‘Investigating the relationship between LMX, safety climate and the components of safety performance in a high accident environment’

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This thesis presents two distinct, but linked, studies. Study 1 contrasted interactive [group] brainstorming against its nominal [individual] counterpart. Previous research has pointed to the productivity advantages of nominal brainstorming in terms of idea production rate [ideation], leading theorists to predict 'the end of interactive brainstorming'. Yet interactive brainstorming has remained the most popular means of ideation within organizations. Central to this research is the thesis that previous studies (a) failed to follow the instructions of the concept originator, Osborn (1953) and (b) used samples and conditions that were not representative of the organizations using brainstorming. Using a total of 10 groups sourced from a UK construction company, participants were asked to brainstorm ideas to improve organizational safety performance. Data produced indicated an equal average number of ideas generated, 30 for interactive, 30.2 for nominal, and an equal number of themes generated, 6.6 for interactive, 6.6 for nominal. Along with ideas and themes, post session group cohesion and process satisfaction levels were measured. Results indicated significantly higher levels of cohesion (t (73.75)=2.35, P<.05) and satisfaction (t (71.07)=4.74, P<.001) for the interactive condition over its nominal counterpart. Implications for research in this area are discussed.

Study 2 consisted of two strands of research. The utility of interactive brainstorming, demonstrated in Study 1, highlighted its potential as a means of improving participation in safety. This formed the first area of research. The second area of research concerned the design and analysis of a working model in which Leader Member Exchange (LMX) and safety climate were identified as antecedents, compliance and participation as components and self report near miss/accident involvement as outcomes of safety performance. This model, and the potential utility of brainstorming as a means of improving participation, was tested using a longitudinal methodology. Study participants, sourced from the Refuse Collections division of a UK Local Authority, were asked to complete a questionnaire. LMX was measured using Graen and Uhl-Bien’s (1995) LMX-7 scale, safety climate using Glendon and Litherland’s (2001) questionnaire whilst measures of compliance and participant were sourced from Neal and Griffin (2006). This produced 101 respondents. Following this, brainstorming sessions were conducted with employees to produce safety improvement ideas. Questionnaires were redistributed seven months later and produced 104 respondents. Results indicated no improvement in participation over the period allocated, however, the measures of antecedents, components and outcomes of safety performance produced a number of significant findings. LMX was found to exhibit a direct relationship with accident involvement, however, analysis revealed the fluctuating mediating roles of compliance and participation in this relationship. Safety climate was found to moderate the relationship between LMX, compliance and participation. Although high levels of safety climate corresponded to higher levels of compliance and participation, LMX was seen to improve compliance and participation only in low climate environments, with this relationship reverse in positive safety climates. This finding is contrary to similar research in this area and the implications for future theory are discussed.

20th May, 2010
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Finally, thank you to Imogen who has heard nothing but PhD worries for longer than she would probably care to remember but has remained (a) around, (b) amazing, and (c) positive; and to Thomas who got me up in the morning.
The Author
Having completed a degree in Chemistry, I worked in the Chemical Industry for a number of years before deciding to retrain in psychology. This decision was influenced by a number of factors, however, one of the main drivers was an interest in human behaviour and safety. Once I completed a conversion course in psychology, I applied for a MSc in Occupational Psychology at Manchester Business School. Prior experiences in the Chemical Industry coupled with discussions with Dr Sharon Clarke triggered a fascination in the concept of safety climate and my dissertation topic concerned the role of cohesion in group safety performance. After completing my MSc, I elected to undertake a PhD supervised by Sharon and focussing on the role of participation and relationships in organizational safety performance. Along with my academic interests, I have worked for a number of consultancies in the UK as a Human Factors specialist. This work has both supported and challenged my academic convictions in equal measure. I currently work as an HM Specialist Inspector (Human Factors) with the UK Health and Safety Executive (HSE).
Introduction

Preface
If you are at a party and conversation moves to work, telling people you are an Occupational Psychologist normally triggers a series of interested questions. When these questions eventually reveal you specialize in health and safety, people tend to look simultaneously sorry and bored. Few occupations can end conversation with the speed and finality of health and safety. To someone who has an interest in this topic, this reaction is a mystery. Workplace accident and ill health is estimated to cost UK society £20 billion (HSE 2009). Whilst the financial implications are staggering, they are insignificant when contrasted with the human cost of poor health and safety. The HSE estimate that an individual loses their life every working day in the UK (HSE 2009). For each fatality a family is left wondering if their lost one could have done more to protect themselves, whether the organization could have done more, whether their manager or supervisor could have done more. It is the study of what more can be done that occupies health and safety specialists and few occupations possess the capacity to positively influence life through such profound and direct means.

Establishing Study Need
For many years, effective health and safety was regarded as an issue of design. The product of this design can be seen around us; crumple zones and airbags in cars, improved lighting and signage on roads, aircraft designed with key component failure rates of $10^{-9}$. Each of these design innovations has likely saved lives and there was a general societal expectation that this pattern of designing in safety would continue until accidents rates were sufficiently suppressed. A number of events challenged this notion. Over time, researchers noted a change in the downward trend of incident and accident rates, a plateau that seemed unaffected by continual technical improvement. In looking to address this plateau, organizations began to look at human factors, focussing primarily on the role of human error in incident causation (Clarke 2000). Researchers began to see error as the end of a causal chain with theorists such as Turner (1978) noting the influence of socio-technical factors. Studies began to tentatively discuss organizational factors, such as management commitment and communication (Cohen, Smith and Cohen 1975).

Zohar (1980) published his account of the significance of safety climate in organizational safety performance in 1980. This, coupled with IAEA comments concerning the role of safety culture in Chernobyl, triggered a surge of research interest in organizational factors and their relationship to
incident and accident occurrence. Climate research focussed on the identification of a stable measure of safety climate and its association with an acceptable measure of safety performance. As research evolved, understanding concerning the nature of safety climate improved. Theorists, such as Dedobbeleer and Beland (1991), Zohar (2000) and Neal and Griffin (2006) identified safety climate as an antecedent of safety performance, a context that allows individuals to gage the suitability of their behavioural responses. Following this, meta-analysis was able to demonstrate a link between safety climate and safety performance (Clarke 2006b), providing added impetus for companies to get their climate and hence culture ‘right.’ Whilst theories of climate developed, researchers began to identify other elements with significance to safety performance. Primary among these was participation.

Participation has been subject to a huge volume of research in the general academic arena. Studies have repeatedly linked a participative approach with a range of positive outcomes, including increased workforce satisfaction and performance (Wagner 1994). Basic health and safety regulation (HSE 1974) provided guidance concerning the requirement for workforce consultation, however, research commissioned by the HSE revealed many organizations were unaware of their statutory requirements in this area (Shearn 2005).

Regulatory and academic research has repeatedly highlighted the effectiveness of worker participation in health and safety management (Walters 1996; Shearn 2004; Shearn 2005; Walters, Nichols, Connor. Tasiran and Cam 2005) and yet, as Shearn reported, organizational commitment to participation in non-unionized working environments can be described as ‘varied’ (Shearn 2005, pg 20). Potential explanations for this fluctuation in commitment are complex but one issue may centre upon a lack of understanding of how participation fits into a model of safety performance. Indeed, few theorists, with the exception of Neal, Griffin and Hart (2000), have combined the concepts of participation and behavioural outcome measures into a model of safety performance. Neal et al identified safety climate as an antecedent of safety performance, and, using a longitudinal methodology, were able to find evidence to support their designation of safety compliance and participation as components of safety performance.

This study intends to build upon Neal and Griffin’s model of safety performance in two ways:
First, the concept of participation will be investigated to ascertain whether an intervention to promote involvement in safety has the potential to effect perceived participation in safety. Although various studies have attempted to promote participation in safety, there remains a lack of cohesion how this can be reliably and universally achieved (Shearn 2005). This study identifies brainstorming as a potential tool to improve participation in safety. In an initial study, two different types of brainstorming will be analyzed, interactive [verbal] and nominal [individual], to identify which possesses the ideal characteristics to improve participation in safety. Judgement will be based upon ideation rate, coupled with group cohesion and satisfaction post-brainstorming session. Once identified, this technique will be integrated into a second, longitudinal study, to identify its efficacy as a promoter of participation. Measures of safety climate, compliance, participation and near miss/accident involvement will be made prior to, and seven months after brainstorming sessions to detect if any changes occur.

The second aspect of this study involves the further study of the relationship between leadership, safety climate and accident involvement. To this end, Leader Member eXchange (LMX) will be identified as a potentially significant antecedent of safety performance. LMX originated as an alternative to average leadership style and is based on the premise that leaders form differing relationship with their followers. Good LMX relationships are characterized by high levels of trust, respect and obligation (Graen and Uhl-Bien 1995). Theorists suggest that positive LMX relationships produce targeted behavioural reciprocation on behalf of the follower. For example, if a worker feels they have a good LMX relationship with their supervisor, they will be likely to reciprocate with behaviours identified as beneficial for the supervisor, for example, hit sales targets.

The inclusion of LMX as an antecedent of safety performance reflects a growing research interest in the role of relationships, more specifically, leader-follower relationships, in safety (Hofmann and Morgeson 1999; Hofmann, Morgeson and Gerras 2003; Zohar and Luria 2004; Michael, Guo, Wiedenbeck and Ray 2006). LMX provides a particularly good platform for the study of leader-follower relationships due to the reliability and validity of its primary measurement tool, the LMX-7 scale (Graen and Uhl-Bien 1995). Additionally, theorists have been able to demonstrate that safety
climate plays a role in influencing the identification of the reciprocal behaviours that are characteristic of positive LMX relationships (Hofmann et al 2003).

This study, therefore, integrates LMX, safety climate, compliance, participation, brainstorming and near miss/accident involvement to produce a theoretical model with the potential to account for individual and organizational aspects of safety performance. Research questions concerning this model are numerous. Although previous research investigating LMX and identification of organizational citizenship behaviours demonstrated a moderating role for safety climate (Hofmann et al 2003), this study has identified compliance and participation as components of safety performance, and, in doing so, has introduced variables with a more direct link to near miss/accident involvement than organizational citizenship behaviours. It is possible that this link could result in a direct relationship between safety climate and compliance/participation, with LMX moderating. In addition, the relationship between LMX, compliance/participation and near miss/accident involvement remains a mystery with potential for compliance/participation fully mediating or partially mediating this link, or even for there to be no link detectable. Whilst the research conducted by Neal and Griffin (2006) indicates a link between safety climate and compliance/participation is likely, this should not be considered prescient for the LMX and compliance/participation relationship.

**Study Aims**
The aims of this study can be summarized:

1. Ascertain which form of brainstorming, nominal or interactive, would be better suited to improving participation in safety performance. Base this judgement on:
   a. Number of ideas produced
   b. Level of satisfaction with process
   c. Level of group cohesion following process
2. Ascertain whether brainstorming can be used to improve levels of perceived participation in safety, and, if effective, whether this improvement has a subsequent impact upon near miss/accident involvement
3. Ascertain the relationship, if any, between LMX, safety climate and compliance/participation
4. Ascertain the relationship, if any, between LMX, safety climate, compliance/participation and near miss/accident involvement
To achieve these aims, a number of objectives are required.

Objective 1: Develop a good understanding of safety climate literature and hence identify a suitable means of safety climate measurement.

Objective 2: Develop a good understanding of the predictors of safety performance, including Performance Shaping Factors and LMX. Identify a suitable means of LMX measurement.

Objective 3: Develop a good understanding of the role participation can have in safety performance.

Objective 4: Develop a good understanding of the brainstorming process and hence its suitability as a means of improving organizational participation in safety.

Objective 5: Knit information gathered to produce a working model of safety performance that takes into account the relevant literature and explains how the different constructs, including LMX, safety climate, participation, compliance and near miss/accident involvement, may interact.

**Thesis Structure**

These aims will be achieved through a stepwise process of literature review, methodology design, data collection and analysis, discussion and conclusion. Study 1 will be charged with the identification of the most suitable brainstorming technique to be used (i.e. nominal vs. interactive) whilst Study 2 will operate these findings alongside research concerning the integration of LMX into an overarching model of safety performance. To accommodate the dual study methodology, this thesis will divided into the following chapters:

Chapter 1 will provide a review of safety climate research. The purpose of this chapter is to further understanding of the relevant research issues and draw out conclusions able to guide research decision making. A number of issues surround safety climate research, ranging from the relationship with safety culture, the level at which climate can be measured (i.e. individual or group) and the use of factorial or global approaches. Each of these issues present a research question that must be addressed in the context of this study. Ultimately, the conclusions drawn from this chapter will assist in the identification of a suitable means of safety climate assessment and provide support for this decision.
Chapter 2 will consider the dual concepts of Performance Shaping Factors (PSF) and LMX; termed predictors of safety performance. This chapter will provide definitions of PSFs and attempt to link this research with the broader topic of safety climate. Particular attention will be paid to any distinct factors associated with PSFs and how they might add value to safety climate research. In addition to PSFs, this chapter will also review LMX research. This section of the review will compare LMX research with competing theories of leadership, such as average leadership style, making clear the distinctions between these approaches. Chapter 2 will also detail the measurement scales available to LMX researchers. At its conclusion, Chapter 2 will demonstrate the association between PSFs and safety climate and provide an overview of how these dual topics could or even should interact. Additionally, Chapter 2 will also make clear the unique features of LMX when contrasted to other measures of leadership and highlight the ideal means of construct measurement.

In its introduction, Chapter 3 will summarize the issues inherent in previous attempts to improve participation in safety, and, in doing so, will highlight the potential for a new approach - brainstorming. Once the potential for this technique has been established, Chapter 3 will outline the major debate in the brainstorming literature, namely the performance comparisons between interactive and nominal techniques. In its conclusion, Chapter 3 will have highlighted the requirement for a novel approach to improve participation in safety and justified the consideration of brainstorming to fill this requirement. Consideration of brainstorming literature will have outlined the requirement for research regarding the optimal brainstorming technique.

Chapter 4 will present the methodology, results, discussion and conclusions for Study 1. The methodology will briefly discuss the epistemological nature of the study, linking this to the research decisions made (e.g. group sizes and participant selection process etc). Following this, information concerning the strengths and weaknesses of the analytic techniques utilized will be provided. This will be supplemented by methodological information concerning the sample, method, scales used and other information. Study 1 results will highlight the advantages of a particular technique (e.g. nominal vs. interactive). Chapter 4 will contain discussion of Study 1 findings as well as any conclusions that can be
drawn. These conclusions will inform the working model that will form the template for the second study, designed to further understanding of the relationships between LMX, safety climate, compliance/participation, brainstorming and near miss/accident involvement.

Chapter 5 will first present the working model of safety performance, informed by the literature reviews completed and the results produced in Study 1. This section of the chapter will aim to tie-in methodological threads and present the reader with a coherent narrative for the main thesis study. Following this, methodological information will be outlined including sample size and composition, statistical techniques employed and the advantages or disadvantages of the decisions made. Results will be presented sequentially in line with hypotheses. At its conclusion, Chapter 5 will have made clear the reasoning behind the methodological decisions made and presented the findings appropriately.

Chapter 6 will provide discussion of Study 2 results with focus placed on any contribution to knowledge made. This chapter will also reference back to address the study aims and objectives detailed in the thesis introduction. Conclusions will be drawn concerning the extent to which these aims and objectives have been met. Particular methodological successes and weaknesses will be detailed and implications for findings discussed.

Chapter 7 will provide Study 2 conclusions. In light of findings, opportunities for further research will be discussed.

This study will begin with Chapter 1, a review of safety climate.
Chapter 1 - Safety Climate

Chapter Preface
This chapter is charged with the delivery of Objective 1, namely the identification of a suitable measure of safety climate. Of the scales used in this study, safety climate represents one of the most mature in terms of research publication. As this chapter will demonstrate, the choice of climate scale carries with it a number of methodological assumptions concerning the nature or understanding of safety climate at an ontological and epistemological level. Debates concerning the context of safety climate, a snapshot of culture or an extension of organizational climate, and the means by which it can be measured, using attitudinal and/or perceptual items, are wrapped up in the selection of scale employed. Hence, the choice of scale must be shown to be the result of a considered process, and, importantly at the doctoral research level, justifiable in the context of the study.

This chapter will first consider definitions of safety culture before reviewing the historical development of the concept. Findings will then be contrasted with the concept of safety climate with a particular focus placed upon strands of similarity and difference in the key areas of definition and development. The review will then take in the wider debate concerning organizational culture and climate before settling again within the domain of organizational safety climate research. Specifics such as group level versus individual level measurement will be considered, along with other salient debates concerning the nature of safety climate. At its conclusion, this chapter will aim to provide valuable guidance to inform the research decisions made concerning the measurement of organizational factors in this study.

Introduction
Every year, 34 million days are lost to British industry as a result of accident or ill health caused by work (HSE 1997). During every working day in the UK, at least one person will loose his or her life as a direct result of their work activities (HSE 2009). Loss of life is compounded by the financial cost of incidents and accidents. BP is estimated to have reserved over $1 billion to deal with the direct costs of the Texas City oil refinery explosion in 2005 (BBC 2006). This figure does not include the cost to the business of loosing refining capacity or other associated insurance premium or rebuild costs. Clearly good health and safety performance is good business.
The last 30 years has seen a perceivable shift in efforts to reduce accidents and ill health at work. Instead of a focus upon technical explanations of accident causation, researchers have begun to look instead at organizational causes of incidents (Reason 1990). This refocus of efforts has produced a prolonged and sustained interest in organizational safety culture. The term safety culture was first coined as part of an International Nuclear Safety Advisory Group (INSAG-3 1988) report, produced in response to the Chernobyl nuclear accident. A later publication offered the following definition ‘that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, [nuclear] plant safety issues receive the attention warranted by their significance’ (INSAG-4 1991, pg 1).

Since Chernobyl, safety culture has been referenced in a number of major incident and accident reports, including Herald of Free Enterprise (Sheen 1987), Kings Cross (Fennel 1988), Piper Alpha (Cullen 1990), Grangemouth (HSE 2003) and Texas City (Baker 2007). The ubiquity of safety culture in major accident investigation findings, it would seem, identifies it as one of the keys to understanding incident causation and hence preventing future occurrence. In this context, safety culture represents the ‘philosophers stone’ (Cox and Flin 1998), the cure all for organizations wishing to prevent major accident. Yet an agreed definition of safety culture remains elusive (Guldenmund 2000) and a review of cultural measurement techniques finds a vast spectrum of methodologies available and in use (Choudhry, Fang and Mohamed 2006; Guldenmund 2007). This, without any consideration of the culture/climate debate (Clarke 2000) which challenges researchers, organizations and regulators alike.

