for work area (Wilk's Lambda = 0.59,  $F_{(56, 877)} = 2.03$ ,  $p < 0.01$ ,  $\eta^2 = 0.11$ ); implying that workers within different locations had varied climate perceptions. The main effect for position was also significant (Wilk's Lambda = 0.93,

$F_{(4,225)} = 4.75$ ,  $p < 0.01$ ,  $\eta^2 = 0.07$ ); suggesting that climate perceptions differed on the basis of position. The results also show that discrimination of workers was better based on location than on position ( $\eta^2 = 0.11 > \eta^2 = 0.07$ ). On the other hand, no significant main effect of gender was observed.

Regarding work location, ANOVA showed that with the exception of the climate dimension labelled production versus safety pressure, all the identified dimensions significantly ( $p < 0.05$ ) differentiated among workers. Thus workers from each of the fifteen locations perceived different levels of safety communication, co-worker care for safety and supervisory monitoring and recognition. Fig 1 for example depicts the variations in safety communication.

*Fig 1: Variations in perceived state of safety communication according to work location*



Concerning job position, ANOVA results as evident in Table 2 revealed that all the four climate dimensions significantly discriminated between foremen and frontline operators.

*Table 2: Variations in Safety Climate Dimensions by Position*

Safety Climate Dimensions	Foremen (n = 32)		Frontline (n = 241)		F
	Mean	SD	Mean	SD	
1. Communication	4.00	0.69	3.46	0.70	14.04**
2. Co-worker safety	3.78	0.67	3.34	0.70	6.65**
3. Sup. Monitoring & Recogni.	3.94	0.60	3.55	0.60	9.89**
4. Production Pressure	2.96	0.67	2.62	0.69	4.16*

\*\*represents statistical significance at  $p < 0.01$ , \*represents statistical significance at  $p < 0.05$

For each dimension considered, the foremen were found to have better scores than frontline operators. Even on the production versus safety dimension though they all felt pressured to work faster instead of safely in order to achieve production target, the mean score for the

foremen was still greater ( $2.96 > 2.62$ ). Thus the foremen reported experiencing less pressure as compared to the operators. In all, the results support hypothesis 2 and 3.

#### *5.4. Additional Analysis*

##### *5.4.1 Differences in Safety Climate Perception by worker's demographics*

In addition to the above, MANOVA was used to examine the main effect of the various demographic variables. With this no significant effect was observed for education ( $F = 0.84$ , ns), age ( $F = 0.79$ , ns) and years of experience ( $1.01$ , ns). This implies that, safety climate perceptions did not according to these demographic variables.

##### *5.4.2. Within Group Homogeneity*

As a situational factor, members within the same work area were expected to share their safety climate perceptions. To determine this, estimates of inter-rater agreement  $r_{WG(J)}$  (James et al. 1993) were calculated for each work location per safety climate dimension. With this, the  $r_{WG(J)}$  value obtained for each location per dimension exceeded the required threshold of 0.70. The observed values ranged from 0.83 – 0.98 with an average of 0.95.

##### *5.4.5. Prevailing climate for safety within the Mine*

To provide an overview of the climate for safety prevailing within the Mine as at the time of this study, a composite mean score per safety climate dimension was calculated using the combined responses from all the work locations. Also, the percentage of respondents who agreed to each of the 18 climate items was determined. As shown in Table 3, the results of these analyses indicated that generally the safety climate within the mine was high. With the exception of the last dimension, the mean score for all the safety climate dimensions exceed 3 (out of 5- the highest possible score).

Item by item consideration revealed that, over 50% of workers responded favourable to most of the items. This is an indication that their supervisors and colleagues by a number of their behaviours and attitudes demonstrate a value for safety. This notwithstanding, items pertaining to supervisor and co-workers expectations when safety conflict with production and those concerned with workers been given feedbacks on their complaints or been praised for acting safe had very low scores below 50%; implying they were problem areas that required attention.

Table 3: Percentage agreement (agree or strongly agree) with items on the safety climate scale

Items	%
<b>Communication (Mean = 3.52, SD = 0.72)</b>	
1. My supervisor often reminds workers of the potential risks and hazards in our workplace	55
2. My supervisor consults us for suggestions about how to improve safety in this unit	60
3. In this unit workers are given sufficient feedback about their safety complaints	44
4. In this unit workers receive regular updates on technical aspects of their job that will help them to work safely	70
5. Workers in this unit are given sufficient information about safety incidents that occur throughout the mine	42
6. Reporting a safety problem in this unit will not result in negative repercussions for the person reporting it	50
<b>Co-worker Safety Caring (Mean = 3.35, SD = 0.76)</b>	
7. My co-workers take immediate actions to correct safety hazards/risks they notice in this units	65
8. Workers in this unit openly discuss near misses and share experiences of past injuries with each other	57
9. Workers in this unit strictly warn any colleague who acts unsafely	59
10. Workers in this unit almost always wear their safety protective equipment when they are supposed to	62
11. Workers in this unit usually discuss about changes that could improve safety	63
<b>Supervisor Monitoring and Recognition (Mean = 3.69, SD = 0.60)</b>	
12. My supervisor frequently checks to see if workers are all following safety rules	72
13. My supervisor often praises or says a good word to workers who pay attention to safety when working	46
14. My supervisor insists on wearing of personal protective equipments (PPE) even if it is uncomfortable	60
15. My supervisor usually gets annoyed with any worker who ignores safety rules and regulations, even minor rules	77
<b>Production versus Safety Pressure (Mean = 2.79, SD = 0.75)</b>	
16. As long as daily targets are achieved, my supervisor does not care whether we worked according to the safety rules or not (R)	59
17. Taking short cut to get a work done quickly is accepted among members of my work crew as long as everything goes well and nothing happens (R)	41
18. Whenever we fall behind schedule and we are not achieving daily targets, my supervisor wants us to work faster rather than by the rules (R)	25

## 6. Conclusion and Discussions

In this study, a unit level safety climate measure was developed and tested in a sample (N = 273) drawn from 15 work locations in a Ghanaian mining industry. The results reveal that the measure has good discriminant validity and provides a means of assessing four (4) dimensions of employees' perceptions of the state of safety within their work units. Also the reliability of the scale as a whole and of its specific dimensions was satisfactory.