The purpose of this chapter is to gain an understanding of the published literature concerning safety culture and climate, and, in doing so, develop clarity concerning how these concepts may be investigated. This will be achieved through the review of safety culture and climate definitions, with particular attention paid to the implications inherent in each statement. Following this, this review will consider the demarcation of organizational culture and climate and expand this to include the theories of safety culture and climate. This review will then look in detail at safety climate literature, focussing on the various issues and methodologies that surround construct measurement. At its conclusion, this chapter aims to have identified a suitable means for the assessment of
organizational safety performance and considered how this technique may add to the available literature and so contribute to knowledge in this area. The first step in this process is the consideration of safety culture definitions.

**Definitions of Safety Culture**

Safety culture has remained a topic of interest in the research community for a number of years, however, little agreement exists concerning its precise definition (Cox and Flin 1998; Clarke 2006b). Using ‘safety culture’ as a key word, a search of ScienceDirect, Psychinfo, APA and Psycline produces the following definitions, summarised in Table 1.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
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<tr>
<td>Pidgeon, Turner, Blockley and Toft (1991, pg 683)</td>
<td>The set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimising the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious</td>
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<td>Lee and Harrison (2000, pg 62)</td>
<td>In a healthy [safety] culture, the avoidance of accident and injury by all available means is the responsibility of every person in the organization… the integration of role behaviours and the consolidation of social norms create a common set of expectations, a ‘way of life’ that transcends individual members. A culture is much more than the sum of its parts</td>
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<td>Reason (1997, pg 220)</td>
<td>A positive safety culture is] ‘A state of grace, a safety culture is something that is striven for, but rarely attained’</td>
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<td>Uttal (1983, pg 67)</td>
<td>‘Shared values and beliefs that interact with an organization’s structures and control systems to produce behavioural norms’</td>
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<tr>
<td>HSC (1993, pg 23)</td>
<td>The produce of individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organizations health and safety programme’</td>
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<td>Geller (1994, pg 18)</td>
<td>In a total safety culture, everyone feels responsible for safety and pursues it on a daily basis; employees go beyond the call of duty to identify unsafe conditions and behaviours and intervene to correct them’</td>
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<tr>
<td>Cox and Cheyne (2000, pg 114)</td>
<td>‘Culture in general, and safety culture in particular, is often characterised as an enduring aspect of the organization with trait like properties, not easily changed’</td>
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<tr>
<td>Jeffcott, Pidgeon, Weymann and Walls (2006, pg 1105)</td>
<td>‘Organizational safety culture reflects the attitudes and behaviours that individuals share in considering and reacting to hazards and risks; ‘safety culture is based around a set of defined practices that an organization is able to adjust in a positive or negative direction’</td>
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<tr>
<td>HSC (1993, pg 12)</td>
<td>‘The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization’s health and safety management’</td>
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Table 1 highlights the ‘holistic approach’ most researchers utilize when attempting to define safety culture (Guldenmund 2000). Whilst some definitions consider the group and individual as separate entities (ACSNI 1993; Jeffcott et al 2006), others refer only to a group mediated construct (Uttal 1983; Gherardi and Nicolini 2000; Hale 2000). Some relate culture to ‘risk’ or ‘risk control’ (Guldenmund 2000; Hale 2000; Jeffcott et al 2006) whereas other consider culture to be aligned to the safety management system (ACSNI 1993; HSC 1993). The association of culture and management systems can be, in part, explained through the evolution of the concept. Safety culture was developed in the prism of accident and incident investigation (Sheen 1987; Fennel 1988; Cullen 1990; INSAG-4 1991; Baker 2007) and so has repeated appeared within the remit of health and safety regulation. Regulators have always been keen to focus safety culture on tangible elements that can be assessed and enforced and safety management systems form a key component in this approach.

It has been noted ‘all definitions that attempt to capture the essence of safety culture are bound to be inadequate because each of its many manifestations are extensive, complex and intangible’ (Lee and Harrison 2000, pg 62). If this is the case, and safety culture is little more than an umbrella term
for organizational safety issues (Cox and Flin 1998) there would seem little point in its investigation as part of attempts to improve safety performance (Fleming and Lardner 1999; Cox and Cheyne 2000; Mengolini and Debarberis 2007) or, indeed, its consideration in major incident and accident reports (Sheen 1987; Fennel 1988; Cullen 1990; Baker 2007). In this context, safety culture is only a collective term for *things that are wrong* as opposed to a precise, objective and empirical element with the potential to address the multitude of individuals and organizational failings known to contribute to accident and incident causation (Reason 1990). Such ‘umbrella’ thinking can be illustrated through consideration of the Baker Report.

On March 23rd, 2005, the BP Texas City oil refinery was engulfed in an explosion that killed 15 people and left more than 170 injured (Baker 2007, pg 1105). The incident, one of Americas worst process safety accidents in the last 20 years in terms of lives lost, prompted authorities to recommend BP establish an independent review to investigate ‘the effectiveness of BP North America’s corporate oversight of safety management systems at its refineries and its corporate safety culture’ (Baker 2007, pg viii). In response, BP established the Refineries Independent Safety Review Panel in October 2005, often referred to as the Baker Panel, less than two months after authority recommendations. The Baker Panel had a clear mandate to investigate safety management systems alongside safety culture; indeed, a review of panel recommendations identifies improvements in *Corporate Safety Culture* as the headline finding, superseding *Process Safety Performance Evaluation, Corrective Action and Corporate Oversight* (Baker 2007, pg xiv).

In their assessment of BP’s safety culture, the Baker Panel reported ‘after considering a number of existing survey assessment tools previously used to evaluate safety culture in a variety of industries...[it was concluded] an appropriate tailored process safety survey or benchmarking tool did not exist’ (Baker 2007, pg 7). As a result, the Panel developed its own survey instrument drawing, in particular, ‘on the expertise of those Panel members with experience in developing and administering workforce surveys’ (Baker 2007, pg 7). The Panel created the Process Safety Culture Survey, a 65-item questionnaire separated into six categories; process safety reporting, safety values/commitment to process safety, supervisory involvement and support, procedures and equipment, worker professionalism/empowerment and process safety training.
This chain of events introduces the apparent paradoxical properties of safety culture. Regulators, organizations, and academics have all identified it as a key component of safety performance, perhaps the key component. As its stock rises, however, so does the debate concerning its constituent parts. The Baker Panel detailed poor safety culture as their primary report finding but it was their version of safety culture, trimmed in some areas, expanded in other to suit the exact frame of the problems they found. This ‘bespoke tailoring’ of safety culture can be observed throughout its development in the shadow of incident and accident investigation.

Despite this criticism, closer consideration of the definitions outlined in Table 1 highlights a number of reoccurring topics and hence indicates some potential points of continuity. The frequency of reference to terms such as values (Uttal 1983, pg 67; HSC 1993, pg 23), attitudes (Turner et al 1989; HSC 1993; Gherardi and Nicolini 2000; Guldenmund 2000; Jeffcott et al 2006) and behaviour (Uttal 1983; HSC 1993; Geller 1994; Gherardi 2000; Guldenmund 2000; Lee 2000; Jeffcott et al 2006) suggest the potential for, if not the emergence of, continuity in factors associated with safety culture. With continuity comes the potential for specification and hence objective measurement, however, if organizations are going to respond to regulatory pressure to develop 'a positive safety culture' (HSC 1993, pg 23) there must be agreement not only in which factors should be measured (i.e. attitudes, beliefs and behaviours) but also how these factors could be measured (e.g. questionnaire, behavioural analysis, focus group).

Despite signs of continuity, a number of academics question the value of safety culture as a concept. Clarke asked ‘safety culture, underspecified or overrated?’ (Clarke 2000). Cox and Flin argued that the popularity of safety culture had exceeded the published evidence of its predictive validity (Cox and Flin 1998). Although these criticisms refer to the content of safety culture assessments as opposed to their definitions, it is clear these elements are intrinsically linked. Such criticisms highlight the value of alternative means of organizational safety performance assessment, namely safety climate. This review will consider definitions of safety climate and use these to contrast climate with culture. The varying epistemological and resulting methodological assumptions will then be considered to aid understanding of the conceptual distinctions that exist between these seemingly homogenous topics.
Definitions of Safety Climate
Coyle, Sleeman and Adams (1995) describe safety climate as ‘the objective measurement of attitudes and perceptions toward Occupation Health and Safety (Coyle et al 1995, pg 247). Coyle et al also suggest ‘safety climate is best considered a subset of organizational climate’ (Coyle et al 1995, pg 247). Niskanen proposed ‘safety climate refers to a set of attributes that can be perceived about a particular work organizations and which may be induced by the policies and practices that those organizations impose upon their workers and supervisors’ (Niskanen 1994, pg 241). In this definition, Niskanen introduces a link between a set of perceptual attributes and the policies and practices that may ‘induce’ them. This definition contains a tacit suggestion of top down climate development, that perceptions of attributes are a result of organizational policies and practices and so are less dependent upon factors such as trust (Itoh, Anderson and Seki 2004), personality (Clarke 2006a) or motivation (Neal and Griffin 2002). Niskanen also separates workers and supervisors from the organization. This not only re-emphasises top down climate development but also selects the worker and supervisor subset as those ‘experiencing’ climate.

Dov Zohar, credited with the publication of the first paper in which safety climate was directly referenced, defined safety climate as ‘a summary of molar perceptions that employees share about their work environment’ (Zohar 1980, pg 96). Dedobbeleer and Beland identified safety climate as ‘molar perceptions people have of their work settings’ (Dedobbeleer and Beland 1991, pg 97). In these definitions, Zohar and Dedobbeleer firmly link climate with perception; no reference is made to concepts such as attitudes, beliefs, values or behaviours.

Donald and Canter (1993) identified safety climate as ‘the extent to which all workers share attitudes towards safety, which allow them to retain control and responsibility for injury prevention’ (Donald and Canter 1993, pg 5). Through the inclusion of ideas such as control and responsibility Donald and Canter are attempting to operationalise the concept of climate, supposing what effect the shared attitudes towards safety might have on the shop floor. Neal, Griffin and Hart (2000) postulate safety climate should be considered purely in terms of perceptions of the working environment where as Williamson, Feyer, Cairns and Biancotti (1997) include factors such as attitudes, beliefs and perceptions. Flin, Mearns, O’Connor and Bryden (2000) identify safety climate as ‘the surface features of the safety culture discerned from the workforce’s attitudes and perceptions...it is a
snapshot of the state of safety providing an indicator of the underlying safety culture of a work group, plant or organization’ (Flin et al 2000, pg 178). This definition allows for the inclusion of perceptions and attitudes, however, it clearly separates climate from underlying cultural aspects of the organization. Implicit in this definition is the suggestion of a surface organizational safety climate and an underlying organizational safety culture.

Consideration of safety climate definitions raises a number of key issues. Zohar, Dedobbeleer and Beland and Neal and Griffin and others identify climate as a concept best defined and measured through perception. Conversely, Coyle et al, Guldenmund, Donald and Canter and others all include attitudes as part of their climate definitions. In addition, theorists such as Zohar (1980) and Coyle et al (1995) conceptualise safety climate as part of a larger organizational climate whereas Flin et al (2000) identify safety climate as a snapshot of safety culture. These debates, although significant, are dissimilar to those encountered whilst attempting to define safety culture. Whilst safety culture practitioners grapple with the inclusion of disparate concepts such as management systems, beliefs, attitudes, values and behaviours, climate specialists consider the intricate implications of an attitudinal or perceptual approach. In this respect, the academic context of safety climate has delivered a degree of uniformity in the understanding of what safety climate is.

This review has considered safety culture and climate as distinct entities, however, a number of researchers have attempted to highlight the overlap between these concepts. Many definitions of culture can be seen to include perceptual and attitudinal elements, conversely, some climate definitions are recognizable for their holistic approach. Many researchers have recognized this confusion and raised concerns about the potential impact this could have upon research (Clarke 2000; Flin et al 2000; Guldenmund 2000; Guldenmund 2007). The so called ‘culture/climate’ debate centres upon the separation of these concepts and must be considered in depth to ensure realistic assumptions are made concerning the measurement and analysis of organizational safety performance.

**Safety Culture vs. Safety Climate**

Safety culture developed in the prism of incident and accident investigation (Sheen 1987; Fennel 1988; Cullen 1990; HSE 2003; Baker 2007), an evolution that contrasts directly with the maturation of safety climate as an academic construct. Although safety culture and safety climate developed as
distinct concepts a merging effect was witnessed over time as authors began to use the terms almost interchangeably (Clarke 2000). Researchers purporting to operationalise culture utilized attitudes (Cox and Cox 1996) while others associated attitudes within the domain of climate assessment (Coyle et al 1995). The demarcation of culture and climate has challenged regulators as well as academics. The HSE developed their safety climate survey with the express aim of helping organizations improve safety culture (HSE 1997), seemingly unaware of the need to separate the two concepts. Tharaldsen and Rundmo wanted to create a safety climate questionnaire and so ‘relevant literature was reviewed and different dimensions, scales and questionnaires were examined ’ (Tharaldsen and Rundmo 2007, pg 4). An analysis of the publications referenced finds a majority concerned specifically with safety culture; where climate is mentioned, it is mainly to contextualise and aid understanding culture. Yet Tharaldsen and Rundmo refer to these, rather than other climate focussed publications, as primary sources for the creation of a safety climate questionnaire.

Flin et al attempted to bring order to the debate with the ‘snapshot definition’, a proposition that linked the two distinct schools of research. Cox and Cheyne agreed ‘[safety culture] is often characterised as an enduring aspect of the organization with trait-like properties and not easily changed. Climate, on the other hand, can be conceived as a manifestation of organizational culture’ (Cox and Cheyne 2000, pg 114). This definition marked a clear departure from Zohar’s conceptualization of safety climate as part of a wider organizational climate, however, the ‘snapshot’ concept of climate provided a good fit for the Offshore Safety Questionnaire (Mearns, Flin, Fleming and Gordon 1998; Flin et al 2000) and Cox and Cheyne’s Offshore Safety Climate Toolkit (Cox and Cheyne 2000) both of which included a mix of perceptual and attitudinal scales along with self reported behaviours. The snapshot definition reflected the zeitgeist, with many researchers explicitly, through holistic definitions, or implicitly, through mixed methodologies, associating the two concepts (Cox and Cheyne 2000).

However broad or popular, the snapshot definition did not address one of the biggest issues in culture and climate demarcation, measurement methodology. In this respect, and perhaps because they felt climate represented a snapshot of culture, Flin et al and Mearns et al were happy to adopt a ‘mixed model' of safety climate assessment (Clarke 2006a), including both attitudes and perceptions
in their questionnaire (Coyle et al 1995; Williamson et al 1997; Flin et al 2000). This mixed approach has received criticism. Neal and Griffin define safety climate as ‘perceptions of policies, procedures, and practices relating to safety in the workplace’ (Neal and Griffin 2002, pg 69). They contrast safety climate with safety culture, ‘attitudes, beliefs and perceptions shared by natural groups as defining norms and values, which determine how they react in relation to risk and risk control systems’ (Hale 2000, pg 2) and highlight that many climate definitions and surveys confuse climate with attitude and behaviour (Neal and Griffin 2002, pg 69). Inclusion of elements such as attitudes towards safety activities (Cox and Cheyne 2000) or attitudes to safety (Niskanen 1994) does more than just broaden the idea of climate, argue Neal and Griffin, it blurs those elements with the potential to elicit an effect on safety climate (i.e. attitudes) with safety climate itself (i.e. perception) (Neal and Griffin 2002; Clarke 2006a).

In his theoretical assessment, Guldenmund suggests the demarcation between perceptions and attitudes may be false noting that perceptions have been defined as descriptions referring to external objects (Glendon and Litherland 2001). Guldenmund questions how these descriptions cannot be infused ‘with the attitudes that underline them’ (Guldenmund 2007, pg 726). If we accept this, Guldenmund contends, safety climate assessment is a simple review of attitudes. Attitudes can be defined as the ‘psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor’ (Eagly and Chaiken 1993). With this definition in mind, a working definition of Guldenmund’s conceptualization of safety climate emerges; the psychological tendency that is expressed through the evaluation of organizational safety.

Whilst this definition makes allowances for the inevitable encroachment of attitudes upon perceptions, Guldenmund’s proposition ‘perceptions are attitudes’ appears simplistic. Psychological theory supports the demarcation of perception and attitude (Clarke 2006a). In addition, the perceptual model allows for the separation of antecedents of safety climate from climate itself (Clarke 2006a). For example, attitudes towards safety, attitudes towards the organization or personality traits can all be described as antecedents of safety climate, elements that can effect perceptions but are in themselves distinct from perceptions. Hence the line of division drawn up initially by Zohar and maintained by Dedobbeleer and Beland and Neal and Griffin, allows researchers to be clear about what they are measuring; perceptions of work environment.
Differences between perceptions and attitudes, behaviours and outcomes represent more than semantics, they illustrate the construct assumptions authors have made and profoundly influence how the concepts are operationalized. Although some researchers have been careful to draw distinction between attitude and perception during safety climate analysis (Zohar 1980; Neal et al 2000), these lines of separation often blur in the name of data collection. As Clarke notes, many perception questionnaires rely upon a Likert-type scale and so encourage participants to express a level of statement agreement/disagreement, a process that captures far more than simple perceptions (Clarke 2006a). Conversely, a number of attitudinal scales feature elements such as normative behaviours (Lee 2000) and risk behaviours (Flin et al 2000); elements that lack attitudinal attributes of motivation and emotion (Clarke 2006a).

The value of a clear distinction between safety culture and climate is emphasised when the parent debate between organizational culture and climate is considered. Attempts to demarcate the broad concepts of organizational culture and climate have absorbed more time and produced more disagreement than the safety culture and climate debates, however, the added time and dispute have produced a clearer picture as to the value of demarcation and the potential lessons to be learned from the process.

**Organizational Culture vs. Organizational Climate**

Schwartz and Davis (1981) made clear the distinction between culture and climate, claiming whatever culture is, it is not climate. In a more circumspect tone, Denison notes that cultural research tends to gravitate around the evolution of social systems whereas climate focusses upon the impact that organizational systems have upon groups and individuals (Denison 1996). James suggests climate measurement to be the collection of surface perception. James and Jones (1974) attempted to separate climate from other job related attitudes, so called cultural factors, through an emphasis upon descriptive and cognitive factors respectively. Meanwhile Schein advocates that cultural assessment requires the understanding of underlying assumption (Schein 1985). Schneider contrasts the ‘perceptions of organizational practices’ and ‘reactions to those same practices and procedures’ (Schneider 1975, pg 464), placing an emphasis upon the separation of internal cognitive processes [climate] and the product of these processes [culture].
To some, separation of organizational culture and climate represented more than a methodological distinction. Many saw the mainstream acceptance of the cultural ethnography in the 1970s and 1980s (Rohlen 1974; Schein 1985) to be a reaction against the positivist, empirical approach that had dominated research until this point (Denison 1996). Once these qualitative techniques had been introduced and established, cultural assessment was viewed by many to be anthropology, bound, as it was, to the ethnography. Cultural research dominated organizational studies during the late 1970s and early 1980s (Denison 1996; Guldenmund 2000). Although publication rates remained high in the mid-1980, researchers began to question whether culture had delivered on its initial promise (Frost 1985). These questions were answered, in part, by the production of a number of books and papers offering new perspectives of organizational culture (Denison 1996). In addition, a number of researchers begun to adopt new methodologies, moving away from the traditional qualitative ethnographic approach to a quantitative, survey driven technique. Such surveys produced cultural dimensions and enabled organizational and national categorization (Calori and Sarnin 1991; Hofstede 2001). Cultural research, it seemed, had completed a full circle and had become the antithesis of the anthropological ideals that burst onto the organizational research scene a decade ago.

Denison demonstrated culture and climate to possess clear distinctions in research perspectives, a summary of which is detailed in Table 2.

Table 2: Contrasting Organizational Culture and Climate Research Perspectives

<table>
<thead>
<tr>
<th>Element</th>
<th>Culture</th>
<th>Climate</th>
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<tr>
<td>Epistemology</td>
<td>Contextualised and idiographic</td>
<td>Comparative and nomothetic</td>
</tr>
<tr>
<td>Point of view</td>
<td>Emic (native point of view)</td>
<td>Etic (researcher’s point of view)</td>
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<tr>
<td>Methodology</td>
<td>Qualitative field observations</td>
<td>Quantitative survey data</td>
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<tr>
<td>Level of analysis</td>
<td>Underlying values and assumptions</td>
<td>Surface-level manifestations</td>
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<td>Temporal Orientation</td>
<td>Historical evaluation</td>
<td>Ahistorical snapshot</td>
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<tr>
<td>Theoretical foundations</td>
<td>Social construction; critical theory</td>
<td>Lewinian field theory</td>
</tr>
<tr>
<td>Discipline</td>
<td>Social and anthropology</td>
<td>Psychology</td>
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(Denison 1996, pg 625)
Denison recognized that any division between proximal research perspectives will always have exceptions, however, recent research has stretched the boundaries set to breaking point. Longitudinal studies (Probst and Brubaker 2001; Neal and Griffin 2006; Tharaldsen and Rundmo 2007) have moved climate research from the snapshot (Flin et al 2000) to a more historical and evolitional assessment. Hofstede’s use of a questionnaire places his cultural study firmly in the domain of the climate literature (Hofstede 1980; Hofstede 2006). Noting the differing research perspectives, Denison questioned ‘are culture and climate different phenomena or different points of view?’ (Denison 1996, pg 625). In conclusion, Denison states that culture and climate represent ‘differences in interpretation rather than differences in phenomenon’ (Denison 1996, pg 645). Researchers, therefore, should feel able to learn lessons across interpretative divides, borrow methodologies, mix orientations and question epistemologies to improve the quality of organizational research conducted.

Most reviews of culture and climate research comment upon the complexity (Guldenmund 2000) and contradictory (Denison 1996) nature of these topics. Whilst recognising the differences between these concepts may be more interpretative than phenomenological, there remains value in their demarcation. Without understanding of the different histories of each concept, it is impossible to adequately contextualise individual culture or climate research projects, to explain why certain methodologies have been adopted and how these may impact upon the results obtained.

This brief summary of organizational culture and climate research provides evidence that the separation of these concepts has provoked debate across many disciplines. It has also emphasized the implications of adopting climatic or cultural perspective and it is these implications that require further investigation. By investigating the history and broad methodologies used in safety culture research this review will illustrate how conceptual assumptions realize themselves in operation and what implications this has for the data produced as a result. Reviewing safety culture research will aid decision making concerning its suitability for use in this study; in this respect a particular focus will be placed upon the reliability and validity of the concept along with the utility of the measurement techniques.
Safety Culture Research

History
Researchers have been considering non-technical accident explanations for a number of years (Keenan, Kerr and Sherman 1951; Cohen, Smith and Cohen 1975; Smith, Cohen, Cohen and Cleveland 1975). Keenan et al (1951) looked beyond simple engineering and technical failure when attempting to investigate accident rates at a car manufacturing plant. Through their analysis of introspective ratings provided by employees, the team were able to identify the key role management played in workforce safety decision-making. Whilst this research can be considered basic in its methodological approach, findings concerning safety leadership remain as significant today as they were when first published.

In a more recent publication, Turner analyzed incident and accidents to produce a socio-technical model of incident causation (Turner 1978). Turner’s model included six distinct stages, as detailed below:

Stage 1: Notionally normal starting point
Stage 2: Incubation period
Stage 3: Precipitating event
Stage 4: Accident onset
Stage 5: Rescue and salvage
Stage 6: Full cultural adjustment

(Turner 1978)

Although Turner’s model was not intended to be an assessment of culture, cultural elements featured heavily in the stages identified and in the progression from one stage to another. For example, the notionally normal starting point summarised culturally accepted beliefs about the world and its hazards (Turner 1978). If individuals perceive no risk associated with a poorly enforced permit to work system, as reported in the Piper Alpha tragedy (Cullen 1990), it will be believed to be acceptable. This belief will contribute to the incubation period and, in the case of Piper Alpha, the precipitating event. Turner also discussed the full cultural adjustment that takes place during and
after an incident investigation; what was seen as acceptable before an incident becomes unbelievable afterwards (Turner 1978).

Although Turner considered cultural aspects of accident causation, the term safety culture was first coined by INSAG during the Chernobyl investigations (INSAG-3 1988). A later International Atomic Energy Agency (IAEA) report suggested a definition that considered characteristics and attitudes as mediators that influenced the priority with which safety issues were dealt (INSAG-4 1991). It is pertinent to note the political environment in which the INSAG and hence the IAEA published their findings concerning the Chernobyl disaster. A number of administrations in Europe had hailed nuclear power as a means by which reliable and controllable energy could be produced (Reason 1990). The 2006 International Energy Agency summary indicates that nuclear power had jumped from producing 3.3% of the world’s energy demands in 1973, through to 15.7% in 2004 (IEA 2006). A bulk of this increase occurred during the 1980s.

Chernobyl therefore occurred at a time of nuclear investment and expansion in the UK (Reason 1997). With funds allocated and plans underway, governments had to suddenly contend with a potential public nuclear policy backlash. At an administrative level there was a requirement for strategy defence, for something that could alleviate concern and ensure that plans remained on course and on budget. Safety culture could be interpreted as a line of demarcation between Russia and the West; the Russians had a bad safety culture whereas western nuclear plants had a good safety culture ergo Chernobyl could never happen in the UK. With this issue resolved, government could continue plans for Sizewell B expansion and hence the stabilisation of the UK’s energy market (Reason 1997).

Yet the concept of safety culture clearly captured the interest and imagination of safety practitioners and researchers alike. The 1980s and 1990s saw an intense burst of research activity in this area. Frequent research publications and constant references in incident/accident investigations underlined the growing significance of the concept. In all of these publications and references interested parties agreed the need for a uniform measurement medium, a means by which safety culture may be captured and recorded. Some, such as the Baker panel, attempted to create their own scales referencing a paucity of suitable candidates in circulation (Baker 2007). Others, such as
Sheen (1987) or Cullen (1990), seemed happy to evidence poor safety culture using quasi-ethnographic techniques (i.e. specific examples cited during investigation).

Improving understanding of the diverse methods used in safety culture assessment will drive the next section of this literature review. The aims and objectives included in the introduction of this study detailed a requirement for a reliable measure of organizational safety. The review to date has identified this requirement as a straight choice between safety culture and safety climate assessment techniques. The following section will therefore provide an assessment of the relative strengths and weaknesses of various safety culture measurement methodologies, and will culminate with a view of the constructs’ applicability in this study. As safety culture has attracted practitioner as well as academic interest, an effort will be made to adopt an inclusive approach where suitable. As such, this review will commence with a summary of the behavioural work published by Dominic Cooper.

**Measuring Safety Culture**

**Combinational Techniques**

Cooper (2000) attempted to understand safety behaviours through the application of Bandura’s model of Reciprocal Determinism (Bandura 1977). Bandura recognised that individuals are not entirely controlled by their environment, but, conversely, are not completely self determining either. Bandura suggested that an individuals’ internal psychological factors should be separated from their behaviour and the situation they are in. Although these elements remain distinct, Bandura argued they could interact with each other, and, in the case of behaviour, produce external observable factors. Bandura believed that individuals could respond to their environment and correct their behaviour based upon what they observed around them. In this respect individuals could be described as being both the product and the producer of the environment. Cooper and Philips (1995) and Cooper (1997; 2000) attempted to apply this process to further understanding of safety culture.

Cooper argued that the that the relationships between internal and external factors should be considered dynamic, constantly responding to changes in the three core elements; situation, behaviour and the individual (Cooper 2000). Crucially, Cooper also suggested these relationships should allow for triangulation and hence a multi-faceted view of safety culture (Cooper 2000).
Cooper offered a number of routes by which the reciprocal model could be investigated. Regarding behavioural aspects, peer observations were discussed, along with self-report and outcome measures (Cooper and Philips 1995). For the situational aspects, Cooper suggested investigation of the safety management system, along with other management investigation techniques such as workflow systems and ergonomic investigation. Psychological elements could be analysed using safety questionnaire investigation and analysis (Cooper 2000).

Cox and Cheyne (2000) attempted to assess safety culture in an offshore environment using a multi-level approach including questionnaires, focus groups, behavioural observations and situational audits. Although this approach contained many similarities to Cooper’s Reciprocal Safety Culture Model, Cox and Cheyne referenced previous multiple perspective approaches proposed by Cox and Cox (1996) and Denison (1996). On using behavioural and situational measures as part of safety culture assessment, Cox and Cheyne proposed a model in which individual perceptions manifest themselves in observable elements such as commitment, attitudes, responsibility and behaviours (Cox and Cheyne 2000).

Whilst researchers such as Cooper and Cox and Cheyne should certainly be commended for attempting to blend situational, personal and behavioural aspects into a ‘whole’, it is possible to identify a number of issues with this approach. Cooper suggests there is considerable value in a safety culture assessment that uses ‘actual ongoing safety related behaviours’ (Cooper 2000, pg 126) as opposed to self-reported measures. The author asserts that behavioural observations are not open to social desirability responses (Paulhaus 1989), however, Hopkins notes that for a behavioural approach to work, an organization must have an established and mature safety culture to ensure behaviours are identified and recorded accurately (Hopkins 2006). If not, an organization may look to punish those who have been observed breaking safety rules and observers may be reluctant to report unsafe behaviours (Hopkins 2006). This creates the paradoxical situation in which an organization must possess a sufficiently positive safety culture before attempting to measure or improve it through behavioural observations.

If the longevity of the assessment technique is considered, combinational measurement would seem to be a time consuming process. Many academic and technical safety experts have labelled
behavioural safety, a technique that requires the measurement of ‘safe behaviours’ by trained team members, as problematic due to the resources required. Indeed, some have suggested that the sustained focus of resources on behavioural measurement can compromise attention in other areas, such as process safety (Anderson 2005). In addition, Hopkins notes that behaviours tend to be at the end of a causal chain of events. For example, observation of protective equipment use when handing dangerous materials is a classic behavioural approach, however, it does not encourage individuals to consider why they are handling these materials or whether this dangerous step could be circumvented. In this respect, Hopkins argues, the behavioural approach can lead to a neglect of root cause in exchange for quick or simplistic solutions (Hopkins 2006).

**Group Mediated Techniques**

The Safety Culture Maturity Model (SCMM) was developed as part of an HSE sponsored study of safety culture improvement options for the offshore industry. The SCMM was based on a model developed by the Software Engineering Institute to improve the way software was built and maintained (HSE 2000). The Safety Culture Maturity Model conceptualises five stages of cultural maturity, progression through which will deliver improved safety culture. The five stages are highlighted:

- **Stage 1: Emerging**
  Develop management commitment

- **Stage 2: Managing**
  Realise the importance of frontline staff and develop personal responsibility

- **Stage 3: Involving**
  Engage all staff to develop co-operation and commitment to improving safety

- **Stage 4: Co-operating**
  Develop consistency and fight complacency

- **Stage 5: Continually improving**

Using a multi-group card sort technique, organizations are able to analyse workforce opinion on ten elements of safety culture, including management commitment and visibility, communication,
productivity versus safety, learning, resources, participation, shared perceptions, trust, industrial relations/job satisfaction and training (HSE 2000). The sum of the data collected establishes a position on the maturity scale. This process can often illustrate varying viewpoints from the shop floor, through to supervisors and management (Fleming and Lardner 1999). The SCMM pioneered a number of unique elements. The card sort methodology still represents one of the only formal group level data collection techniques in circulation. In addition, the maturity model presents safety culture as a dynamic, rather than a static concept. In this respect, organizations are able to see how they need to improve to make the step up to the next level and so are able to operationalize safety culture.

Parker, Lawrie and Hudson (2006) presented a framework for the development and maturation of organizational safety culture informed by 26 semi-structured interviews conducted with oil and gas executives, each with considerable experience in the industry. The framework was based on Westrum’s ‘three level typology’ of organizational cultures, but was extended to include another two levels (Reason 1997). Five levels of safety culture were proposed and characterised as follows:

- Pathological - who cares about safety as long as we are not caught
- Reactive - safety is important: we do a lot every time we have an accident
- Calculative - we have systems in place to manage all hazards
- Proactive - we try to anticipate safety problems before they arise
- Generative - HSE is how we do business around here

(Parker et al 2006, pg 555)

Parker et al reported that ‘the use of in-depth interviews as a method of eliciting descriptions of each of the levels of safety culture advancement was very successful' (Parker et al 2006, pg 560). The companies sponsoring the project elected to produce brochures to distribute to the workforce to help explain the concept of culture and their role in developing a positive organizational safety culture. This approach was adopted by both Shell and the Energy Institute Hearts and Minds Programme, both of whom use Parker et al’s culture development ladder to illustrate organizational safety culture.
Both the SCMM and safety culture development ladder represent unique and well structured techniques designed to assist organizations in the measurement and development of their safety culture. Use of focus groups in both methodologies allow for a group mediated measurement of culture to occur, however, this technique does have a number of limitations. First, factor content for both the SCMM and safety culture development ladder suggests researchers have missed the opportunity to exploit their measurement technique and investigate group specific factors such as cohesion (Birkbeck 2005) or group conflict (Antonsen 2008). Second, the focus group/single answer methodology adopted by both techniques forces individuals to form a potentially artificial consensus about individually mediated topics such as competence or trust. Is it likely that a work groups share the same attitudes towards their competency assurance processes or trust their work mates at the same level? At best, these techniques can be said to produce a forced group average of individual attributes.

**Ethnographic and Anthropological Techniques**

In his review paper published in 2000, Guldenmund differentiates safety culture and climate according to the general framework proposed by Schein (Schein 1985). Using a three element model, Guldenmund identifies basic assumptions, espoused values and artefacts (Guldenmund 2000). Artefacts are visible, but hard to comprehend in terms of underlying culture. In a move that distinguishes this model from many that view culture and climate as distinct entities, Guldenmund suggests ‘at the level of espoused values, we find attitudes, which are equated with safety climate’ (Guldenmund 2000, pg 215). At the core of his model, Guldenmund places basic assumptions, the safety culture. The author suggests not all basic assumptions must be specifically about safety to effect the safety culture. For example, if the organization considers written rules and procedures to be futile, this will apply equally to safety procedures as it does for operational or maintenance procedures (Guldenmund 2000). In this respect, ‘basic assumptions can only function as explanatory variables i.e. they explain the attitude structure found. Moreover...basic assumptions transcend particular organizational units like groups or departments or particular types of culture, like safety culture’ (Guldenmund 2000, pg 249).

Guldenmund concludes the assessment of safety climate using safety attitudes questionnaires is only part of the recommended approach. To capture a full picture of safety culture, researchers must
also consider the organization’s basic assumptions, those elements that explain the attitudes measured. The author concludes that study should not be focussed in the development of new safety climate instruments, rather, researchers should direct effort to uncover means of assessing basic assumptions to get a much deeper understanding of ‘the way we do things around here’ (Guldenmund 2000, pg 254). The inadequacy of questionnaire based assessments of safety culture is a theme Guldenmund has developed in subsequent publications. In his 2007 paper, he argues ‘questionnaires have not been particularly successful in exposing the core of an organizational safety culture. This is clear both from the factors found and the relations between these and safety indicators. The factors primarily seem to denote an overall evaluation of management, which does not say much about cultural basic assumptions’ (Guldenmund 2007, pg 723).

In both papers published, Guldenmund fails to provide a viable means by which ‘cultural elements’ may be measured (Guldenmund 2000; Guldenmund 2007). This has significance as organizational culture research witnessed a the shift from ethnographic to quantitative research methods caused, in part, by a frustration with the product of the former and a desire for the tangible results of the latter (Denison 1996). Whilst Guldenmund’s desire to include basic assumptions in a review of safety culture makes intuitive sense, the absence of a means by which this may occur indicates a lack of specificity (Pidgeon 1998; Clarke 2000).