Safety climate which refers to the shared perceptions of employees about the overall importance accorded safety (Neal & Griffin, 2002) has hardly been explored in the Ghanaian industrial context. The only few studies conducted (mainly by Gyekye, 2005; 2006; 2008) made use of questionnaires developed in other cultures with no report on their factor structure. Assessing the structure and psychometric properties of a safety climate measure in Ghana is thus a unique contribution made by this study. Theoretically, Zohar's (2000) model of group level safety climate was also extended by including co-worker safety behavioural pattern as another referent for employees' perceptions in addition to that of supervisors.

Principal component analysis revealed four underlying dimensions of the measure. It is important to note that these dimensions also have been reported in a number of previous studies. For example, Glendon and Litherland (2001) as well as Wills et al (2005) reported communication as a dimension of safety climate. In these two studies, items pertaining to communication loaded as the first factor. Observing a similar loading in this study thus depicts that when perceiving the overall value for safety in their units, employees attach great importance to the extent to which they are timely informed of the safety aspects of their job as well as the extent to which they receive safety related feedbacks.

Though the dimensions identified may not be new, this study highlights an important point in safety climate assessment. It was observed that a strong within group homogeneity on climate perceptions existed among respondents from the same work area. Also differences in climate perceptions among workers from different work location were observed. These two observations justify the aggregation of the individual climate scores in this study to the chosen unit of analysis (work location). This is because the results satisfy the required validating criteria for climate aggregation as proposed by Zohar (2003). Thus, the aggregation was done based on naturally existing social units within the mining industry and there were sufficient evidence of within-unit homogeneity and between-unit heterogeneity in climate perceptions.

The observation that the identified climate dimensions satisfied the validating criteria highlights an important methodological issue. It emphasizes the importance of clearly specifying the unit of analysis of theoretical interest when conducting a safety climate research. As stated earlier, most researchers have often assessed the safety climate dimensions that identified in this study. For example Cox and Cheyne (2000) included aspects of safety communication in the measure they developed for their study in the UK oil industry. Lu and Shang (2005) also had aspects of supervisor and co-worker safety actions as part of their survey used in Taiwan. However, these researchers aggregated the scores on these dimensions to the level of the entire company. But



from the findings of the present study it is evident that for those survey items with supervisor or co-worker as their referents, the subunit or work group level is the more appropriate unit of analysis.

Modern day organizations are complex and many of them comprise of several semi autonomous departments or units. Due to differences in leadership style and functions within these units, it is expected that workers would develop shared perceptions of supervisor and co-worker safety actions on the basis of their working units. Attempts to aggregate scores on these dimensions to the company level may thus mask certain significant between group differences which may probably serve as targets for safety enhancing interventions.

### *Reliability*

Generally, there are two broad types of reliability referred to during a survey. These are the test-retest reliability and the internal consistency reliability. Of interest in this study was the internal consistency of the safety climate measure used. This type of reliability refers to the degree of interrelatedness among a set of items designed to measure a construct (Netemeyer et al, 2003; Coolican, 1999). Observing a high internal consistency therefore implies that respondents answered related items in a similar way while a low value implies that the scale may be measuring more than one variable and as such unrelated items were answered differently by respondents. In this study, the reliability of the overall safety climate scale was 0.76. This value according to the criteria by Coolican, (1999) is quite high. Implying that, the items on the scale were interrelated to each other and assessed a similar variable – the priority given to safety within the workplace. The reliabilities of the four identified dimensions were also within acceptable range (0.58- 0.78).

### *Discriminant validity*

This refers to the ability of a scale to differentiate between groups that are theoretically supposed to be distinct (Murphy, 2003). In the case of this study, the various dimensions of the safety climate scale were able to discriminate among workers from different work locations and those in different job positions. These are in line with Tharaldsen, Oslen and Rundmo's (2008) observations in the Norwegian offshore company as well as the findings of Findley et al. (2006) and Clarke (1999). In addition to this, it is worth mentioning that the discrimination among respondents in this study was better on the basis of location than position. Also no significant differences in perception were observed based on age, gender, education, or work experience.

Together these findings make sense because safety climate is a situational factor which concerns what people see with regards to how safety is treated and operationalized in the workplace at a particular moment (Cooper & Philips, 2004). Its assessment is thus not concerned with how the prevailing safety climate affects a worker as man or women, old or younger and as experienced or inexperienced. Having stated this, the differences according to position should be noted as an expected result. This is because according to Trice and Beyer (1993) people at different level of the organizational hierarchy have different distinct mental models or ways of viewing and representing their organizations and its practices.

By discriminating better based on location, the finding emphasis the point advocated by Zohar (2003) as well as by Griffin and Neal (2000) that, safety climate should be operationalized only in terms of perception of the work environment. Meaning, items pertaining to closely related constructs like attitudes of respondents should be treated as independent factors that also affect a worker's safety behaviour.

The fact that the measure used in this study discriminated effectively among workers in various groups also has an important practical implication. It suggests that changes in employees' perceptions can be reflected in the data obtained using this scale. Practitioners can therefore employ the measure to periodically map the safety climate within work units as well as to assess changes in the state of safety after an intervention strategy has been implemented.

A major limitation of this study is that the predictive validity of the measure was not examined. However with evidence of good discriminant validity, the measure can be used in a study focusing purposely on its predictive validity and any other studies involving safety climate as a variable especially in the Ghanaian context with some degree of confidence. It is recommended that such studies are carried out in the future to assess how unit level safety climate and its specific dimensions relates to various safety and non-safety outcomes like employee safety behaviour, injury frequency and compensation claims.

Paradoxically, while the multidimensionality of safety climate is widely acknowledged, most existing studies exploring the climate-behaviour relationship have employed the construct in its global sense. It is therefore recommended that future studies make use of the current scale to assess how specific climate dimensions relate to various kinds of employees' safety behaviour (e.g. safety compliance and safety initiative taking). Results from such investigations can give an idea of where to focus attention when safety climate driven interventions are been pursued to bring about changes in the way employees behave in relation to workplace safety.

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## **Safety Climate, Attitudes and Risk Perception as Predictors of Safety Behaviours among Mine Workers**

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### Abstract

The core aims of this study were to: a) confirm an observed relationship between global measure of safety climate and safety behaviour among a sample of mine workers and b) examine the relative strength of the relationships between specific safety climate dimensions and safety behaviour. These explorations were done in the context of two other known behavioural influences – perceived risk and safety attitudes. Data analyses of responses from 273 workers (92% response rate) indicated that, global safety climate was more strongly related to safety behaviour than attitudes and risk perception. Also, certain safety climate dimensions were found to be more strongly associated with safety behaviours than others. Further, different climate dimensions were more salient for different kinds of safety behaviours. The implications of these findings for future research and practice have been discussed.