Although Guldenmund failed to provide a means by which researchers might study basic cultural assumptions, a number of researchers have applied quasi-ethnographic methodologies in an attempt to further understanding in this area. Richter and Koch studied of meaning and symbols related to work, hazards, occupational accidents and prevention. Their approach was ‘characterized by an open set of concepts used by the ethnographer in the field work. We were looking for and listening to primary verbal symbols such as metaphors, myths and narratives, as well as meaning and interpretations, regarding central assumptions of safety’ (Richter and Koch 2004, pg 709). Results indicated the ethnographic methodology was capable of identifying and differentiating between safety micro-cultures. In one example, researchers found evidence that parts of the organization perceived incidents and accident were attributable to excessive risk taking by the workforce whilst others looked for technical explanations (Richter and Koch 2004).
Brooks used an ethnographic methodology to study the safety management and safety culture in an Australian commercial fishing port (Brooks 2005). This study was able to discern that participants did not possess a strong learning culture; Brooks linked this with wider cultural assumptions and other external issues concerning safety management (Brooks 2005). In a recent and much more ambition publication, Brooks attempted to apply an ethnographic approach to test his theory that cultural assumptions resemble memes (Dawkins 1976) and replicate within an organization through natural selection (Brooks 2008). This theory is clearly ill considered, the author having made little or no effort to associate the contrasting topics of evolutionary theory and safety performance. The use of ethnographic techniques must serve to frustrate those who wish to see this methodology taken as seriously as questionnaire based approaches (Guldenmund 2000; Richter 2004).

Despite setbacks, ethnographic studies clearly have value in safety culture research. Indeed, it could be argued that the ethnography is essential to safety culture research, reflecting its consideration of core assumptions (Guldenmund 2000) and hence its uniqueness in organizational research. The burst of ethnographic studies witnessed over the last ten years may be indicative of a topic growing confidence as it matures. Yet it is difficult to dismiss the impression that safety culture research will inevitably mirror organizational culture research, and will, as a result, capitulate to the demand for empiricism (Denison 1996). Indeed, safety culture research is at even higher risk of such pressures due to its reliance upon organizations for financial support. It is these companies who demand the ‘quick and dirty’ questionnaires that provide clear and actionable findings (Guldenmund 2000, pg 235). Added to this, the SCMM, safety culture development ladder and behavioural techniques all offer a means by which cultural improvement may be measured. The ethnography, on the other hand, can only be considered a single shot methodology, able to be repeated ever three to four years at best.

**Summary**
A review of safety culture publications reveals that no one model or approach provides a definitive account of the complexities inherent in safety culture research. Cooper’s approach should be praised for the consideration of internal and external factors, however, the reliance upon behavioural outcome measures would seem to be an oversimplification that negates potential significance of
internal cognition. Similarly, Cox and Cheyne do not seem able to settle upon a particular conceptualization, preferring perhaps to cover as many elements as possible. The Safety Culture Maturity Model provides a good template for organizations wishing to drive improvement in organizational safety performance, however, it’s simplistic and contradictory methodology coupled with a limited scope suggests a victory for operability over utility.

Guldenmund’s attempt to integrate ‘basic assumptions’ in the overall assessment of culture, although commendable, is fraught with difficulty. At face level, Schein’s cultural model adds value to the safety culture literature, however, attempts to operationalize the framework highlight serious issues. The blanket assertion that perception is wholly encapsulated by attitude is a poorly considered argument that lacks research support. More worrying, however, is that Guldenmund offers little or no guidance how organizations might reliably attempt to measure their basic assumptions. The influence of Schein and the focus upon the individual characteristics of the organization suggest a grounded methodology, however, this would rob organizations of one of the most attractive elements of culture or climate assessment, namely benchmarking.

One of the most significant aspects of safety culture research is the ambiguity and lack of consistency that surrounds the factors that form published operational models of culture. Pidgeon and Clarke both identified safety culture’s lack of specificity and this problem has persisted despite research publications. The Safety Culture Maturity Model and Safety Culture Development Ladder form a case in point. Both operationalise safety culture using very similar models but assess it using completely different scales. The results gained from one tool would not be comparable with the other, and yet both assert to be measuring the same thing.

The last thirty years has seen safety culture measured through questionnaire (Baker 2007), focus group (Fleming and Lardner 1999) and ethnography (McDonald, Lipscomb, Bondy and Glazner 2009). In this time no agreement has been reached concerning the preferred methodology (Cox and Flin 1998). Similarly, little agreement has been reached concerning the constituent elements or definitions of safety culture (Lee 1998; Clarke 2000). Yet, paradoxically, it has featured and continues to feature in the most significant incident investigations of our time (Sheen 1987; Fennel 1988; Cullen 1990; INSAG-4 1991; Baker 2007). Clearly there is a demand for further research to
bind the different epistemological assumptions, methodological techniques, factors, elements and definitions into a meaningful whole.

Researchers wishing to gather a valid and reliable snapshot of organizational safety performance, however, find themselves looking to other potential avenues of study. To measure organizational safety performance it is necessary to define, to specify, to narrow down the field of inquiry. Such requirements identify safety climate as a medium through which the capture and analysis of reliable and valid data could occur. To investigate this potential in more depth, it is important to first understand the history of safety climate research and so understand how researchers have attempted to analyze safety climate from its inception through to contemporary research. Consideration of safety climate in context should allow for informed decision-making concerning the suitability of safety climate as a means of safety performance analysis.

**Safety Climate Research**

**History**

Zohar published *Safety Climate in Industrial Organizations: Theoretical and Applied Implications* in 1980. This article represented the first attempt to define, contextualize and operationalize safety climate in an organizational setting. In his study, Zohar produced a multi-factorial safety climate structure which displayed a strong relationship with safety programme effectiveness (Zohar 1980). This publication triggered a number of studies that used Zohar’s scale, albeit with a number of minor alterations (Brown and Holmes 1986; Dedobbeleer and Beland 1991; Coyle et al 1995; Hofmann and Stetzer 1996). Over time, however, researchers began to branch out and consider more varied sources for their safety climate scales (Rundmo 1992; Lee 1993; Cheyne, Cox, Oliver and Tomas 1998; Cox and Cheyne 2000), and in doing so broadened the safety climate literature.

Schneider (1975) argued that cues present in the working environment allowed individuals to develop perceptions and expectancies concerning the appropriateness of behaviour. Zohar defined safety climate as *molar* perceptions of the working environment and argued that it was these perceptions that allowed individuals and groups to develop a ‘frame of reference for gauging the appropriateness of behaviour’ (Dedobbeleer and Beland 1991, pg 97). It was this espoused link between safety climate and safety behaviour that frustrated Zohar, however, as he was unable to correlate his safety climate scores with organizational accident rates (Zohar 1980). Despite this, his
attempts to associate safety climate with an outcome measure such as accident rates captured researchers attentions and provided a template for a future work. It is the content of these studies, and the assumptions implicit within them, which forms the next section of this review.

**Safety Climate and Outcomes Measures**

Since Zohar published his paper, researchers have attempted to associate safety climate with a wide variety of outcome measures. Studies have focussed on behavioural outcomes such as the proliferation of micro-accidents (Zohar 2000) and unsafe behaviours (Hofmann and Stetzer, 1996) in more negative safety climates. Conversely, researchers have noted the tendency towards safety related behaviours in more positive safety climates (Cooper and Philips 2004; Glendon and Litherland, 2001). Linking all of these studies is the assumption that safety climate acts to provide ‘guidance on suitable organizational behaviour’ (Clarke 2006a, pg 316); if individuals perceives the organization as taking the appropriate measures to ensure a safe working environment, they are likely to reciprocate or gage their behaviour accordingly. Changes in behaviour, it is theorized, will then influence the likelihood of incident or accident involvement. It is this tripartite link between perception, behaviour and accident involvement that has allowed researchers to successfully use company accident records (Hofmann and Stetzer 1996; Zohar 2000; Gillen, Baltz, Gassel, Kirsch, Vaccaro 2002; Oliver, Cheyne, Tomas and Cox 2002; Zohar 2002) and self report accident scales (Mearns et al, 1998; Lee, 1998; Barling, Loughlin, Kelloway 2002) as viable outcome measures that have supported the efficacy of safety climate scales.

Although many researchers have focused on the link between safety climate and outcomes theorized to have a direct link with accident rates, a number of studies have looked to broaden their catalogue of potential outcome measures. Wilkens and London (2006) were able to demonstrate a relationship between group feelings of psychological safety and process improvement in US hospital Quality Improvement Groups. Huang, Chen, DeArmond, Cigularov and Chen (2007) found significantly lower perceptions of injury risk in more positive safety climates, a conclusion supported by Rundmo (1995). Rundmo also found no relationship between risk perception and behaviour, a finding confirmed by Oliver et al (2002).
Hofmann, Morgeson and Gerras (2003) presented a relationship between managerial support for safety and subsequent worker broadening of safety related Organizational Citizenship Behaviours (OCB). In a related study, Neal et al (2000) detailed a link between a positive safety climate and increases in motivation and, consequently, safety participation. The link between climate and participation is of particular interest considering the reciprocal cue based relationship between climate and behaviour detailed by generalists such as Schneider (1975) and safety climate researchers (Zohar 1980; Brown and Holmes 1986) and will be considered in more detail in the next chapter.

Clarke summarised much of the published data in this area performing a meta-analysis of the relationships between safety climate, safety performance and occupational accidents. This study provided support for a relationship between safety climate and safety performance, however, subsequent links to accident involvement were found to be weak (Clarke 2006b). Clarke noted that an association between safety climate and accident involvement could be observed when accident figures were measured following safety climate research. To make sense of these findings Clarke considered the timeline involved in safety climate measurement. Often researchers attempt to measure safety climate and associate the findings with self reported accident data from the past (Brown and Holmes 1986; Mearns et al 1998; Lee and Harrison 2000). In doing so, they capture safety climate data that has been influenced by past events. If it is considered that most safety climate research has been conducted in counties with highly developed health and safety regulation, then it is likely that any serious near miss or incident has been investigated and results acted upon. These actions, along with the workers natural desire to reduce the potential for reoccurrence, could well lead to a positive correlation between self report accident records and safety climate.

This so called reverse causation hypothesis is supported when it is noted that prospective studies, in which safety climate has been measured before accident reporting, have indicated a strong link between climate and accident outcome (Zohar and Luria 2004; Neal and Griffin 2006). This finding supports the notion that safety climate acts as an antecedent of safety performance and accident involvement (Zohar 2002; Neal and Griffin 2006). Despite complications concerning accident involvement, Clarke’s review supports the relationship between safety climate and safety performance and a weakened relationship between safety climate and accident involvement (Clarke
2006b). These findings, compiled with the strong relationships demonstrated by longitudinal assessments, provide a foundation for two broad research questions.

**Research Questions:**

Will those individuals who have provided a favourable safety climate score be less likely to have been involved in a near miss?

Will those individuals who have provided a favourable safety climate score be less likely to have been involved in an accident?

Finding in favour of a relationship between safety climate and reduced accident and near miss involvement would not only provide support for prior research finding (Clarke 2006b), it would also provide added confidence that the climate survey selected had successfully measured elements with significance for overall safety performance. It is worth noting the significance placed upon the link between safety climate and the key outcome measures of accident and near miss involvement. For organizations, it is safety climate’s potential to provide a leading indication of safety performance that justifies the investment in time and money made over the last thirty years. As such, a positive answer to the research question detailed above would have significance in organizational as well as academic terms.

Whilst the assessment of outcome measures has provided good evidence for the value of safety climate as an antecedent and predictor of safety performance, it is necessary to understand the mechanism by which these factors interact. A number of researchers have produced models of safety performance including safety climate and a variety of outcome measures and it is in the review of these models that this chapter will shed further light on the utility and scope of safety climate as a concept. In addition, it is hoped that the consideration of these models will assist in the creation of a working model of safety performance, detailed in the aims and objectives for this study.

**Models of Safety Performance**

Tomas, Melia and Oliver (1999) developed an eight factor model including safety climate and accident occurrence to aid understanding of the relationship between organizational and psychological variables and workplace safety. Using a 17 point safety climate scale separated into
three dimensions, *training and information on safety, safety structure* and *safety goals*, Tomas et al were able to support the structure of their hypothetical model, the details of which are provided in Figure 1, detailed below:

The researchers concluded there was a significant explanatory chain that flowed from safety climate, through supervisors, co-workers and worker attitudes and behaviours to accidents. These variables had an indirect effect upon accidents due to the presence, or otherwise, of hazards and actual risk (Tomas et al 1999). Although Tomas et al were keen to reference their novel separation of hazards and actual risks, their model also drew distinctions between climate, supervisor and co-worker response, attitudes and behaviour. Factor separation of this nature represented a move away from the holistic approach to the measurement of safety climate favoured by originators such as Zohar (1980) and Dedobbeleer and Beland (1991). Tomas et al noted this step away from the inclusive approach, but argued this decision was taken to ‘understand their complex relations with other criteria’ (Tomas et al 1999, pg 53). The significance of this distinction will be discussed alongside Zohar’s later multi-level model.

Using a questionnaire based methodology, Oliver et al (2002) collected over 525 individual interviews and produced a structural model that included organizational involvement, physical work environment, safe behaviours, general health and accidents. Within these variables was a mix of organizational elements. The full model is detailed in Figure 2:
Organizational involvement included items referring to social support and safety climate; both scales were appropriated from previous research. The general health section used items from the General Health Questionnaire (GHQ-12) and included anxiety and depression sub-scales. Safe behaviours included four items, use of safety equipment, taking of shortcuts, following safety rules and incompatibility of working safely and quickly. The accident occurrence section inquired about accident involvement over the last two years and included scales intended to ascertain incident seriousness (e.g., working days lost). The physical work environment scale measured factors such as light, heat, humidity and noise levels as well as workload and the routine nature of the work (Oliver et al. 2002). The role of the physical work environment in accident causation has been the subject of some debate. Researchers have demonstrated that the work or organizational environment can be considered a determining factor in incident prevention (Simard and Marchand 1995), however, there remains a growing consensus that this should be complemented by the consideration of individual contribution to incidents or accident (Cox and Cox 1996). It is the interaction between organizational and individual factors that formed the main focus of Oliver et al.'s study and the findings present a complex picture.
The structural model of best fit proposed relationships between all the variables, prompting the researchers to suggest ‘each of the variables has an effect on accidents’ and that ‘individual variables, including safety behaviour and general health, mediate the indirect effects of organizational variables’ (Oliver et al 2002, pg 473). To illustrate, the researchers suggest that it is the procedures developed as a result of specific environment hazards that influence behaviour, rather than the hazards themselves. This finding, supported by previous research (Rundmo 1995; Mearns and Flin 1999) appears counterintuitive as it discounts the role individuals have in assessing risk, however, researchers have been able to determine that individual risk assessments often focus on unlikely major hazard events rather than the more likely and equally personally damaging incidents and accidents such as trips or slips (Rundmo 1996). It should be noted that this work was conducted in highly regulated offshore environments with developed safety management systems. As such, it is possible that worker behaviour has evolved to trust that prior risk assessments have been completed leading to a dependence upon the organization to recognize risk.

Whilst the models detailed by Tomas et al and Oliver et al provide valuable insight into the mechanisms that operate to allow perceptions of the work environment to influence behavioural outcomes, they supply little detail concerning the behaviour itself. Although both models identified safety climate as an antecedent, the jump from attitude (Tomas et al 1999) or organizational involvement (Oliver et al 2002) to behavioural outcome seems to omit the potential for other psychological mechanisms to influence or explain the nature of the observed outcome.

When looking for a model that deals with the ‘black box’ between safety climate and behaviour, Neal et al’s model of safety performance is immediately identifiable. Neal et al made a distinction between antecedents, components and determinants of safety performance. Their recognition of safety climate as an antecedent reflected research carried out by Tomas et al, Oliver et al and others, however, their choice of determinants, namely safety knowledge, motivation and, latterly, skill, represented a new perspective with the potential to address the omissions of previous research. Their model of safety performance provides structure and explains how the proposed elements interact.
Although antecedents can include a wide range of factors, Neal et al focused on organizational climate, and, more specifically in this study, safety climate sub-dimensions including ability, personality, organizational climate, safety leadership and conscientiousness (Neal et al 2000; Neal and Griffin 2002). They referenced Campbell, McCloy, Oppler and Sager (1993) in recognition of their choice of determinants of safety performance; knowledge, motivation and skill. Whilst safety motivation has been defined as an employee’s ‘motivation to perform a job in a safe manner’ (Hofmann, Jacobs and Landy 1995, pg 133), Neal et al (2000) suggested the motivation to perform safety behaviours.

Using the valence-instrumentality-expectancy theory (Vroom 1964), Probst and Brubaker theorized that individuals will expend effort on activities that deliver desired rewards. As such, if an individual is rewarded for following safety rules, motivation will be high for these behaviours; conversely, if an individual is rewarded for non-compliance, motivation to follow rules will be diminished (Probst and Brubaker 2001). In detailing a role for expectation in defining behavioural outcomes, Neal et al drew parallels between their model of safety performance and those mechanisms, originating from theorists such as Schneider (1975) and applied by Zohar and others, which explained the link between safety climate and behaviour. Now, however, researchers were attempting to further explain the types of behaviour possible and the originating underlying psychological processes associated with them.
It is the distinction between safety compliance and safety participation, identified as the components of safety performance, that separates Neal et al’s model from research considered previously. In separating compliance and participation, Neal and colleagues reference Borman and Motowidlo’s work on task and contextual behaviour. Differentiating these components clearly has value as there is a difference between ‘compliant activities that need to be carried out by individuals to maintain workplace safety’ (Neal and Griffin 2002, pg 70) and participative ‘behaviours that do not directly contribute to an individual’s personal safety, but which do help develop an environment that supports safety’ (Neal et al 2000, pg 70).

Neal et al measured organizational climate using Hart, Wearing and Griffin’s (1996) Organizational Climate Scale. This scale was designed to assess components that were ‘common to most organizations’ (Neal et al 2000, pg 102). Previous research had suggested a good level of discriminant validity between this measure and other factors, such as organizational stressors (Hart et al 1996).

To test their model, Neal et al (2000) conducted an assessment of organizational climate, safety climate, determinants and components of safety performance at an Australian hospital. Findings supported the relationship between organizational climate and safety performance, mediated, as predicted, through safety climate (Neal et al 2000). It was also noted that the relationship between safety climate and safety performance was influenced, in part, by safety knowledge and motivation (Neal et al 2000). In a five year longitudinal study of the relationships between safety climate, safety motivation, safety behaviour and accidents, it was established that a positive group safety climate related to an increase in safety motivation over a two year period (Neal and Griffin 2006). In addition, safety motivation was found to be positively associated with participation (Neal and Griffin 2006).

These findings provided strong support for Neal et al’s model of safety performance and so the role of antecedents, determinants and components in this process. Not only do these findings reinforce the supposition that safety climate forms part of a larger concept of organizational climate, but they also drill down to the mechanism through which climate may effect individual safety behaviours. The
notion that individuals will carry out ‘above the line’ safety related activities when they believe safety is important (Neal and Griffin 2006) suggests that organizations can create ‘virtuous circles’, in which investment in safety climate improvement leads to reciprocation from employees in the form of safety related activities.

Neal and Griffin also discovered a reciprocal relationship between safety motivation and participation. This indicated that the act of participating in safety related activities was related to an increase in safety motivation. This reciprocal relationship was not found for compliance, although previous research by Probst and Brubaker (2001) supported this association. Neal and Griffin explained this variation by highlighting the context in which compliance was measured in the two studies; Probst and Brubaker looked at extrinsic motivators such as rewards and punishments for compliance behaviours whereas Neal and Griffin considered intrinsic factors captured through self report items (Probst and Brubaker 2001; Neal and Griffin 2006).

Neal and colleagues work should be commended for a number of reasons. The summary of antecedents, determinants and components of safety performance explained the efficacy of safety climate at an organizational and individual level. In addition, their longitudinal methodology, conducted over five years, provided validation for the model proposed. Perhaps one of the most intriguing findings of Neal and Griffin's work is the importance of participation in safety performance. The reciprocal relationship between participation and motivation led Neal and Griffin to advise ‘organizations attempting to improve safety should focus on changing the work environment to motivate people to actively participate in safety activities, rather than simply blaming and punishing individuals who fail to comply with standard work procedures’ (Neal and Griffin 2006, pg 952). By suggesting a move away from a compliance oriented safety management programme to a more participative approach, Neal and Griffin link their work with a whole body of research that has attempted to investigate the relationship between participation and safety and will be featured in more detail in the third chapter of this review.

The introduction of this thesis detailed a core aim concerning the creation of a model of safety performance for analysis. The models considered in this section of the review all have much to offer to this process. Tomas et al (1999) demarcated workers and supervisors in their approach, as well
as their separation of hazards and risks. Oliver et al (2002) were able to consider the working environment and so integrated physical ergonomics in the form of Performance Shaping Factors into the assessment of safety performance. Whilst aspects of these studies have the potential to inform elements of the safety performance model to be created by this review, it is the work of Neal and colleagues that attracts particular attention. Their unpacking of the psychological processes present from the antecedent through to the outcome stage of safety performance presents a comprehensive picture of this process and so an excellent framework with which to develop.

In considering the various models that have attempted to operate safety climate alongside a meaningful outcome measure, it has become evident that a number of distinct safety climate assessment tools have been and continue to be used. Therefore, whilst the models proposed by Tomas et al (1999), Oliver et al (2002) and Neal et al (2000) provide strong support for the relationship between safety climate and safety outcomes, the question of safety climate measurement remains. Chief among the issues that concern the measurement of safety climate is the design, analysis and interpretation of the safety climate questionnaire and it is this complex topic that forms the next section of this review.

Measuring Safety Climate
This section will deal with a number of the prescient issues in safety climate measurement. These will range from organizational hierarchy, through to levels of analysis, climates dimensionality and techniques used for the separation of safety climate studies. This process will begin with organizational hierarchy, the correct assessment of which is considered by many theorists to be the key to safety climate measurement.

Organizational Hierarchy
Zohar (1980) was the first researcher to establish the significance of management as a dimension in safety climate assessment. In later thematic analyzes of climate sub-dimensions, it is notable that Flin et al (2000) and Guldenmund (2000) both replicated these findings, providing support for Zohar’s early identification of the significance of this theme. In the context of safety climate assessment, management scales often investigate ‘perceptions of management attitudes and behaviours in relation to safety’ (Flin et al, 2000, pg 185), but, as Clarke (2000) identified, there are layers of management within most organizations, each with distinct roles and responsibilities. For
example, senior management may be responsible for populating the health and safety policy whilst middle management identify the objectives required to deliver said policy. It may fall to supervisors, however, to understand and enforce these policies on a daily basis. In recognition of these differences, some researchers draw distinctions between management and supervision in their safety climate surveys. Flin et al identified four safety climate tools with separate factors relating to supervision; HSE, Niskanen (1994), Mearns, Rundmo, Flin, Fleming and Gordon (1997) and Budworth (1997). Of these, the HSE and Niskanen both included a separate supervisor items whilst Mearns and Budworth used a single questionnaire with a section dedicated to supervision.

For some, the role of supervisor is of such significance to safety performance that it is directly referenced in their definition of safety climate. Niskanen (1994) analyzed supervisory and workforce safety attitudes and found a degree of agreement between these groups. Both felt safety working habits improve production, that the prevention of accidents is the responsibility of everyone and safety is a part of skilful job performance (Niskanen 1994). Niskanen did find some disagreement between these groups however, with supervisors believing they gave instructions on safety more frequently than the workforce thought to be the case (Niskanen 1994).

Thompson, Hilton and Witt (1998) analyzed management and supervisor support for safety and found these two groups mediated different relationships. Whilst management support mediated the relationship between organizational politics and safety conditions, supervisor support mediated the relationship between fairness and safety compliance (Thompson et al 1998). Clarke (2000) identified the critical role of the supervisor whilst attempting to produce a theoretical model of the influence of safety culture on behaviour. In this model, Clarke differentiated senior managers, line managers, supervisors and workers and highlighted that many studies (Cox and Cox 1991; Cheyne et al 1998) were happy to include supervisory attitudes as part of a parental topic, normally leadership or management, and so lost this vital distinction. Clarke noted such inclusive studies have led to a ‘paucity of information about the role of supervisors in promoting good safety culture’ (Clarke 2000, pg 83).

Zohar researched means by which supervisory practices could be influenced to improve safety performance. A leadership-based intervention model was designed to modify supervisory monitoring
and rewarding of subordinate safety performance (Zohar 2002). Prior to the intervention, baseline rates of safety oriented supervisory interactions were collected, along with micro accident figures and group safety climate scores. The intervention lasted eight weeks, during which weekly feedback was given to supervisors and section managers. This feedback consisted of cumulative frequencies of reported episodes between operations staff and supervisors in which safety was the criteria for approval or disapproval. This information was fed back to the supervisors on an individual basis, however, the line managers were able to access information about all supervisory actions.

Findings indicated that the simple feedback mechanism established increased the number of supervisor/operator safety orientated interactions. This had a subsequent effect upon minor incident rates, earplug use and even safety climate scores, collected three months after the intervention (Zohar 2002). In this study, Zohar not only underlined the importance of the supervisor in group safety performance, he also demonstrated a means by which safety performance could be improved over the long term. The use of the safety climate score as a pre and post intervention barometer of safety performance also underlined the usefulness of this tool in an academic and industrial context.

Whilst the issue of supervision has produced a number of specific research publications, the role of management in defining and reinforcing safety in the workplace is less clearly understood. Although management has featured as a core factor in safety climate surveys (Dedobbeleer and Beland 1991) and in Cheyne et al’s (1998) model of safety performance outcomes, the mechanism through which management effect safety remains under researched. This lack of detail is surprising given the frequency with which poor management is identified as a causal factor in incident or accident occurrence (Sheen 1987; Fennell 1988; Cullen 1990; Baker 2007).

Despite the scarcity of academic research investigating the relationship between management, safety climate and safety outcomes, the HSE and Institute of Directors (IoD) have responded to the perceived ‘primacy of management’ (Flin et al 2000, pg 186) through the development of the ‘Leading Health and Safety at Work’ initiative. This programme involves regular cross-sector seminars hosted by the HSE and IoD that highlight senior management roles and responsibilities in delivering effective health and safety performance. These seminars are supported by guidance documents that detail the significance of leadership in defining attitudes, providing opportunity for
worker involvement and delivering positive safety outcomes (HSC 2007). The action of stakeholders such as the HSE and IoD underlines the importance of management in delivering safety but also reinforces the need for further research to ensure that well meaning initiatives target those areas most likely to deliver significant safety performance improvement.

The work of Niskanen (1994) illustrated the potential for homogeneity between worker and supervisor safety attitudes. Zohar (2002) demonstrated the impact that supervisor behaviours could have on overall safety performance. This research highlights the significance of the worker/supervisor dyad and underlines the need for further work to understand why these effects are witnessed. Could it be a simple case of in-group behaviours with cohesion mediating a homogenisation of attitudes? Zohar’s work suggests supervisors play a more active role than this and are able to dictate terms through changes in their safety related behaviours.

The relationship between worker and supervisor will form an important part of this research making this section of the literature review highly significant. Of particular interest is the distinction made between manager, supervisor and worker and the implications of a homogenisation in attitudes between supervisors and workers. These topics, along with some of the wider aspects of safety leadership, will feature in the second chapter of this review when they will be closely associated with other antecedents of safety performance.

This section of this chapter has served to underline the significance and dominance of organizational hierarchy in safety research. In their attempts to explain safety climate and wider concepts of organizational safety performance, many theorists have referenced the roles of managers and supervisors and the impact that these roles can have on operator safety performance. The next section of this chapter will illustrate that, such is the significance of organizational hierarchy as a topic, it has prompted a completely new means of conceptualizing and operationalizing safety climate. Zohar’s multi-level model will form the next section of this review reinforcing the growing research driven consensus that the effective capture of elements significant to leadership and/or supervision form the future of safety climate research.
Multilevel Models

In his first publication, Zohar interpreted the continuity in his data as an indication that workers had a 'unified set of cognition's regarding safety aspects of their organizations' (Zohar 1980, pg 101). This statement had two implications. First, safety climate was universally applicable and second, safety climate could be measured at an organizational level. It is the second implication that is of particular interest in this section. The concept of an organizational climate, of shared perceptions among members of an organization concerning policies, procedures and practices, is one that has support (Reichers and Schneider 1990) and it is this model that Zohar, amongst others, initially adopted (Zohar 1980; Brown and Holmes 1986; Dedobbeleer and Beland 1991; Donald and Canter 1993).

As safety climate evolved, however, researchers begun to look at a multi-level model of safety climate. To illustrate this approach, Zohar (2000) highlighted the difference between policies and procedures, often the product of senior management thinking [termed organizational], and practice, often controlled by supervisory influence [termed group level]. This, Zohar argued, suggested the source of safety climate perceptions related to two levels of analysis, organizational level and group level. To test this hypothesis, Zohar conducted a study in a metal works with 534 participants in 53 work groups. To create a group level safety climate scale, Zohar interviewed employees to identify safety relevant incidents involving their supervisor. Critical incident technique was used to aid this process. This data was classified to produce themes which were then converted into 23 questions. These questions were presented to 152 workers and their responses analyzed using Principal Component Analysis to produce a two factor model (Zohar 2000).

Results revealed within workgroup homogeneity and between workgroup variance in perceptions concerning supervisory safety practices (Zohar 2000). Both findings supported the group level hypothesis suggesting a natural harmonisation in perceptions within groups and a distinction in between group perceptions. As part of this study, Zohar was also able to correlate safety climate findings with micro-accident rates recorded in the following months (Zohar 2000). In summarizing his findings, Zohar argued that safety climate perceptions develop at the sub-unit as opposed to the organizational level and that this process is influenced by the actions of the supervisor.
In a second study, Zohar and Luria (2004) further developed the multi-level model specifying that supervisory safety practices would predict safety climate level and strength. Key in this prediction was their assertion that safety climate functioned as a social-cognitive construct. The concept of safety climate as a social-cognitive construct relates to the process of ongoing sense making that individuals undertake to draw conclusions about the environment that surrounds them (Weick 1995). Zohar and Luria argued that this process is dynamic and is influenced by the actions of stakeholders such as supervisors and managers (Zohar and Luria 2004). The study was conducted using over 2000 soldiers from the Israeli Army. Measures included a group safety climate, created following data collection to identify relevant themes, scripted supervisory practices, in which respondents predict how their supervisor would respond to a scenario designed by the platoon commander, and a measure of transformation leadership.

Findings supported their supposition with results indicating that workers search heuristically for relevant indicators or cues [Zohar and Luria termed these scripts] with which to form climate assumptions. Where supervisors display a clear, coherent and consistent safety behaviours, safety climate was positive influenced (Zohar and Luria 2004). Safety climate was found to partially mediate the relationship between scripts and injury rates over a six month period (Zohar and Luria 2004). Zohar and Luria also identified a moderating role for leadership quality. Findings indicated that close leader-member relationships partially compensated for situations in which supervisory safety scripts were unclear or inconsistent. In accounting for this findings, Zohar and Luria suggested better relationships resulted in better observation opportunities for the assessment of supervisory action patterns in situations involving competing goals (Zohar and Luria 2004).

In their conclusions, Zohar and Luria recognized a number of potential weaknesses in the design of their study including the use of military personnel and the limited sample size. Added to this, Zohar and colleagues had to design a organization specific questionnaire to measure group level safety climate in both instances; it could be argued that it was this specificity that delivered significant correlation as opposed to the group level methodology. Furthermore, although questions referred to perceptions of supervisor activities, the ‘group measure’ has remained the aggregation of individual perception; essentially the same technique used to measure organizational climate. A number of cultural measures have successfully employed a team based card sort exercise to encourage the
capture of group level attitudes and values (The Keil Centre 2000); the adoption of such a technique represents a clear opportunity to develop the group level hypothesis. In addition, the group level approach does not provide a distinct measure of senior management or leadership regard for safety, a nebulous but important element of safety climate measurement (Guldenmund 2007).

Both of these studies provide significant support for the distinction of safety climate into organizational and group dimensions. The link between Zohar’s group level tool and micro-accidents is a significant one, and, when it is combined with the social-cognitive construct, the importance of the supervisor is further reinforced. The design and successful operation of a group level safety climate survey represents a significant achievement, as does the identification of the moderating effects of the supervisor-follower relationship. In promoting a multi-level approach, Zohar effectively questioned the methodological assumptions of previous safety climate assessments. According to group level theory, it is the individual worker perceptions of how supervisors put into practice organizational procedures that informs safety climate, alongside organizational perceptions. Zohar used his results to highlight deficiencies in other studies that measured management using commitment scales (Dedobbeleer and Beland 1991) or defined climate as ‘shared attitudes or beliefs’ (Williamson et al 1997). It should be noted that Zohar based these criticisms on the results of two studies, one of which was conducted with the military and both of which relied upon the creation of a unique measurement tool.

In the context of this review, the concept of a group level measure of safety climate is of interest, however, the suitability of Zohar’s scales is questionable. As each tool was developed specifically for the organization in question, no data supporting reliability or is available. Whilst a number of studies have operationalized a group level assessment of safety climate (Hofmann and Stetzer 1996; Morgeson and Hofmann 1999; Hofmann et al 2003; Neal and Griffin 2006; Lingard, Cooke and Blismas 2009), this has been predominantly done using adapted versions of organizational level questionnaires as opposed to Zohar’s bespoke approach.

At a more strategic level, there is also an issue with the assumptions associated with Zohar’s methodology. One of the key explanations for the popularity of safety culture and climate questionnaires centres upon their universal appeal; every organization has a climate of safety. In
moving the measurement of safety climate to a group level whilst simultaneously maintaining its universal appeal, Zohar and colleagues assume that a majority of company structures are arranged around a management-supervisor-workforce hierarchy. Additionally, it is assumed that supervisors take a traditional ‘hands on’ role with workers that allows their dynamic interpretation of management requirements to inform workforce behaviours. Without these vital roles and relationships, Zohar’s distinction between organizational and group climate does not function effectively.

Regulatory research in this area provides sobering reading for Zohar and colleagues. The HSE have commissioned a variety of studies to investigate and respond to changes in workforce management and working practices. These changes, including demanning and skills pooling (HSE 2001) and the introduction of self-managed teams (HSE 1999b) all have implications for the sustainability of the traditional supervisor role and so have implications for the concept of group level analysis. Whilst certain industries have maintained the traditional manager-supervisor-workforce arrangement, there is a requirement to fully understand the extent to which the wholesale adoption of a group level approach may marginalize those companies no longer organizing their workforce in this manner. Without this, the choice of individual level analysis of safety climate presents itself as more desirable than the group level methodology promoted by Zohar and colleagues.

In both the 2000 and 2004 study, Zohar and colleagues elected to collect workforce safety climate data entirely consisting of workforce views of supervisor activities. This decision can only be seen to reinforce the importance of leadership in safety. In addition, Zohar and Luria’s identification of leadership style as an antecedent of safety climate provides valuable support for the consideration of the supervisor-follower relationship in the study of organizational safety performance. The theme of leadership, more specifically, leadership relationships, is one that will feature extensively in the second chapter of this review.

In a paper aimed at the generating ‘renewal and progress’ and ‘drawing a line’ under the further development of measurement scales, Zohar (2008) presented a multi-level model of safety climate that identified organizational-level and group-level climates as distinct constructs with separate measurement scales. In addition, Zohar identified a complementary climate, termed work-ownership climate, through which the effect of safety climate will depend (Zohar 2008). Closer inspection of
work-ownership climate finds a scale similar in nature to participation, a feature of a number of other safety performance studies (Neal et al 2000; Neal and Griffin 2006).

In summarizing this multi-level multi-climate model, Zohar suggests that safety climate might interact with other climates, such as climate for ethics (Zohar 2008). This publication allows the reader to gather an understanding of the strategic implications of his multi-level model of climate. Although he effectively started debates concerning the dimensionality of safety climate, the multi-level model side steps this issue to focus upon inter-group homogeneity and intra-group differences. To gain a full appreciation of the magnitude of this shift, this review will now consider the issue of safety climate dimensionality, from Zohar’s initial study through to contemporary research.

**Dimensions**

*Top Down Approaches*

When designing the first published safety climate questionnaire, Zohar conducted a literature review to identify organizational characteristics that differentiated high and low accident rate companies. This review initially distinguished seven organizational dimensions, however, a pilot study and subsequent principal components analysis produced eight factors that largely overlapped the original seven. The components identified included:

- Perceived -
  - Importance of safety training programs
  - Management attitudes towards safety
  - Effects of safe conduct on promotion
  - Level of risk at the workplace
  - Effects of required work pace on safety
  - Status of safety officer
  - Effects of safe conduct on social status
  - Status of safety committee

(Zohar 1980)
Zohar investigated safety climate using a 40-item questionnaire, delivered by way of interview, to a stratified sample of 20 organizations. Responses for each item varied on a scale of one to five, five indicating high agreement with a statement and one indicating strong disagreement. The sum of these figures was considered the safety climate score for the individual and the average of these scores for 20 individuals was identified as a factory score (Zohar 1980). The questionnaire was structured with dimensions, repeated questions concerning the same subject area. Each of the eight dimensions detailed above were investigated with five questions.