*Key Words: Safety Climate; Attitudes; Risk Perception; Safety Behaviours*

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### **1. Introduction**

Hazards are present in every work environment; but the mining industry is among those at the greatest risk. The industry is characterized by; falling rocks, excessive noise and vibration, dust, gas explosions and dangerous chemicals (Quick et al, 2008; Amweelo, 2001; Ikingura, 2001). Together these hazards make mine workers most vulnerable to work-related injuries and diseases (Lewis, 2001). However, whether workers will sustain such negative safety incidents or not is fundamentally related to the way they behave in relation to the hazards inherent in their workplace.

Workers often know more about these hazards than any safety officer; for the obvious reason that they live with them daily. Their participation in the identification, assessment and control of these hazards is thus essential to reducing the rate of incidents caused by them. Also, workers compliance with the laid down safety standards when performing their jobs (e.g. using correct PPE) may protect them against exposure to certain hazards and hence limit the chances for work related injuries and diseases. Implicitly, if mine workers can be influenced to engage

in safe rather than at-risk work behaviours then it should follow that there will be a possible decrease in the rates of work-related injuries and diseases. To do this, understanding the factors behind why employees behave in various ways in relation to safety is necessary.

In the past, the personality characteristics of employees were targeted as the root cause of their safety related behaviours. This led to the de-selection of the so called “accident prone” individuals as a means of ensuring safety in the workplace (Hayos, 1995). Though personality and other person-related factors might be involved, it has been recognized that the socio-organizational context in which employees work also impact their safety behaviours (Rundmo, 1998; DeJoy et al., 2004). One of the constructs concerned with this contextual influence is safety climate.

Introduced into the literature by Zohar (1980), safety climate has been investigated and developed by many other researchers. It is conceptualized as employees’ shared perceptions of the enacted safety policies, procedures and practices in their workplace (Zohar, 2008; Neal et al, 2000). These perceptions are grounded in employees’ observations of the safety attitudes and actions of their managers, supervisors and co-workers. Thus, safety climate is an experiential based description of what workers’ see happening in their workplace with regards to the overall importance accorded safety in comparison to other priorities like work speed (Wallace et al., 2006; Neal & Griffin, 2006). Put it in another way it represents the overall mental construct or framework that employees have about how safety is treated in their workplace or what is considered normal safety practices (Wills, Watson & Biggs, 2004).

Researches from various industries have reported that a positive safety climate is related to increased safety compliance with safety standards (Wills et al, 2006; Seo, 2005; Clarke, 2006); workers’ participation in non-mandatory safety enhancing activities (Griffin & Neal, 2000; Pousette et al, 2008) and improved safety reporting culture (Kath et al, 2010; Hofmann & Stetzer, 1998). While these findings provide support for the notion of safety climate in mining industries, there is still the need for more empirical investigations to establish the extent of the link between safety climate and mine workers safety behaviours. It is also necessary to identify how safety climate assessment can be used to guide the development of behavioural change interventions.

Factor analytic studies have demonstrated that safety climate is multidimensional (Wills et al 2009; Cooper & Philips, 2004). However, in most studies in which the climate-behaviour relationship has been explored, it has been treated as a global indicator without consideration



of its multidimensionality. As a result, very little is currently known about how its specific dimensions relate to safety behaviour in various industries. That is, the question regarding the relative importance of each safety climate dimension in relation to aspects of safety behaviour is still unanswered.

Like all complex organizational phenomena, safety behaviours may hardly be influenced by only one factor. As such it is deemed appropriate to consider other factors also linked to safety behaviours when exploring the relative impact of safety climate on behaviour. These other factors include safety attitudes and perceived risk (Arezes & Miguel, 2005; Rundmo, 1999; 1995)

### ***1.2.Aims of study***

The core aims of this study are therefore to: (a) Examine the relationship between safety climate and employee's safety behaviour among a sample of mine workers, (b) Assess the safety attitudes and the level of risk perceived by the mine workers and (c) Explore the relative strength of the relationships between four safety climate dimensions and safety behaviour when analyzed together with risk perception and safety attitudes.

### ***1.3. Relationship between Safety Climate and Safety Behaviour***

Safety behaviour as considered in this study involves more than obeying safety rules and using the correct personal protective equipments. According to Neal and Griffin (2004) as well as Marchand et al (1998), these are known as safety compliance and form only one aspect of safety behaviour. The other aspect is safety participation or initiative. This refers to 'activities that do not directly contribute to an individual's personal safety, but which do help to develop an environment that supports safety' (Neal & Griffin, 2002). These includes attending volunteering to be members of safety committees, reporting hazardous situations, making suggesting to improve safety and correcting colleagues who engage in unsafe acts.

Organizations with positive safety climate are characterised by a strong support and commitment to safety. Safe behaviours are also valued and rewarded. Therefore, based on the expectancy – valence theory (Vroom, 1964) it can be anticipated that workers within such settings will be motivate to exhibit safe behaviours. This is because they will perceive that their efforts are deemed important by others. On the other hand, workers in settings with negative safety climate may adapt to the atmosphere around them. Consciously or unconsciously they may prioritize other goals like work speed over safety and are more likely to engage in unsafe behaviours which increase their susceptibility to work related accidents or injuries (Reason,

1997). This may be due to the fact that no positive reinforcement for safe behaviours (e.g. praise from supervisor or respect from co-workers) usually exists in such contexts. In the absence of these reinforcements the short term benefits of unsafe behaviours like completing a job quickly may be an alternative. Based on this and findings from previous studies, it is expected that mine workers' perceived safety climate perceptions will be positively and significantly correlated with their safety behaviours.

#### ***1.4. Dimensions of Safety Climate***

Reviews by Flin et al (2000) and Guldenmund (2000) revealed that, great variations exist in the number and kinds of factors that researchers over the years have assessed as part of the safety climate construct. These variations have been attributed to culture (Vinodkumar & Bhasi, 2009; Dedobbeleer & Beland, 1991) as well as the developmental history of the various measures – either based on literature review or incident reports or interviews (Flin et al., 2000). On the whole, there seem to be currently no consensus regarding the definite primary dimensions of safety climate. This notwithstanding, certain dimensions have emerged throughout most of the reported scales. Among them are those assessing management commitments to safety, supervisor safety and safety communication.