Analysis of responses identified management attitudes concerning safety and the relevance of safety in general production processes as most significant in determining employee’s perception of safety programme effectiveness. The importance of management commitment to safety had been isolated in a number of previous studies (Cohen et al 1975; Smith et al 1975) and its significance in Zohar’s safety climate data provided an excellent thread of continuity. Zohar’s study was significant for a number of reasons, chief among these being the methodology applied; a safety climate questionnaire and subsequent dimensional analysis. This technique proved to be a highly effective means of identifying the constituent elements of safety climate and provided the template for a number of subsequent studies looking to confirm Zohar’s findings (Brown and Holmes 1986; Dedobbeleer and Beland 1991).

Whilst Zohar’s methodology has undoubtedly influenced academics, none have been able to replicate his original ‘eight factor’ findings. Brown and Holmes (1986) assessed 425 production workers using a slightly modified version of Zohar’s original questionnaire. The subsequent conformational factor analysis identified only three factors, management concern, management action and level of risk. Low accident figures prevented any correlation between climate and accident rate although results did show differences in climate perceptions between injured and uninjured workers (Brown and Holmes 1986).

Using Brown and Holme’s questionnaire, Dedobbeleer and Beland (1991) conducted a climate assessment in the construction industry and produced a two factor model; management commitment to safety and worker involvement in safety. Using an adapted version of Zohar’s questionnaire, Glennon findings expanded on Zohar’s original eight factors to produce a nine factor scale (Glennon}
Hofmann and Stetzer modified Dedobbeleer and Beland’s safety climate tool to investigate the association of three group level factors group process, safety climate and intentions to approach other team members engaging in unsafe acts with unsafe behaviours. Findings supported a significant association between the independent and dependent variables (Hofmann and Stetzer 1996).

As researchers moved away from Zohar’s factorial content, the scope of safety climate broadened. In their study of safety attitudes, Cox and Cox (1991) identified five orthogonal factors; personal scepticism, individual responsibility, the safeness of the working environment, the effectiveness of arrangements for safety and personal immunity. Using focus groups to elicit safety relevant beliefs, attitudes, perceptions and values Lee created a 172 item questionnaire (Lee 1998). Data was collected from 5296 participants at a British Nuclear Fuels site in Sellafield, Cumbria. Principal component analysis found evidence for nine domains of safety, including safety procedures, risks, job satisfaction, safety rules, participation, training, control and design of plant.

Rundmo was particularly interested in the relationship between perceptions of risk and safety performance. In creating his questionnaire, Rundmo used focus groups to acquire and refine content and it was this process that highlighted a need for a measure of safety attitudes. Rundmo chose to source this scale from Lee’s nuclear safety climate attitudes publications (Lee 1993). Rundmo related risk perception, physical working conditions and safety and contingency factors with numbers of self report accidents and near accidents (Rundmo 1992b). In a further publication based on the same data set, Rundmo addressed the issue of injury experience, highlighting that employees who suffer an injury may feel more at risk, become more dissatisfied with safety and contingency measures, and experience more job stress than they did before the injury occurred (Rundmo 1995).

Mearns, Flin, Gordon and Fleming published a number of papers utilising Rundmo’s risk perception scale, renamed the Norwegian Offshore Risk Perception Questionnaire (NORPQ) (Flin, Mearns, Fleming and Gordon 1996a; Flin, Mearns, Fleming and Gordon 1996b). Their product, the Offshore Safety Questionnaire, was similar to Rundmo’s NORPQ, however, researchers included a number of new items identified through employee focus groups and literature review (Mearns, Flin, Gordon and Fleming 2001). Findings indicated self reported unsafe behaviours were the best predictor of self
reported accidents/near misses and that unsafe behaviours were, in turn, driven by perceptions of pressure for production (Mearns et al 2001). Meanwhile, Mearns et al (1997) identified ten significant categories as part of an HSE sponsored study of safety climate in offshore environments.

Coyle et al (1995) performed a concurrent validity test in two organizations of similar size, location and infrastructures. The questionnaire was based on interviews with a representative cross sample of personnel. Researchers asked groups of ten people to anonymously record issues they perceived as important to health and safety. All issues were then summarised and displayed for the group to discuss and rank. Those items that were ranked in the first six in each group formed the basis of the questionnaire items. Factors that were not identified by this process but were considered generalizable from Zohar’s (Zohar 1980) and Glennon’s (Glennon 1982) climate scales were incorporated (Coyle et al 1995). Results produced a different factor structure for each organization and led Coyle et al to conclude ‘the universal stability of safety climate factors is highly doubtful’ (Coyle et al 1995, pg 253). Coyle et al drew parallels between the variability of personality traits over time and the potential for variability for safety climate factors suggesting it is in the quantification of variability that safety practitioners should focus.

The studies detailed above point to a large number of safety climate dimensions, indeed, excessive dimensionality has been identified as a key criticism of safety climate research (Guldenmund, 2000; Flin et al 2000). Theorists have attempted to explain dimension number and diversity by focussing on the spread of industry sectors that participated in the study (nuclear, offshore, manufacturing) and their multiple locations (Israel, USA, UK, Norway) (Guldenmund, 2000). In addition, it has been noted that some studies lacked theoretical underpinning (Clarke 2000) whilst others have framed questions concerning safety using different techniques such as attitudes towards safety (Cox and Cox 1991) versus perceptions of the working environment (Zohar 1980).

**Thematic or Meta-analytic Identification**
Although the potentially confounding factors detailed above have not been discounted, Flin et al elected to approach the issue of factorial diversity from a different perspective. Rather than attempting to explain the differences in headline factors, Flin et al applied a thematic approach to look for similarities, threads of continuity between each climate study. Researchers identified 18
published reports that met criteria concerning sample size (over 100), language (English only) and sector (industry only therefore excluding healthcare, retail, clerical publications). Findings identified three themes that appeared in two-thirds of reports; management (13)/supervision (4), safety systems (12) and risk (12). Two themes were found to appear in a third of reports; competence (6) and work pressure (6) (Flin et al 2000) [where () indicate number of studies included].

Guldenmund conducted a similar review and identified [in order]; management, risk, safety arrangements, procedures, training and work pressure (Guldenmund 2000). Flin et al noted Guldenmund had counted dimensions more than once from the same study (Flin et al 2000). Flin et al conceded the limitations of the thematic approach and concluded there to be three ‘core themes’; management, risk and safety arrangements. Clarke presented a summary of ‘16 empirical studies which involved the development of the architecture of safety attitudes’ (Clarke 2000, pg 70) and identified five dominant themes; work task/work environment, personal involvement and responsibility, management attitudes, safety management systems and management action (Clarke 2000).

In discussing the product of their thematic analysis, Flin et al commented, ‘the real test of the safety climate measure is validity, in terms of their power to reveal the site safety’ (Flin et al 2000, pg 189). As such, they identified the requirement for a meta-analyzes to investigate the link between safety climate tools and agreed outcome measures. The findings of this study, conducted by Clarke (2006b) and reviewed previously, can be seen to complete a powerful body of evidence in support of the measurement and analysis of safety climate.

**Factorial Stability**

The work of Guldenmund (2000), Clarke (2000) and Flin et al (2000) presents a mixed message when considering safety climate dimensionality. Whilst it is evident factorial differences exist, top down thematic assessments points to the possibility of limited uniformity. Although both Brown and Holmes (1986) and Dedobbeleer and Beland (1991) were unable to replicate Zohar’s dimensions, a number of researchers have been able to broadly reproduce prior factorial findings. Tharaldsen, Olsen and Rundmo published a longitudinal assessment of safety climate in 2007. A combination of exploratory factor analysis and confirmatory factor analysis produced a safety climate structure with
five dimensions; safety prioritisation, safety management and involvement, safety versus production, individual motivation and system comprehension (Tharaldsen and Rundmo 2007). This structure was found to be stable over the two year study period. Longitudinal findings indicated a significant improvement in safety climate for four dimensions over the two year period. Safety climate dimensions were shown to be negatively associated with risk perceptions and accident rates, however, risk perception and accident rates were found to be positively correlated with safety prioritisation (Tharaldsen and Rundmo 2007).

Summary
The issue of safety climate factors and factorial stability must be viewed in relation to earlier observations concerning the history of safety climate research and the move towards group level climate analysis. Prior sections of this review noted the dominance of hierarchy in early safety climate assessment with theorists noting the core role of management commitment, and, latterly, supervision. This funneling process was aided by factorial analysis; the links between identifiable factors and significant outcome measures. Consideration of factorial analysis does more than explain the shift to group level climate analysis, however. It also illustrates the tendency of research to be influenced by what has come before and hence reinforce the populist position. For example, Zohar and colleagues identified the core role of management commitment in the expression of safety climate in the early 1980s. This finding influenced researchers to consider management commitment in their subsequent assessments of safety climate. Thematic and meta-analysis then emphasizes this message finding, perhaps unsurprisingly, the aggregated measure of management commitment to be significant.

This is not to argue that management commitment does not play a key role in the expression of safety climate. Rather, it is to consider the bigger question, that safety climate research has been dominated by a significant factor at the expense of other, potentially more significant, factors. In considering factorial stability, this review has already touched upon longitudinal safety climate assessment. Whilst the longitudinal approach has played a key role in improving understanding of the factorial debate, research applying this methodology has not been limited to this issue. Indeed, as the next section of this review will demonstrate, longitudinal research has played a key role in improving understanding of core topics such as climate-outcome relationships and theories concerning safety climate causality.
Longitudinal Assessment of Safety Climate

A number of studies have attempted to research the nature of safety performance over time (Probst and Brubaker 2001; Neal and Griffin 2006; Tharaldsen and Rundmo 2007). Probst and Brubaker assessed perceptions of job security, job satisfaction, safety knowledge, safety motivation and safety compliance at two different time periods, six months apart. Results indicated that job security was related to safety knowledge, safety motivation and reported compliance with safety policies. In addition, injuries and accidents were shown to be predicted by safety motivation, and, to a lesser extent, safety knowledge and compliance (Probst and Brubaker 2001). The authors commented ‘perhaps most significantly, the majority of these results were confirmed in both cross-sectional samples and a more rigorous longitudinal design’ (Probst and Brubaker 2001, pg 155).

Tharaldsen and Rundmo used their Norwegian Offshore Risk and Safety climate inventory, carrying out two surveys in 2001 and 2003. Structure equation modelling indicated a good factor model fit for 2001 and 2003 data; analysis revealed safety climate was significantly improved from 2001 to 2003 (Tharaldsen and Rundmo 2007). Tharaldsen was able to illustrate that safety climate dimensions were negatively associated with risk perception and accident rate, however, no correlation was forthcoming (Tharaldsen and Rundmo 2007). Neal and Griffin measured perceptions of safety climate, motivation and behaviour at two time points, five years apart, and linked them to accident levels over the five year period. Results indicated longitudinal relationships between safety climate, safety motivation and self reported safety behaviours. Self reported safety behaviours were linked with a subsequent reduction in accidents at the group level; a majority of the accidents reported were strains and sprains (68.5%) and bruises (10.3%) (Neal and Griffin 2006).

Mearns et al (2001) conducted a longitudinal study designed to improve understanding of safety climate benchmarking in hazardous environments. Using a total of nine offshore oil and gas platforms, Mearns et al employed the Offshore Safety Questionnaire over a number of consecutive years. Discriminative Factor Analysis (DFA) identified elements of safety climate predictive of self report accidents. These were initially found to vary between platforms, however, the researchers noted a convergence of significant elements over the timeframe used. Whilst accounting for these changes, Mearns et al (2001) highlighted improvements to safety culture delivered by company and
industry/regulatory programmes such as Stepchange, an initiative designed to improve offshore safety through improved reporting and sharing of incident and accident data.

Longitudinal studies are able to make a number of significant contributions to the safety climate literature. In a meta-analysis of safety climate and related outcomes, Clarke noted the potential for reverse causality and the impact this could have upon the relationship between climate and outcome. Longitudinal studies allow researchers to navigate around these issues and have produced significant support for a relationship between climate and accident occurrence. In addition, longitudinal studies allow the further investigation of climate factor stability as they allow researchers to control a number of organizational variables. Their contribution in this area has been significant with studies supporting (Tharaldsen and Rundmo 2007) and dismissing (Coyle et al 1995) factorial stability on the basis of longitudinal studies.

As part of its review of the longitudinal approach, this review has touched upon attempts to define climate, and, through this, has identified a clear rift in opinion. Whilst some conceptualize climate as a snapshot of culture (Flin et al 2000) others regard climate to be a subset of a wider concept of organizational climate (Zohar 1980; Neal and Griffin 2006). This disagreement has already been seen to have significance for the nature of safety climate assessment with some 'snapshot' theorists happy to measure safety climate using a mix of attitudinal and perceptual questions, an approach that was subsequently identified to have a potentially detrimental effect on safety climate factor stability (Clarke 2000).

**Mixed, Attitudinal and Perceptual Approaches**

Clarke (2006a) elected to further investigate the nature of safety climate assessment with the aim of disaggregating the psychological constructs underling the measurement of safety climate and safety culture. This investigation identified three major approaches, mixed, attitudinal and perceptual. Clarke introduced the approaches as follows ‘1. the attitudinal approach, which focusses on measuring employees’ attitudes towards safety; 2. perceptual approach, which focusses on measuring employees’ perceptions of the work environment, including organizational policies and practices; and, 3. ‘mixed models’ which measure a combination of perceptions and attitudes, and are
sometimes extended to include other variables, such as dispositions, beliefs and work-related attitudes' (Clarke 2006a, pg 538).

Mixed Models
Despite a relatively recent publication history, Lee can be considered a pioneer in the study of safety performance using a mixed methodology. Although Lee described his study as an assessment of safety culture, his inclusion of a perceptual and attitudinal scale encouraged those who had an interest in safety climate to make use of both. Rundmo used elements of Lee’s nuclear safety questionnaire to assess risk perception and safety climate in an offshore environment (1994). Mearns et al (1997;1998) subsequently tailored elements of Rundmo’s scale to create the Offshore Safety Questionnaire, a tool that remains in frequent use (Mearns, Whitaker and Flin 2003). Rundmo (1994), Mearns et al (1998), Oliver et al (2002) have all measured perception of risk as an extension of safety climate and so have advocated a truly mixed methodology inclusive of attitude, perception and dimensions of risk. Others have integrated concepts such as job satisfaction (Lee 1998) and work pressure (Lu and Shang 2005).

Using a mixed approach, it is possible to accommodate these elements and hence understand their context either alongside or within safety climate. Conflating attitude and perception, risk and safety climate should not necessarily be seen as a methodological weakness if it is recognized and managed within the methodology and findings of the study. In too many cases, however, such clarity is missing leaving the door open to the misinterpretation of findings. Advocates of a mixed approach should be clear, therefore, whether they see elements such as attitude, risk, job stress or satisfaction as an integral part of safety climate or, alternatively, whether they see them as factors with the potential to impact upon safety climate. This is an important methodological distinction and one that will feature in the second chapter of this review.

Clarke and Robertson (2005) conducted a meta-analysis to investigate what relationship, if any, existed between personality type and accident involvement. Personality research has identified the 'big five' personality traits, recognized to be broad factors or dimensions of personality. The big five traits are openness, conscientiousness, extraversion, agreeableness and neuroticism. Meta-analysis of 47 studies in which personality traits and accident involvement were recorded revealed
criterion validity for two personality dimensions, agreeableness and conscientiousness, indicating that individuals low in conscientiousness and agreeableness were more liable to be accident involved (Clarke and Robertson 2005). Whilst the authors noted the potential for in-trait variation (i.e. aspects of agreeableness increasing and decreasing the potential for accident involvement) and the limitations of the sample size available for analysis, this study provides a glimpse of an alternative means of safety performance assessment. The potential for a combinatorial approach that mixes an assessment of perceptions and/or attitudes to safety along with other elements such as personality, trust or relationships would seem to be evident.

**Attitudinal Approaches**
Attitudinal assessment of safety climate has been dominated by a number of studies, including Purdham (1984), Cox and Cox (1991) and Cheyne et al (1998). Cox and Cox based their approach on Purdham’s (1984) attitudinal framework focussing on attitudes towards safety software, people and risk. Their assessment of attitudes at a multinational industrial gases distributor produced 630 responses and five dimensions detailed previously. Cheyne et al used an adapted version of Cox and Cox’s (1991) and Tomas and Oliver’s (1995) questionnaires to identify five safety specific dimensions, however, their use of safety activities as an outcome measure singled out individual responsibility as the only factor with a direct data-outcome relationship Cheyne et al (1998). Along with these findings, research has identified that individuals who report more positive attitudes to safety are less likely to be injured (Donald and Canter 1993) and are more likely to engage in safety behaviours (Tomas et al 1999).

As the limited study number demonstrates, using attitudes on an exclusive basis to measure safety climate has not dominated research. Although little has been written concerning this topic, an assertion by Cox and Cox offers some potential insight. In their discussion, the authors suggest attitudinal data concerning hardware and physical hazards ‘might influence (and interact) with those representing the three other objects [software, people, risk]’ Cox and Cox (1991, pg 103). Such a link demonstrates the proximity of attitudinal analysis with safety culture and assertions concerning organizational artefacts (Guldenmund 2000). It is possible that some researchers have elected to mix or minimize attitudinal analysis in the assessment of safety climate to ensure clear lines of demarcation between culture and climate.
Perceptual Approaches
In his article introduction, Zohar clearly identified safety climate as a facet of a wider concept of organizational climate ‘the purpose of this article is to describe a particular type of organizational climate and to examine its implications’ (Zohar 1980, pg 96). Zohar highlighted research that had identified other aspects of organizational climate, including House and Rizzo (1972), who had developed a holistic climate measure, and Litwin and Strinders (1968), who had researched motivational climate. Zohar concurred with Schneider proposal that, such was its size and complexity, organizational climate should only be considered an area of research as opposed to a research topic (Schneider 1975). In this respect, organizational climate could be considered to be a collective term for the many different areas of climate research.

Zohar found support for his perceptual hypothesis from a number of theorists, including Brown and Holmes (1986), Dedobbeleer and Beland (1991) and Neal et al (2000). For many, a mixed or attitudinal approach undid much of the work undertaken that identified safety climate as a gage of reference for subsequent behavioural outcomes (Dedobbeleer and Beland 1991). Neal and Griffin have always been clear in their assertion that safety climate represents ‘perceptions of policies, procedures, and practices relating to safety in the workplace’ (Neal and Griffin 2002, pg 69). Indeed, their observation that many scales used to date ‘confound climate with attitudes and behaviour’ (Neal and Griffin 2002, pg 69) provides further support for perceptual process and the value of successfully demarcating these concepts.