For the purposes of the current study, safety climate will be operationalized with a measure developed based on data from a sample of mine workers (refer to paper 1 of this thesis). This measure assessed four dimensions of safety climate. The dimensions are safety communication, co-worker safety, supervisory monitoring and recognition and lastly production versus safety pressure. Safety communication refers to workers perception of the extent to which their supervisors and safety officers rely safety related information as well as how they react to workers who complain about safety issues. This concept is similar to the communication dimension reported in previous studies (e.g. Wills et al, 2005; Glendon & Litherland, 2001; Mearns et al, 1997). Since this characterized downward communication (from superiors to workers), it may also influence the extent to which workers will voice out their safety concerns or report near misses and injuries.

Co-worker safety concerns the extent to which workers perceive their colleagues as valuing safety. A co-worker who values safety presumably will act safely; take steps to eliminate hazards and also warn others who act unsafely. This is similar to previously identified dimensions like perceived effects of safe conduct on social status (Zohar, 1980) and co-worker safety (Varonen & Mattila, 2000, Hayes et al, 1998). Based on social exchange theory (Blau,

1964), workers who perceive that their colleague care for their safety may also be pushed to reciprocate with similar behaviours.

The third dimension of the measure employed in this study is supervisor monitoring and recognition. It describes employees' perceptions of the extent to which their supervisor keep track of unsafe practices as well as acknowledges workers who adapt safe working behaviours. In the literature is analogous to supervisor safety (Lu & Shang, 2005; Hayes, et al. 1998; Mearns et al, 1997). The fourth dimension labelled production versus safety pressure assesses workers' perceptions of the expectations others in their workplace have regarding working according to the safety rules when production targets are delayed. It gives an idea of whether they are expected to bend the safety rules and work faster in order to meet targets. It also indicates whether safety is valued at all times or only under conducive circumstances. This is quiet similar to the supervisor expectation dimension extracted by Zohar (2000) except that it also includes items pertaining to co-worker expectation.

From the definition of safety climate, it is clear that the four dimensions which are of interest in this study will cue workers with respect to the safety norms in their workplace. But as stated earlier, the relative saliency of each of them to worker safety behaviour is unclear. Clarke (2006) in her meta-analytic study noted that, there were variations in the strengths of the reported relationships between overall safety climate and behaviour. However, since in various studies the overall safety climate scores have been derived from different dimensions, it can be argued that the strength of the safety climate-behaviour relationship is dependent on the kind of dimensions assessed. As such while each safety climate dimensions may uniquely contribute to predicting behaviour, it is expected that there will be significant difference in the strength of the relationships between the specific dimensions and safety behaviours. This hypothesis will be supported if certain climate dimensions significantly predict behaviour and others do not and also if the coefficients of the significant predictors differ greatly from each other.

### **1.5. Risk Perception and Safety Attitudes**

The level of risk perceived by workers' has also been reported to be related to their safety behaviour (Arezes & Miguel, 2003; Rundmo, 1999; 1995). As defined by Lund and Rundmo (2009) risk perception refers to employees' subjective evaluation of the probability of them or others to experience a negative event at work and the perceived severity or consequence of such event should it occur.

In any situation, employees tend to engage in a cost – benefit analysis before deciding on how to act. They compare the costs (perceived risk of being injured) to the benefits (finishing a job earlier, praise from co-workers, good wages etc.) and it is highly probable that they may engage in unsafe behaviours if the benefits of such actions are considered to be greater than the costs. According to Mullen (2004) employees are likely to judge risk as been greater if they perceive that the negative effects of their actions will be immediate as opposed to delayed. Regarding, workplace safety, injuries and certain illnesses which happen to be the negative consequence of unsafe behaviours may not be immediate. As such employees who do not recognize ‘visible’ and immediate negative event are likely to have lower risk perception as well as engage in unsafe practices.

Apart from risk perception, many studies have also examined the relationship between attitude and behaviour in the context of workplace safety. Attitudes are the feelings and beliefs that individuals have about specific objects or activities. Considered in the context of workplace safety, Pidgeon (1991) defines it as individual beliefs about hazards and the importance of safety, together with the motivation to act on those beliefs. Attitudes can be positive or negative and are generally considered to influence the way the people act towards the attitudinal object. Rundmo and Hale (2003) as well as *Ulleberg and Rundmo* (2003) observed that attitude towards safety was one of the predictors of safety behaviour. Also Wills et al (2009) found evidence for this relationship between attitudes and safety behaviour among drivers. Their study included a global measure of safety climate and this emerged as a better predictor of behaviour compared to drivers safety attitudes. In a similar vein, Clarke (2006) in a meta-analytic study observed safety climate to be strongly related to safety behaviours at work than attitudes.

In all, risk perception and attitudes are expected to be related to mine workers self reported safety behaviours. However based on the above review, it is also expected that employees’ global safety climate perceptions and its dimensions will emerge as stronger predictors of safety their behaviours over and above perceived risk and attitudes toward safety.

## **2. Method**

### *2.1. Sample*

In a cross sectional survey, the data for this study was collected from 273 technical workers in a Ghanaian mining industry. These workers performed non-clerical jobs such as drilling, refilling, processing, equipment repairs and electrical works. Thirty (32) of them were in the position of foremen and 241 were frontline operators. The sample was predominantly male

(96.7%) with a few female (3.3%). However, since this reflected the gender distribution within the industry, both genders were included in the analysis to ensure that the sample was representative of their population. The age distribution was such that; 26.7% were between 18-29 years, 33% (30-39 years), 31.9% (40-49years) and 8.4% were 50 years and above. The majority of respondents had some form of basic education only (28.9%) while others had secondary education (25.3%), technical (24.2%) and tertiary education (2.6%). Regarding number of years at current workplace, respondents working for less than 1 year were 15.8%, 1-5 years (19.4%), 6-10 years (24.5%), 11-20 years (27.8%) and 21+ years (12.5%).

## *2.2. Measures*

A five sectioned questionnaire was used in this study. Aside demographics, the questionnaire assessed the safety climate perceptions, safety attitudes, risk perception and self reported safety behaviours of respondents.

### Explanatory Variables

**A). Safety climate:** An 18 item scale was used to assess workers' perceptions on four safety climate dimensions. These dimensions were: 1) safety communication ( $\alpha= 0.78$ ) [e.g. In this unit workers are given sufficient feedbacks about their safety complaints]; 2) Co-worker safety ( $\alpha= 0.65$ ) [e.g. Workers in this unit almost always wear their personal protective equipment when they are supposed to]. 3) Supervisor monitoring and recognition ( $\alpha= 0.60$ ) [e.g. My supervisor frequently check to see workers are all following the safety rules] and lastly 4) Production versus safety pressure ( $\alpha= 0.58$ ) [e.g. Whenever we fall behind schedule and we are not achieving daily targets, my supervisor wants us to work faster rather than by the rules]. All items on this scale were rated on a 5 point Likert scale ranging from strongly disagree (1) to strongly agree (5) and were scored in such a way that higher values indicated a positive safety climate. When considered as a measure of a global safety climate, the scale has a reliability of 0.76.

**B). Attitudes:** Respondents' beliefs and feelings about accident prevention, safety activities and safety rules were assessed by seven (7) items selected from a scale previously used by Rundmo (1998). Responses were made on a five point Likert scale ranging from strongly agree (1) to strongly disagree (5). Example of items: Rules and instructions relating to personal safety sometimes make it difficult to keep up with the production target.

**C).Risk Perception:** Four items taken from Rundmo's (1998) scale were used to assess the cognitive component of risk perception. Respondents' indicated on a five point Likert scale the probability of themselves or their co-workers being injured at the workplace, the severity of such injuries should they occur and the overall safeness of their work area compared to other sections of the Mine. High scores on this part of the questionnaire indicated a greater degree of perceived risk.

### Outcome Variable

**Safety behaviour:** This was assessed with eight (8) items that asked respondents to indicate the extent to which they engaged in various safety-related practices such as wearing PPE, reporting colleagues who break safety rules to supervisor etc. These items were selected and reworded from previous surveys used by researchers like Tucker et al (2008). Ratings were done on a four point Likert scale ranging from Never (1) to Very Often (4).

### *2.3. Procedure*

Within the mining industry for this study, work units hold safety meetings at the beginning of each day's work. One a day that has previously been agreed upon, potential respondents were met at the end of their units' safety meeting. A brief information regarding the aims of the study, what was expected of respondents and the voluntary nature of participation was provided and questions about the study were answered. The study questionnaires were then distributed to industrial workers who were willing to participate. Workers who were proficient in English – the language in which the questionnaire was presented, filled the questionnaire themselves. On the other hand, those with poor literacy skills responded to questionnaire interviews in which the local dialect (Twi) was used. Time allowed for completion of the questionnaire ranged from 15 to 20 minutes. The research team (researcher and two assistants) remained with respondents throughout this period to clarify issues and to collect completed questionnaires

## **3. Analysis and Results**

### *3.1. Preliminary Analyses*

The data collected was prepared for analysis by first recoding all reverse reworded items. Then the means, standard deviations and ranges of reported scores were examined to ensure that all the data were appropriately entered. Missing values were excluded list wise as recommended

by Peng (2003). This was because the missing data analysis revealed that none of the items had more than 5% missing values and also the pattern of missing data was completely random.

Separate principal component analyses (PCA) with varimax rotation were used to determine the factor structure of all the major study constructs except safety climate (see paper 1 for structure). In all the current PCA performed, the case to variable ratio exceeded 10:1 as recommended by Field (2008). Also by obtaining KMO values of 0.68, 0.71, 0.69 as well as significant Bartlett's Test of Sphericity, the factorability of the data was confirmed. Extractions of factors were all based on Kaiser's criterion of eigenvalues > 1.

The results showed that the items measuring risk perception formed a unidimensional scale with loadings between 0.53 – 0.85. The items together explained 54.37% of the total variance. Regarding attitude and safety behaviour, the extracted dimensions with their labels and loadings are presented in Tables 1 and 2 respectively. The attitudinal factor labelled fatalism consisted of 2 items and concerned respondents' beliefs about whether accidents could be prevented in their workplace or not.

*Table 1: Rotated Factor Structure of the Safety Attitudes Scale and the Reliabilities of Factors*

Items	Factor loadings	
	Attitude towards safety rules	Fatalism
1. Sometimes it is necessary to ignore safety regulations in order to finish a task / job on time.	<b>.67</b>	-.12
2. Due to my experience I do not need to follow all the routine safety rules and instructions when working	<b>.62</b>	.16
3. Following all safety rules and instructions would be the same as a 'go slow' action and I would never be able to complete my work on schedule	<b>.60</b>	.27
4. Rules and instructions relating to personal safety sometimes makes it difficult to keep up with the production target	<b>.54</b>	.07
5. Information given at safety briefings / talks are not all that necessary for doing my work safely	<b>.53</b>	.12
6. Accidents / injuries would just happen and little can be done to avoid them	.05	<b>.87</b>
7. People who get injured or are involved in an accidents are just unlucky	.18	<b>.85</b>
<i>Eigenvalues</i>	<i>1.78</i>	<i>1.60</i>
<i>% of variance explained</i>	<i>25.40</i>	<i>22.91</i>

*Table 2: Rotated Factor Structure of the Safety Related Behaviour Scale*

Items	Factor loading	
	<b>Safety Compliance</b>	<b>Safety initiative</b>
1. Making conscious effort to follow all safety procedures when working	.74	.05
2. Taking Short cuts due to work pressure (R)	.68	.06
3. Avoiding the use of PPE's in order to get a task done faster (R)	.66	.14
4. Attending safety meetings and briefings	.59	.03
5. Reporting injury to your supervisor no matter how small it is	-.02	.78
6. Reporting to your supervisor when colleagues break any safety rule	0.8	.76
7. Warning a colleague for his / her unsafe act	.17	.64
<i>Eigenvalues</i>	<i>1.83</i>	<i>1.66</i>
<i>% of variance explained</i>	<i>26.64</i>	<i>25.11</i>

The two factors identified for safety behaviour were labelled safety compliance and safety initiative respectively. Whiles the first factor assessed the extent to which respondents follow safety rules and regulations when working, the second factor was concerned with the extent to which respondents on their own take actions to improve safety of the workplace and of co-workers. Together these factors accounted for 51.74% of the explained variance.

Cronbach's alpha coefficients as well mean and standard deviation scores were calculated for all the extracted factors. The Cronbach's alpha values indicated that each of the variables included in this study had satisfactory internal consistency reliability (see Table 3).Also inspection of the mean values shows that, generally respondents had low score for the four safety climate dimension – production versus safety pressure. From the items that assessed this dimension, such a low score implies the foremen and co-workers of respondents expect them to put speed before safety whenever they are behind production schedule. This is an indication of low or negative safety climate and demands attention.