Summary
Using these categories, Clarke revealed that employees work perceptions had greater predictive validity towards safety than attitudes and that one aspect of personality, namely agreeableness, had a greater predictive validity than either perception or attitude (Clarke 2006a). In addition, the relationship between perceptions and work accidents was shown to be susceptible to situational factors such as industry type, occupational or environmental conditions and perceived importance of safety (Clarke 2006a). Whilst these findings are of significance in themselves, it is the means by which Clarke separated the various areas of research that is of particular interest. In demarcating these constructs along perceptual and attitudinal lines, Clarke dealt simultaneously with the culture
and climate debate and the trend for mixing climate surveys with other factors such as personality (Jones and Wuebker 1993) or risk perception (Rundmo 1992a).

Whilst the perceptual approach displayed better predictive validity than its attitudinal counterpart, it is the clarity that perceptual theorists bring to the culture/climate debate that provides their most compelling argument. The successful study of safety climate begins with a clear understanding of what it is, and, most importantly, how it relates to other factors. In the context of this review, consideration of the mixed/attitudinal and perceptual approaches identifies the requirement for a perceptual assessment of safety climate, clearly separated from other elements to improve understanding of interactive rather than combinatorial climate relationships.

Although this review has dealt with a number of the problems associated with safety climate research, many of these have been known to researchers and so already in possession of suitable explanations. The next section deals with an issue that has not yet featured as part of a peer reviewed article. This issue influenced decision making concerning the choice of safety climate assessment tool used for this study and its inclusion forms part of the reasoning detailed in Chapter 2 of this review.

**Chapter Summary**

This chapter was written with a number of aims in mind. The primary aim was to ensure the consideration of a sufficiently broad range of safety culture and climate literature as to enable the identification of conclusions with significance to the design of this study. In addition, it was intended that this chapter would identify gaps in the literature into which research questions could be placed. Finally, this chapter was intended to help identify the potential structure and components of a model of safety performance. This summary section will follow the flow of this chapter, identifying conclusions in the same sequence as the literature was reviewed. These conclusions will illustrate how this chapter has influenced the identification of relevant research questions and hence the overall design of this study.

This chapter commenced with a review of safety culture definitions. The propensity towards broad and inclusive language was underlined. This inclusive approach was explained, in part, through the
symbiotic relationship between safety culture and major incident and accident investigations such as Chernobyl and Piper Alpha. In these examples, safety culture was poorly specified but formed a significant piece of the causation jigsaw. Explanation for this pattern centred upon a need to simplify the often complex nature of incident causation, to draw multiple strands together under a single umbrella term. This pattern of poor specification but high significance was seen to be as relevant to contemporary accident investigation, such as the Baker Report, as those early examples. This review considered the relative merits of a number of safety culture measurement techniques, from behavioural audit to card sorts and cultural questionnaires. Consideration of this research, however, underlined the notion that safety culture remains an excessively broad concept, under-specified in terms of measurement medium and construct content. Whilst this breadth may be the key to its popularity, it does not lend itself well to academic study where conceptual discipline and specification are required. For example, how can research illustrate how safety culture interacts with potential antecedents if it is unclear whether these antecedents are, in fact, to be considered constituent elements?

The catchall nature of safety culture was contrasted with safety climate. A review of safety climate literature revealed a conceptual development process conducted in the theoretically uncompromising environment of academic research. This environment has produced a construct with a sound theoretical grounding. This product of this grounding is exhibited in the good levels of agreement concerning the ideal measurement medium, the questionnaire, and the mechanisms through which climate can be linked with measures of safety performance. This is not to ignore debate concerning the factorial stability and content of safety climate questionnaires or criticisms regarding their ‘quick and dirty’ nature.

The conclusion to use a safety climate questionnaire reflects academic and operational realities. When it is considered that few organizations have the time and resource to run repeated focus group or behavioural measurement programmes, the appeal of the questionnaire becomes apparent. With the decision concerning medium made, a review of literature reveals safety climate research to be the most consistent exponent of the questionnaire and therefore the ideal means for of safety measurement in this study.
Conclusion 1: Utilize the theory of safety climate and measure via a questionnaire

Decisions concerning the nature of safety culture and safety climate are complex. This complexity is compounded, however, when literature concerning safety climate measurement is considered. This review attempted to highlight the trends in prior safety climate research and explain how these trends have influenced contemporary thinking. During this process, a thread of continuity was detectable. Since the concept of safety climate was introduced, researchers have been motivated to understand its constituent elements. This motivation led to a number of studies that claimed to support the idea of factorial stability and a number that disputed it. As time progressed, thematic analysis of this growing body of research seemed to deepen the confusion with the identification of a wide variety of key constituent elements or factors. Amid this confused picture, one theme has been consistently identified as significant; namely management commitment.

Management commitment has dominated this chapter, explicitly, in the form of thematic reviews conducted by theorists such as Clarke (2000), Flin et al (2001) and others, and implicitly, in the form of the group level methodology proposed by Zohar and advocated by many contemporary researchers. It is salient to note that the group level approach is predicated on Zohar’s conviction, supported through his findings, that management commitment is almost all pervasive in safety climate research. This chapter has chartered Zohar’s theoretical radicalisation, from his identification of management commitment in 1980 through to his group level methodology and his treatment of safety climate as a global [single] scale.

Whilst management commitment clearly plays a pivotal role in the understanding of safety climate, few researchers would claim that safety climate consists only of management commitment. And yet much of the contemporary climate research can be seen to be ‘locked in’ to the further study of management commitment through the medium of group level analysis with researchers seemingly willing to accept the concept of a global measure of climate, a single factor measured at the group level. This review has therefore detected a gap in literature, a requirement to further understanding of what, if any, factors relevant to safety climate are detectable and to what significance. This
requirement will be further defined and addressed in Chapter 2, however, in this chapter in can be summarized as follows.

**Conclusion 2: Requirement to study elements other than management commitment**

The significance of management commitment to safety climate cannot be underestimated. It has been used as the central argument for group level analysis, one of the most significant methodological shifts in climate research over the last 30 years. In his argument in favour of group level analysis, Zohar disposes of arguments concerning factorial stability in favour of a global measure of climate. The combination of these arguments make clear Zohar’s priorities; the effective measurement of management commitment at the cost of factorial understanding. Such is the prevalence of group level safety climate analysis, it would seem Zohar has persuaded many towards the group and global model.

The consideration of leadership alongside safety climate and organizational outcome measures produces a large and diverse research catalogue. Whilst the significance of leadership cannot be denied, the means of modelling and measuring its impact has evolved and remains subject to debate. The issue of supervision has dominated the leadership debate and Zohar has done much to underline the effect that supervisors can have upon safety climate propagation. This work was instrumental in the identification of leadership relationships as a significant factor in climate propagation and the identification and support of the multi-level climate model.

Zohar’s multi-level model represents a significant shift in safety climate research. In his summary paper, Zohar advocates a move away from the study of dimensionality and safety climate outcome to the consideration of micro-climates and climate level interactions (Zohar 2008). Whilst Zohar has provided research support for the multi-level model, an argument could be made that where other researchers discuss dimensionality, Zohar discusses micro-climates. In addition, the representation of elements such as work-ownership as climatic illustrates a shift from perceptions of work environment to perceptions of behavioural outcomes, a different construct.
Most significantly, however, research suggests the multi-level approach may ostracise those organizations that no longer manage using traditional supervision models. Evidence for the evolving nature of supervision is sparse, however, a number of HSE reports reviewed in this chapter have identified the changing role of the supervisor from a ‘hands on’ team member to a ‘hands off’ office based role, as well as the continued utilization of self managed teams (HSE 1999b; HSE 2001). Both of these changes have implications for the role of the traditional supervisor, a necessity for Zohar’s group level approach. These implications were captured in the body of this review and will feature extensively in the discussion of this study. For these reasons detailed above, however, it was decided to adopt an individual, rather than group level assessment methodology.

**Conclusion 3: Adopt a individual level approach**

The final conclusion identified in this chapter refers to the nature of safety climate research detailed by Clarke (2006a). The identification and consideration of the mixed, attitudinal and perceptual constructs applied by many researchers allowed for a fuller understanding of safety climate on a number of levels. To many, the mixed methodology, in which researchers utilized risk, attitude and perceptual measures, may be seen as safety culture assessment in itself (Lee 1998; Meams et al 1999; Lee and Harrison 2000). Although the simplicity of this supposition may be attractive, it requires climate to be directly attached to or integral with culture. Some researchers have attempted to explain this connection through the culture/climate snapshot thesis, in which climate represents a snapshot of culture (Flin et al 2000) whilst others have proposed an integrative model of perception and attitude (Guldenmund 2000). Upon review, these approaches may be guilty of neglecting the value of climate assessment in itself; the added validity, reliability and continuity this construct has introduced to the measurement of safety performance. Better, then, to allow culture and climate to interact whilst encouraging researchers and practitioners to remain aware of their distinctions.

Attitudinal climate research, although limited, does present an issue to the representation of safety climate as a purely perceptual process. Comparison of questions used in attitudinal and perceptual research reveals a clear similarity (Clarke 2006b) suggesting it could be semantic rather than practical differences that separate these models. As this review has revealed, however, accepting this argument only leads to further confusion regarding the meaning of safety climate; a snapshot of
culture or a measure of a subset of organizational climate? As Neal and Griffin assert, using attitudinal or behavioural scales confuse elements with the potential to impact safety climate with climate itself (Neal et al 2000). In addition, it moves the idea away from the original research that described safety climate as a function of a broader organizational climate (Zohar 1980). This position has support Neal and colleagues finding a clear relationship between organizational climate and safety climate (Neal et al 2000).

Representing safety climate as a purely perceptual process helps to contextualize its role within safety performance assessment and brings clarity to the ‘muddied waters’ (Clarke 2000) that persist when attempts are made to demarcate climate and culture. Advocating the perceptual approach to safety climate measurement does not preclude the inclusion of topics such as attitude (Cox and Cox 1991), trust (Flin and Burns 2004), risk awareness (Rundmo 1996) or personality (Clarke 2006a) in related research. Instead, it allows these elements to be analyzed in relation to safety climate and so helps further understanding of how their interaction impacts safety performance. The perceptual measure allows the assessment of elements with the potential to impact upon safety climate without confusing them with safety climate. Viewed through this prism, researchers can contextualize attitude and other factors with clarity concerning what culture is and is not.

**Conclusion 4: Agree upon a perceptual approach**
Chapter 2 - Predictors of Safety Performance

Chapter Preface
The literature reviewed in Chapter 1 has done much to inform thinking concerning the nature of this study. Safety culture was discounted as a means of measuring perceptions of safety in preference of safety climate. A perceptual questionnaire has been identified as ideal, measuring safety climate at the individual level. A core finding in Chapter 1 concerned the observed gap in the literature regarding safety climate’s constituent factorial elements. The focus upon management commitment, it was argued, has resulted in a paucity of information regarding alternative or complimentary factors and the almost default understanding that safety climate is management commitment. Chapter 1 concluded there was a requirement for further research in this area and this chapter will operationalize this.

When looking for an alternative approach to the measurement of safety climate, the work of Glendon and colleagues is immediately identifiable. When creating their new questionnaire, Glendon et al were heavily influenced by ergonomics, more specifically, literature concerning Performance Shaping Factors. This chapter will commence with an introduction to the Performance Shaping Factors literature before attempting to understand how this research may sit within the broader study of safety climate. At its conclusion, this section will present the case for the use of Glendon and Litherland’s safety climate scale, detailing clearly the potential value this approach may deliver.

The second section of this chapter will introduce the concept of LMX and provide justification for its inclusion in this study. This justification will concern the perceived added value that LMX can bring to the understanding of organizational and individual safety performance; value associated with the growing consensus concerning the importance of leadership style in safety performance and LMX’s unique tripartite measurement of the leadership-follower-relationship. Following this, a review of general LMX literature will help identify the scales used to measure this construct as well as the roles identified in its operation (e.g. as a mediator or moderator of variable relationships). Along with the more general review of LMX literature, this chapter will pay particular attention to those studies in which LMX and safety performance have been operated simultaneously. Studies by Hofmann and Morgeson (1999) and Hofmann et al (2003) will provide vital clues concerning the likely relationships
between variables in this study and so will inform the hypotheses generated at the conclusion of this chapter.

**Introduction**

Chapter 1 provided a review of safety climate, a topic that has received a huge amount of research interest and, in some respects, has dominated study of safety performance predictors. This chapter is charged with the review of two topics that have been identified as significant in the study of safety performance prediction, namely Performance Shaping Factors and Leader-Member Exchange (LMX). Although linked in their use as predictors of safety performance, LMX and Performance Shaping Factors share very little ground concerning their development and methodological application. It is important, therefore, to justify the inclusion of these loosely associated concepts in a study intended to further understanding of organizational safety climate and performance.

This chapter will link the theory of LMX to the concepts of leadership reviewed in Chapter 1. This process will highlight some of the unique aspects of LMX, including development history and theories of measurement, that distinguish it from other leadership research and therefore justify its inclusion as part of a study of safety performance predictors. This chapter will also investigate a broad range of research to further understanding of the role assigned to LMX in the study of organizational and safety performance outcomes. At the end of the process, the argument for the inclusion of LMX as a predictor of safety performance will be clear. In addition, there will be a good understanding of how LMX will integrate into a holistic model of safety performance and what its relationship with other factors already identified is likely to be.

At the conclusion of Chapter 1, the argument for an excessive focus upon management commitment was made. The inclusion of Performance Shaping Factors in the second chapter of this review can be viewed, in part, as a response to this issue. As this review will illustrate, Performance Shaping Factors research has been mainly conducted by ergonomists, and, as such, has focussed upon the external influences upon individual behaviours. A number of researchers have used Performance Shaping Factors as a source of data to inform the assessment of safety climate (Glendon, Stanton and Harrison 1994; Glendon and Litherland 2001; Oliver et al 2002) and this chapter will investigate the methodological grounding for this combinatorial approach. Particular interest will be paid to the
development of Performance Shaping Factors, the points of overlap between this concept and safety climate research and the benefits, if any, this methodology can deliver.

Before beginning with a review of performance shaping literature, it should be stressed that this chapter is not intended to represent a wholesale review of safety performance research. Topics known to exhibit a significant relationship with safety performance include a wide variety of elements such as group interactions (Zohar 2000), use of quality circles Wilkens and London (2006) managerial training (Stokols, MacMahan, Clitheroe and Wells 2001), the management of social capital (Rao 2007) and the impact of job insecurity (Probst and Brubaker 2001). These publications, along with a multitude of other articles, have been excluded to ensure this chapter remains manageable and focussed. The exclusion of these topics is no comment on the significance of these findings, rather, it is a comment on the breadth and depth of safety performance research.

**Performance Shaping Factors Research**

**Introduction**

Studies have attempted to integrate themes such as perception of risk (Rundmo 1995) or job satisfaction (Lee 1998) with organizational and individual safety performance, however, this has often been achieved using mixed methodologies (Clarke 2006a). Concerns with this methodology were outlined in Chapter 1 and centre upon theoretical confusion (i.e. attitude/perception) and potentially destabilising effects on factorial content. In their thematic and meta-analytic reviews of safety climate factors, researchers have repeated underlined the significance of management commitment. A review of the group level analysis technique utilized and promoted by Zohar was seen to be the zenith for this conceptualization of safety climate, a methodology that sacrificed factorial content in exchange for a global scale of organizational and group safety climate. Towards its conclusion, Chapter 1 formed the argument that, although management commitment is clearly important in the understanding and measurement of safety climate, it cannot be the only significant factor. To counter this thinking, researchers must look further afield, perhaps away from the dominant climate theorists and their associated publications.

Glendon et al derived their questionnaire content from an atypical source, namely Performance Shaping Factors. Indeed, Glendon et al’s initial publication in 1994 chartered the creation of a ‘performance shaping factor questionnaire’ (Glendon et al 1994, pg 340) as opposed to a safety
climate tool. The result was a 58 item questionnaire, originally derived from 300 generic Performance Shaping Factors ‘with the potential to influence safety performance’ (Glendon and Stanton 2000, pg 203). This was a questionnaire, therefore, influenced primarily by performance shaping as opposed to safety climate literature and initial findings, such as the stable factor structure, provided a good level of support for this atypical methodology.

To understand the suitability of Performance Shaping Factors as sources of safety climate items, this chapter will perform a review of performance shaping literature, concluding with points at which Performance Shaping Factors and safety climate have overlapped. At this point, a review of Glendon and Litherland’s safety climate tool will be conducted and a final judgement concerning its suitability for this study will be made.

**Performance Shaping Factors Research**

**Error Analysis**

In his review of Swain’s Technique for Human Error Rate Prediction (THERP), Reason identifies Performance Shaping Factors as ‘the work environment; the quality of the man-machine interface; the skills, experience, motivation and expectations of the individual operator; and the degree of stresses likely to be present in various situations’ (Reason 1990, pg 222). In a later publication, Reason defines performance influencing factors as ‘the immediate workplace conditions that shape the occurrence of human or technical failure’ (Reason 1997, pg 147). Literature concerning Performance Shaping Factors is limited and generally concerns their integration into human error identification systems (Doytchev and Szwillus 2009; Stanton, Salmon, Harris, Marshall, Demagalski, Young, Waldmann and Dekker 2009). Human error identification techniques are varied, including Systematic Human Error Reduction and Prediction Approach (SHERPA) (Embrey 1986) and Human Error identification in Systems Tool (HEIST) (Kirwan 1998), and are mainly charged with the identification and rating of task criticality (HSE 1999a) using structured Task Analysis (either Hierarchal or Tabular) and error analysis techniques (Stanton et al 2009).

Human error identification techniques were initially criticised for their excessively empirical approach and so the integration of Performance Shaping Factors was seen by many to recognize the fallibility of human actions (Reason 1990). Whilst human error identification has now been adopted by a
multitude of industries it was the nuclear and aviation sectors that initially led the way. In reflection of this advance, Miller and Swain (1987) were commissioned by the Nuclear Instillation Inspectorate (NII) to produce a comprehensive list of Performance Shaping Factors, the results of which are detailed below:

- Emotional state
- Intelligence
- Motivation/Attitude
- Perceptual Abilities
- Physical Condition
- Sex Differences
- Skill Level
- Social Factors
- Strength/Endurance
- Stress Level
- Task Knowledge
- Training/Experience

(Miller and Swain 1987)

The list produced by Miller and Swain is still regarded as one of the most comprehensive in circulation and remains in regular use within the nuclear sector Health and Safety Commission (1991). An assessment of the factors identified by Miller and Swain finds a number of topics which have already featured in the study of safety performance outcomes. Berland, Natvig and Gundersen (2008) conducted a qualitative assessment of the relationship between patient safety and job related stress and concluded increased stress can often effect patient safety. Rundmo (1995) detailed that accident involvement can increase the levels of job stress in the offshore oil and gas environment.