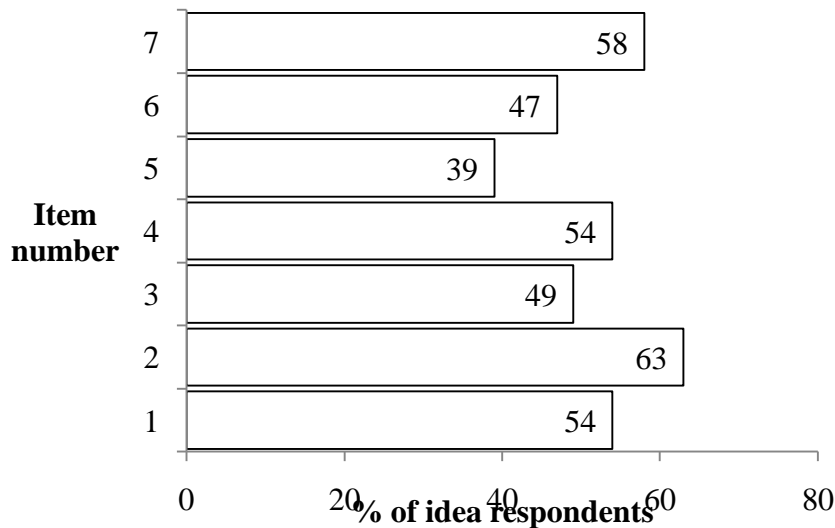
Also the mean score for the attitude towards safety rules was just a little above average. As such, the percentage of idea responses on each of the items measuring the two dimensions of safety attitude was examined. Idea responses in this case refer to a disagreement to the various attitudinal statements. From Fig. 1 it can be seen that more than half of the respondents reported ideally on all the items except for three of them. The one with the lowest ideal response (39%) was item 5 which assessed workers feelings about the information being provided during the safety meetings within their respective work units.



Table 3: Means, SD and Reliabilities of Study Variables

Variables	Mean	SD	Items	$\alpha$
<b>1. Safety Behaviour</b>				
Safety Compliance	3.01	0.63	4	0.61
Safety Initiative	3.32	0.56	3	0.59
<b>2. Safety Climate</b>				
Safety Communication	3.52	0.72	6	0.78
Co-worker Care For Safety	3.36	0.76	4	0.65
Supervisor Monitoring & Recog.	3.70	0.60	3	0.60
Production versus Safety	2.79	0.75	4	0.58
<b>3. Safety Attitudes</b>				
Attitude toward S. Rules	2.53	0.63	5	0.54
Fatalism	3.02	0.51	2	0.71
<b>4. Perceived Risk</b>				
	2.64	0.69	4	0.72

Figure 1: Percentage of ideal attitudinal responses (disagree or strongly disagree)



### 3.2. Group Differences

One-way ANVOAs and t-tests were conducted to determine differences between employees on the various study variables based on their gender, position, education, and work experience. The results revealed that respondents with different levels of education differed significantly in their risk perception ( $F(3, 269) = 3.66, p < 0.01$ ) and self reported safety compliance ( $F(3, 269) = 2.47, p < 0.05$ ). Bonferroni *post hoc analyses* showed that the significant difference in

risk perception was between respondents who had a primary education and a technical school as their highest level of education.

Differences in risk perception were also observed among respondents based on their age ( $F_{(3, 269)} = 2.76, p < 0.05$ ) and work experience ( $F_{(4, 268)} = 5.054, p < 0.01$ ). Respondents who have spent a longer time at their workplace (11<sup>+</sup> years) reported lower risk perception as compared to those who have been there for 5 or less years. Respondents' aged (40-49) had lower risk perception scores than those aged (18 – 29). However post hoc analysis revealed that this difference was approaching significant ( $p = 0.05$ ).

Aside these no other significant differences were observed in the study variables based on respondents' demographics.

### *3.2. Primary Analyses*

#### *3.2.1 Bivariate Correlations*

Table 4 depicts the bivariate correlations among study variables. Moderate and significant correlations were observed between all the main study variables except between risk perception and attitude towards safety rules. The safety climate dimensions were found to be significantly correlated with each other ( $r = .17$  to  $.40$ ). A positive correlation was also observed between respondents' age and work experience ( $r = .62$ ). Though not included in table 4, respondents' overall / global safety climate score (the average of all the 18 items considered together) showed positive and significant relationships with safety compliance and safety initiative ( $r = 0.55$  and  $0.41$  respectively). This suggests workers within a unit with a positive safety climate were more likely to engage in safer behaviours.

#### *3.2.2. Predictors of Safety Behaviours*

To assess which of the independent variables significantly predict safety behaviours, each of the two aspects of safety behaviours (Compliance and safety initiative) was regressed on the measures of safety climate, risk perception and safety attitude.

First, two hierarchical regressions were conducted to examine the ability of the global safety climate variable to predict safety compliance and safety initiatives over and above the other study variables. Key demographic variables were entered as controls in step 1. The two dimensions of safety attitudes together with risk perception were then entered in step 2. Lastly, the global safety climate factor was entered in step 3.

Table 4: Bivariate Correlations between variables (N = 273)

Variables	2	3	4	5	6	7	8	9	10	11	12	13
1. Safety Compliance	.23**	.35**	.24*	.34**	.26*	.49**	.30**	.14**	-.10	-.16**	.03	.16*
2. Safety initiative		.30**	.14*	.24**	.37**	.21**	.43**	.10**	-.13*	-.13*	-.07	-.07
3. Perceived Risk			.08	.20**	.19**	.23**	.14*	.11**	-.16**	-.06	-.22**	.15*
4. Att. towards rules				.28**	.27**	.21**	.10**	.20**	.03	.08	.15*	.05
5. Fatalism					.24**	.21**	.17**	.27**	-.01	-.05	.00	-.04
6. Safety Communication						.32**	.40*	.25**	-.11	-.23*	-.04	.03
7. Co-worker care for safety							.29**	.22**	.10	-.17**	-.10	.19**
8. Sup. Monitoring & Recog.								.26**	.04	.12*	-.11	.00
9. Production vrs safety									-.09	-.16**	-.09	.01
10. Age										.10	.62**	-.15*
11. Position											-.09	-.07
12. Work Experience												-.17*
13. Education												

\*\*represents significance at  $p < 0.01$ , \* represents significance at  $p < 0.05$

Table 5: Hierarchical Regression for Safety Behaviours with overall Safety Climate

Variables	Safety Compliance			sr <sup>2</sup>	Safety Initiative			sr <sup>2</sup>
	β	β	β		β	β	β	
Steps	1	2	3		1	2	3	
Age	-.07	-.05	-.02		-.11*	-.08	-.07	
Position	.13*	.10	.02		-.13*	.00	.04	
Years at work unit	.08	.11	.10		.00	.03	.01	
Education	-.17**	-.15*	-.11*		-.03	-.06	.08	
Perceived Risk	-	.27**	.18**	6.30		.16**	.17**	5.10
Attitude towards rules	-	.13	.04			-.03	.00	
Fatalism	-	.25**	.17**	5.78		.11**	.12**	2.88
Global Safety Climate	-	-	.42**	23.1		.25**	.32**	17.6
R <sup>2</sup>	.06	.25	.38		.03	.15	.22	
Δ R <sup>2</sup>		.19	.13			.12	.08	
Δ F	3.78**	22.10**	55.31**		.11	11.58**	25.64**	

Safety Compliance: Overall  $R^2 = 0.38$  [ $F_{(4,255)} = 19.80, p < .001$ ]; Safety initiative Overall  $R^2 = 0.22$  [ $F_{(8,255)} = 9.15, p < .000$ ] \*\* represents significance at  $p < .01$ , \* represents significance at  $p < .05$

As evident from table 5, the first block comprising of demographic factors was significant in predicting safety compliance [ $F_{(4, 259)} = 3.78, p < 0.01$ ] and accounted for 0.06 or 6% of the total variance explained. The second block which consisted of risk perception and safety attitudes was also significant [ $F_{(3, 256)} = 22.10, p < 0.01$ ]; accounting for 19% ( $\Delta R^2$ ) of the total variance. The global safety climate factor which formed the third block also significantly [ $F_{(1, 255)} = 55.31, p < 0.01$ ] accounted for 13% of the variance explained. The overall model (comprising of all the factors) for safety compliance was significant accounting for 38% [ $F_{(4,255)} = 19.80, p < .001$ ] of the total variance.

Inspection of the Beta ( $\beta$ ) coefficient in the final step revealed that three of the independent variables significantly contributed to the prediction of safety compliance over and above the demographics. Relatively the global safety climate factor contributed the most; uniquely accounting for 23.1% of the explained variance, followed by perceived risk (6.3%) and lastly fatalism (5.78%). That is, safety climate predicted employees' compliance with safety rules and standards over risk perception and safety attitudes. Collinearity was not a problem in this analysis since the average VIF obtained (1.03) was very close to 1.

In a similar vein, safety climate emerged as the strongest predictor of workers propensity to take safety initiative over the other independent variables. Its unique contribution however was 17.6% which lower than that of safety compliance. The overall model for safety initiative (Table 5 right) significantly accounted for 22% [ $F_{(4,255)} = 9.56, p < .001$ ] of the explained variance.

To investigate the capacity of the specific safety climate dimensions to the two aspects of safety behaviour, two other regressions were conducted. The variables were entered in a manner similar to the regressions reported in table 5. However in step 3, the four specific dimensions of safety climate were entered instead of the global safety climate factor. Table 6 shows the results of the regression analyses which regards to the two safety behaviours - Compliance (left) and safety initiative (right). Collinearity was also not a problem in these analyses too since the no high VIF was obtained. They were all was very close to 1.

The results revealed that the overall model for safety compliance was significant accounting for 51% [ $F_{(11,252)} = 25.93, p < .001$ ] of the total variance. Four of the independent variables significantly contributed to the predicting compliance above the demographics. Relatively a safety climate dimension - co-worker value for safety contributed the most; uniquely

Table 6: Hierarchical Regression for Safety Behaviours with Safety Climate Dimensions

Variables	Safety Compliance				Safety Initiative			
	$\beta$			$sr^2$	$\beta$			$sr^2$
Steps	1	2	3		1	2	3	
Age	.07	.05	.00		-.11*	-.09	.08	
Position	.13*	.10	.01		-.13*	.11	.00	
Work Experience	.08	.11	.07*	0.21	.01	.03	.02	
Education	.17**	.15*	.04		-.03	-.05	.05	
Perceived Risk	-	.27**	.18**	6.30		.23**	.16**	4.8
Attitude towards rules	-	.13	.02			-.07	.09	
Fatalism	-	.25**	.15**	5.10		.18	.02	
Safety Communication	-	-	.02				.27**	10.0
Co-worker care for safety	-	-	.34**	16.66			.00	
Sup. Monitoring & Recog.	-	-	.12**	3.60			.34**	14.62
Production vrs safety	-	-	.01				.05	
R <sup>2</sup>	.06	.25	.51		.03	.15	.31	
Delta R <sup>2</sup>		.19	.26			.12	.17	
Delta F		22.00**	37.90**			11.53**	15.06**	

*Safety Compliance: Overall R<sup>2</sup> = 0.53 [F<sub>(11,252)</sub> = 25.93, p < .001]; Safety initiative Overall R<sup>2</sup> = 0.31 [F<sub>(11,252)</sub> = 10.28, p < .001]*

*\*\* represents significance at p < .01, \* represents significance at p < .05*

accounting for 16.6% of the explained variance, followed by risk perception (6.3%), then fatalism (5.1%) and lastly supervisory safety actions (3.6%). That is, two safety climate dimensions made significant contribution to predicting respondents' safety compliance with one of them emerging as the strongest predictor.

Also, two safety climate dimensions contributed to predicting employees' safety initiative. Of these, employees perception of their supervisors' monitoring and recognition of safety related behaviours was the strongest predictor; uniquely accounting for 14.62% of the explained variance. The other variable was safety communication with a unique contribution of 10%.

Beside these two, the level of risk perceived made a significant unique contribution of 4.8%. The overall model for safety initiative significantly accounted for 31% [ $F_{(11,252)} = 10.28, p < .00$ ] of the explained variance.

#### **4 .Discussions and Conclusions**

This study examined the relationship between safety climate and mine workers' safety behaviour in the context of two other known behavioural influences – attitudes and perceived risk. The results revealed that for this group of workers, safety climate, perceived risk and fatalism (i.e. the belief about whether or not accidents could be controlled) were associated with safety compliance. Also, safety climate and perceived risk were found to be associated with safety initiatives.

Relatively, perception of safety climate was more strongly related to workers' safety behaviours than their demographics, attitudes and the level of risk perceived. Technical workers who perceived more positive safety climate reported high levels of compliance with safety standards than those who did not. They also reported undertaking more safety initiatives (non-mandatory safety activities) as compared to their colleagues who perceived less positive safety climate in their units.

Together these observations support the point that, what workers perceive regarding the priority given to safety in the workplace strongly influence how they act in relation to safety. This is consistent with what majority of previous safety climate studies conducted in other industries (e.g. Wills et al, 2009; Morrow et al, in press; Clarke, 2006; Neal et al, 2003) have reported. It therefore serves as a first step towards justifying the use of safety climate as a

leading indicator of safety conditions within the mining industry and also as a guide for developing behavioural change interventions.

In addition to examining the impact of the global safety climate construct on behaviour, this study also explored the relative importance of specific safety climate dimensions in relation to safety behaviours. The results revealed that different dimensions of safety climate were more salient for specific kinds of safety behaviours. This was evident from the fact that different dimensions uniquely made the most contribution in predicting either compliance or safety initiative. Among the dimensions examined, co-worker value for safety emerged as the strongest significant predictor of safety compliance over and above attitudes and risk perception. On the other hand, supervisory monitoring and recognition of safe behaviours was the strongest predictor of workers' propensity to undertake non-mandatory safety activities.

These observations indicate that safety climate dimensions differ in terms of the relative strength of their relationships with safety behaviour. In essence, this offers an insight into why Clarke (2006) observed considerable variations in the strength of the relationships between overall safety climate and safety behaviour reported in previous studies. It suggests that the use of different dimensions in different studies to assess the overall safety climate perception might be responsible for the variations.

In another regards, the observation that the magnitude of the effect of co-workers value for safety on workers' safety compliance was larger than that of supervisory monitoring and recognition is an interesting one. Among the current sample, this may be attributed to the nature of their work organization and their cultural background. They are mine workers who usually work as crews and it is common to find several crews working under a supervisor. Since supervisors have to give attention to all the crew under him, there may be limited supervisory contacts and hence safety monitoring. Thus workers may most of the time find themselves under the watch of their peers. Consistent with informational social influence hypothesis (Westaby & Lowe, 2005), because supervisors are not always available to guide and monitor safety behaviour, workers are likely to learn key components of their job by watching how their co-workers get work done. Thus, workers can be expected to comply with safety standards when they co-workers do so. This influence might even be greater for the current sample due to their background as individuals from a relational culture – Ghana where

much importance is attached to group harmony (Markus & Kitayama, 1991; Oyserman et al., 2002).

Nonetheless, this finding has an important implication for investigating safety climate as well as employee performance in general. It is in line with recent studies of the concurrent impact of management (supervisors) and co-workers on employee behaviour (Tucker et al, 2008; Westaby & Lowe, 2005) and supports the point that focusing on supervisors' behaviour alone may be insufficient in getting employees to work according to the required standards. Most existing models of unit level safety climate do not include aspects of co-worker safety actions (Lingard et al, 2009). But the current results suggest that depending on the nature of work organization, co-workers can be important social referents for safety climate perceptions. Their safety related practices guide their colleagues and indicates to them the overall priority accorded safety during work performance. As such there is the need for future studies to inculcate items pertaining to co-worker safety into measures developed to assess unit-level safety climate.

#### Implications for Safety Management

To improve employees' safety behaviour, insight into potentially important and modifiable antecedents is needed when developing effective strategies. Findings from this study provide some suggestions for developing interventions to enhance employees' safety compliance as well as their propensity to undertake safety initiative. These findings indicate that different aspects should be focused on when promoting safety compliance and initiative behaviours.

When developing interventions to encourage safety compliance, one should particularly focus on co-worker safety norms, risk perception and supervisory monitoring. For example, the focus of improvement in this case should be on promoting active caring among workers, enhancing risk perception and improving the coaching behaviour of supervisors. Active caring according to Burts et al (1998) refers to the notion that employees care about their colleagues to the extent that they actively promote safe behaviour, monitor the environment for hazards, and intervene whenever necessary to ensure safety. It includes ensuring that colleagues do not act unsafely and hence increase their chances of getting injured. This can be promoted within a particular work unit by introducing a safety 'buddy system' in which workers are paired to befriend and monitor each other. This kind of informal social control has proven to be



effective in improving pro-environmental (Cialdini, 2007) and health (Real and Rimal, 2007) behaviours and can have the same effect with regards to workplace safety.

Supervisory monitoring and recognition of safe behaviours, safety communication and risk perception should be addressed when focusing on improving safety initiative behaviours. In this case, a suitable environment where workers face no negative repercussions for raising safety concerns should be created. Also, the intervention should ensure that supervisors do not only keep track of the unsafe practices of workers but also acknowledge their safe behaviours.

### Limitations

It is important to note some potential limitations of this study. The first concerns extending the research to other group apart from the targeted population. The research data was collected in a mining industry which tends to be more hazardous than the working environments in other industries. Most often the safety hazards that mine workers may encounter can be extremely dangerous situations which are rarely the case in an office working environment. Considering this together with the nature of work organization in the mining sector, the findings may be less extendable to working environments where workers are not confronted with such serious hazards on a daily basis or where workers do not often work as a team or crew.

A second issue concerns the fact that data were collected from the same survey and the same set of respondents; which implies the potential for the observed relationships to have been either inflated or deflated by common method variance (Podsakoff et al., 2003). On two grounds this possibility can be ruled out in this current study. One reason is that, the bivariate correlations did not indicate consistently high coefficients, which would have been the case if the relationships were due to common method variance. Also the magnitude of the variance explained by safety climate is similar to that found by Clarke (2006) in her meta-analytic studies (i.e. 13% and 8% as compared to 22% in the meta-analysis). Nonetheless, it is recommended that in future studies it would be desirable to establish the observed relationships using data from different sources. For example safety behaviour can be measured through observation.

## Conclusion

On the whole, the study showed that perceived safety climate is associated with safety oriented behaviours of technical mine workers. This implies that mining industries may indirectly shape the behaviours of workers through a modification of the safety climate in the various work locations. To do this efficiently and effectively, the study suggests that practitioners should first identify the safety climate dimension that is strongly related to the particular behaviour of interest so that much attention can be focused on that dimension. For example efforts to improve compliance should seriously consider restructuring the descriptive safety norm among workers since co-workers safety value and practices significantly influence safety behaviour. For future safety climate investigations it is recommended that emphasis should be placed on identifying the dimensions most salient for the various aspects of safety behaviour in different industries. This will enhance the applicability of safety assessments as a tool to guide behavioural change initiatives.

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