Glendon and Litherland (2001) reveals a focus on the physical outcome of Performance Shaping Factors as opposed to their cognitive mechanisms. In essence, Glendon et al (1994) reduced the multitude of Performance Shaping Factors to a small number of task specific items that were suitable for analysis using a perceptual scale. In this respect, Glendon and colleagues can be considered to have borrowed from the performance shaping literature without being excessively tied to it. This is a theme that will be considered in more depth in the following section; Integrative Models.

The historical context of Performance Shaping Factors research has been considered, along with a definitive list of its constituent elements, however, the issue of conceptual integration remains. How have researchers attempted to contextualize Performance Shaping Factors in the past? How do these efforts related to the work of Glendon et al and other theorists who have used Performance Shaping Factors to inform safety climate?

**Integrative Models**

In many cases, Performance Shaping Factors have been integrated into holistic models intended to assist in the management of safety performance. In one such case, Bellamy, Geyer and Wilkinson (2008) created a three component model intended to support key stakeholders such as inspectors or chemical companies in their understanding of how human factors, safety management systems and wider organizational issues ‘fit together’ (Bellamy et al 2008, pg 461). The authors conducted extensive reviews for each component of their model, including relevant literature. The human factors component included the following:

Demand PSF (Performance Shaping Factors) such as the nature of the job, task design operator information, workplace layout, workload - 96 elements

Environmental PSF (heat lighting noise) stressors (false alarms, process updates) - 17 elements

Capacity PSF relating to the individual (experience, competence, attitudes, risk perceptions) psychological capabilities (attention, alertness, arousal, perception, adaptation, cognition, understanding, memory) - 47 elements

(Bellamy et al 2008)
A review of Bellamy et al’s taxonomy finds multiple points of overlap with climate literature with elements such as attitudes and perceptions featuring alongside functional factors concerning the workplace, task design and risk perception. For example, whilst demand Performance Shaping Factors include cognitive elements such as task design and operator information, it also includes workload, a topic that has appeared in a number of safety climate scales (Flin et al 2000). Environmental Performance Shaping Factors include more of the traditional physical ergonomic issues such as light, heat and noise, but also include more cognitive elements such as alarm cascades and process updates. Few of these elements have found their way into safety climate surveys. Capacity Performance Shaping Factors, on the other hand, show clear commonality with measures of safety climate, however, no mention is made of this construct in the literature review, methodology or findings.

The work of Bellamy et al underlines the broad nature of Performance Shaping Factors and, to some extent, confirms the operational focus noted by Glendon and Litherland. The wholesale omission of safety climate is of particular interest as it suggests the existence of two parallel research topics, safety climate and Performance Shaping Factors, with little interaction between them.

Mohaghegh and Mosleh present a causal framework for organizational risk, termed SoTeRiA, intended to address the absence of multi-disciplinary links between organizational factors, system risks and social and individual aspects of organizational safety (Mohaghegh and Mosleh 2009). SoTeRiA indicates there are two ways in which the organizational safety structure can effect individual Performance Shaping Factors. One route is through organizational safety practices, which influence organizational safety climate and group safety climate and eventually impact upon psychological safety climate. A second route is through the direct effect organizational safety structure and practices have upon individual Performance Shaping Factors, for example training effecting operator knowledge (Mohaghegh and Mosleh 2009). Although Mohaghegh and Mosleh provide no quantitative support for their model, it is their presentation of psychological safety climate as a function of Performance Shaping Factors that is of particular note.

Kim and Jung (2003) conducted a comprehensive review of performance shaping literature to rationalise relevant publications and produce a taxonomy for use in task analysis in the nuclear
sector. They identified a number of performance influencing factor groups, including Human, Task, System and Environment (Kim and Jung 2003). Whilst they included plant policy and safety culture as an element within their Environment group, safety culture and climate specialists could argue that many of the groups identified contained items which could feature as components of culture or climate questionnaires. For example, time pressures (Flin et al 2000), training (Zohar 1980), procedures (Mearns et al 1998) and communication (Dedobbeleer and Beland 1991) all featured in Kim et al’s framework and have all featured as factors in safety climate questionnaires.

May and Decker (2009) conducted a review of failures in engineering structures and components and identified human factors as a major issue. When attempting to drill down into the causal pathways, May and Decker detailed a number of Performance Shaping Factors directly, such as fatigue, ergonomics of control room design and communications and interfaces, as well as a number of factors which could be linked to Performance Shaping Factors, such as procedure clarity, human factors in design and staffing arrangements (May and Decker 2009). Although May and Decker did not reference them directly, the overlap between Performance Shaping Factors and human factors as defined in their study underlines the need for specificity.

**Conclusion**

Kim and Jung (2003), May and Decker (2009) and Stanton et al (2009) all provide a good assessment of the role of Performance Shaping Factors in their particular high reliability industries, however, in all of these publications safety climate is notable for its almost complete omission. This pattern is replicated by regulatory publications that reference safety climate as a completely independent entity to Performance Shaping Factors, which usually feature as part of an error identification process (HSC, 1991). This, despite the clear overlap between the definitive list of Performance Shaping Factors produced by Miller and Swain (1987) and antecedents of safety performance such as safety climate. Work by Bellamy et al (2008) and Mohaghegh and Mosleh (2009) has gone some way to addressing this apparent oversight, however, their theoretical models requires operation before any conclusions regarding efficacy can be made.

As this chapter section has illustrated, there are clear threads of continuity between Performance Shaping Factors and safety climate. Despite this, very few researchers have attempted to integrate
these competing schools of work. This absence of integration can be best understood, perhaps, when it is considered that a majority of PSFs research has been conducted by ergonomists, whereas safety climate has been traditionally viewed as the domain of the psychologist. This apparent divide of discipline raises the prospect that a combinatorial approach, in which the knowledge in both sectors is exploited, could significantly move understanding of climate in a new and positive direction. With this potential in mind, the work of Glendon and colleagues looks worthy of particular focus.

**Performance Shaping Factors and Safety Climate**

Glendon and colleagues were the first researchers to recognize the potential benefits of combining the Performance Shaping Factors and safety climate literature. As this review of Performance Shaping Factors literature has demonstrated, these concepts overlap at multiple points and it was these overlaps that Glendon and colleagues looked to exploit when using Performance Shaping Factors to inform a new safety climate assessment tool.

Glendon et al (1994) pooled and reduced over 350 Performance Shaping Factors to produce a 58 item questionnaire. This questionnaire was found to produce a good eight factor structure over two distinct studies, one in 1994 and a second, unpublished study (Litherland 1997). By the year 2000, Glendon and Stanton were promoting this questionnaire as an alternative to other safety climate assessment tools. The following year, Glendon and Litherland used a modified version of the questionnaire as part of a study intended to determine the factor structure of safety climate within a road construction organization (Glendon and Litherland 2001). Whilst analysis derived a six factor structure, clear similarities existed between these findings and structures obtained previously (Glendon et al 1994; Litherland, 1997). Five of Glendon et al’s six factors were confirmed by the 2001 study: adequacy of procedures, work pressure, personal protective equipment, relationships and safety rules (Glendon and Litherland 2001, pg 174). A sixth factor identified by Glendon et al, communication and training, was partially supported although the communication items loaded with another factor and training items were not included. The final two items identified by Glendon et al (1994), incident investigation and development of procedures and spares, were irrelevant to the study in 2001 and so were not included.
Although Glendon and Litherland were able to produce a relatively stable factor solution, they found no relationship between safety climate and safe behaviours, their choice of outcome measure (Glendon and Litherland 2001). Issues concerning the utility of behavioural observation as safety performance outcome measure have been reviewed in Chapter 1, and, as such, this finding can be attributed to a number of error mechanisms unrelated to questionnaire efficacy.

In summary, Glendon et al (1994), Litherland (1997) and Glendon and Litherland (2001) produced a safety climate scale that showed good levels of factor stability across different sectors and different countries. The concept of a stable six factor solution, demonstrable over different industries and countries contradicts Coyle et al (1995) and is of particular interest to theorists purporting the universality of safety climate. This work questioned assumptions concerning the stability of safety climate, although the performance shaping origins of the questionnaire did raise some objections from theorists who expressed doubt concerning the face validity of climate questionnaire that did not include a measure of management commitment (Zohar 2000).

In explaining their results, Glendon and Litherland suggested their use of Performance Shaping Factors may have delivered a questionnaire that was ‘operationally anchored’ (Glendon and Litherland 2001, pg 174). This point was illustrated by the absence of higher order or abstract safety climate factors such as management commitment, in favour of content that was proximal to work activity. The result is a questionnaire with six stable cross-industry ‘core’ safety climate factors. Glendon and Litherland recognized that organizations may wish to include higher order factors, such as management commitment, however, this could be achieved without effecting the stability of the core factors. In some respects, this questionnaire offers a third way between Zohar’s universality and Coyle et al’s specificity.

Summary
This review has raised the tantalising possibility that, whilst safety climate researchers have been defining factorial content in one domain of research, ergonomists have been considering very similar factorial content in another. Few researchers, with the exception of Glendon and colleagues and Oliver et al (2002), have connected these independent schools of study and their initial findings, such as factor stability, suggest this connection, and the body of research concerning Performance
Shaping Factors that come with it, may have much to offer safety climate research. It is for these reasons that the six core factors identified by Glendon et al (1994) and confirmed by Glendon and Litherland (2001) will form the safety climate scale used in this questionnaire.

As noted previously, Glendon and Litherland (2001) were quick to recognize that, although their questionnaire produced excellent factor stability, it was not sufficiently broad as to be considered a stand alone measure of safety climate. As a result, they recommended the introduction of less robust but equally important factors according to organizational requirements. Of the factors omitted from Glendon and Litherland’s scale, perceptions management commitment is identifiable as an organizational prerequisite. The argument in favour of management and leadership as a safety climate factor featured in Chapter 1, however, Glendon and Litherland’s findings led them to theorise that it may be the variation in perceptions towards more abstract concepts such as management that are responsible for the poor factor stability displayed by some safety climate scales.

All of which leaves researchers in a paradoxical situation in which the study of a recognized element of safety climate may be responsible for findings that suggest that construct displays poor reliability. It can be theorised that, at its root, this is an issue of complexity. Leadership is a ubiquitous concept with reach into nearly every aspect of organizational safety performance. As such, individual perceptions of leadership will necessarily vary and it is this variation that will likely dilute factor stability and hence prevent its inclusion as a universal climate factor. One solution to this problem is the stratified analysis of leadership; the analysis of prescient aspects of leadership sufficiently reduced as to fulfil factorial stability. As the next section of this chapter will demonstrate, LMX focusses specifically on three aspects of leadership; the leader, the follower and their relationship. This approach represents a genuine departure from the leadership scales normally employed by safety climate researchers which attempt to gather perceptions or attitudes towards topics as varied as leadership style (Diaz-Cabrera, Hernandez-Fernaud and Isla-Diaz 2007) through to management attitudes towards safety practices (Dedobbeleer and Beland 1991).
Leader-Member Exchange (LMX) Research
This chapter section will explain the thinking behind the inclusion of LMX in a working model of safety performance. To answer ‘why LMX?’ this chapter will detail what is unique about this concept, and, as a result, what it was the introduction of LMX would add to this study. Following this explanation, the chapter will expand to include more general content regarding definitions and conceptual development of LMX. This exercise will chart the evolution of LMX from its parental idea, Vertical Dyad Linkage (VDL), through to its application as a contemporary measure of distinct leader-member exchange relationships. Following this, attention will be paid to the operation of LMX, more specifically how researchers have accounted or modelled LMX alongside other organizational antecedents and outcomes. Finally, this review will consider LMX within the context of safety performance with a view to the creation of an operable model that combines the elements reviewed in this chapter with those considered in Chapter 1.

Why LMX?
Chapter 1 underlined the key role of leadership through a number of direct and indirect observations. Direct observations concerned the results of the theme analysis of safety climate questionnaires carried out by Flin et al (2000), Guldenmund (2000) and Clarke (2000). All three identified leadership or management commitment as a key factor, confirming this variable had appeared in a majority of safety climate questionnaires since Zohar (1980). Indirect observations concerned more subtle indications of the significance of leadership, such as the theoretical underpinning of Zohar’s group and organizational level climates. It is the differentiation in leadership roles and responsibilities that Zohar used to demarcate these climates; in essence, this approach served to underline the criticality of leadership, its position as a core if not the core factor in climate measurement.

Chapter 1 detailed the traditional means through which leadership has been measured. These techniques have ranged from management commitment scales and demarcated items for managers and supervisor through to Zohar’s group level analysis process. Whilst these techniques have undoubtedly improved knowledge in the area of safety leadership, a number of theorists have adopted a slightly different approach, focussing on the mechanics and quality of the relationships between workers and leaders (Hofmann and Morgeson 1999; Hofmann et al 2003; Zohar and Luria 2004; Michael et al 2006). It should be emphasized that this approach is not intended to act as an
alternative to the safety climate leadership scale, indeed a number of studies have researched these elements side by side (Hofmann et al 2003; Zohar and Luria 2004). Rather it is regarded by many as a means of improving understanding of leadership and providing a means by which leadership can be practically improved through action research (Graen and Uhl-Bien 1995).

Researchers looking to study leadership quality in the context of safety performance have a variety of tools at their disposal. Of these, LMX and Transformational Leadership (TL) are immediately identifiable as suitable candidates. Exponents of TL theory suggest transformational leaders foster closer working partnerships with their followers, characterized by a reduced power-distance and individualized attention to members’ needs and capabilities (Bass and Riggio 2008). The four components of authentic TL have been identified as idealized influence, inspirational motivation, intellectual stimulation and individualized consideration (Bass and Steidlmeier 1999).

Transformational relationships are based on values such as trust, honesty and openness and lead to rich verbal communication between leader and follower (Bass and Riggio 2008). Measures of TL have been successfully applied in safety performance research (Zohar and Luria 2004; McFadden, Henagan and Gowen 2009) making it a suitable candidate for this study.

LMX theory distinguishes itself from TL in a number of ways. First, exponents of LMX theory regard the leader, follower and their relationship as distinct entities. As such, each is as important as the other in influencing the outcome of the interaction between the parties. Whilst this may sound obvious, many leadership theories regard only leaders’ behaviours as significant to outcomes measured. In regarding the leader, follower and relationship as distinct, LMX makes allowances for the nature of the follower and their collective relationship on measures of performance. The dyadic measurement process reflects this consideration (Graen and Uhl-Bien 1995). Second, operative models of LMX describe a process of reciprocation in which followers respond to positive LMX relationships with behaviours they perceive to be beneficial for their leader. These behaviours can be directly outlined by their leader, or identified by the follower using climatic or cultural cues. This process provides a point of continuity between LMX and theories of safety climate.

In the context of this study, these points of distinction make LMX particularly appealing. The final, and perhaps more general argument in favour of LMX research concerns its growing popularity in
the field of leadership research. In their developmental review of LMX, Schriesheim Castro and Cogliser (1999) identified 147 studies completed between 1972 and 1998. Of these, 15 were undertaken between 1972-1979, 50 between 1980-1989 and 82 between 1990-1998. This provides a very clear illustration of the rise in popularity of LMX as a research topic and therefore its significance in the academic community (Gerstner and Day 1997).

Definitions and Mechanism of Operation
For reasons which will become clear later, a review of LMX research reveals a paucity of operable definitions. LMX differentiation has been defined as ‘the process by which a leader, through engaging in different types of exchange patterns with subordinates, forms different quality exchange relationships (ranging from low to high) with them’ (Henderson, Liden, Glibkowskii and Chaudhry 2009, pg 519). Scandura, Graen and Novak (1986) offer ‘LMX is (a) a system of components and their relationships (b) involving both members of the dyad (c) involving interdependent patterns of behavior and (d) sharing mutual outcomes instrumentalities and (e) producing conceptions of environments, cause maps, and value’ (Scandura et al 1986, pg 580). Liden, Wayne and Stilwell note ‘LMX theory suggests that leaders do not use the same style in dealing with all subordinates, but rather develop a different type of relationship of exchange with each subordinate’ (Liden, Wayne and Stilwell 1993b, pg 664).

LMX was first conceptualized as an alternative to Leadership Style over 30 years ago (Dansereau, Graen and Haga 1975; Graen and Cashman 1975). Leadership Style was pioneered by Lewin, Lippitt and White (1939) and theorized group task performance could be effected by the style in which managers lead their teams. Study of this concept identified three styles, Authoritarian (also termed Autocratic), Participative (also termed Democratic) and Delegative (Laissez-Faire). Although this study contained a number of questionable methodological decisions, including the use of children as participants, it captured the imagination of the research world and continues to influence contemporary ideas such as transformation and transactional leadership (Eagly, Johannesen-Schmidt and Van Engen 2003).

Whilst LMX certainly took some cues from the theory of Leadership Styles, its methodological focus on effective leadership delivery through the development and maintenance of mature leadership
relationships (Graen and Uhl-Bien 1991) represented a sufficiently significant departure from established leadership theory as to merit conceptual recognition on its own merits. The mechanism by which LMX is theorized to operate is relatively simple. Building upon the concept of Leadership Styles, researchers identified the potential for variation in leader-follower relationships. These variations ranged from those relationships based strictly on the contract of employment (i.e. low LMX relationships, also were termed *outgroup* in early research), and those characterized by mutual trust, respect and reciprocation (i.e. high LMX relationships or *in-group*) (Liden and Maslyn 1993a).

Research linked high LMX relationships with increased instances of follower organizational commitment (Duchon, Green and Taber 1986) and citizenship behaviour (Scandura, Graen and Novak 1986). Researchers maintained that high LMX relationships, relationships into which the leader invested time, produced a reciprocal response from the follower, characterized by above the line or Organizational Citizenship Behaviours (OCBs). Other outcome measures were correlated including innovation (Scott 1993) and goal commitment (Klein and Kim 1998). To many, LMX is seen as an established management tool, however, before its suitability for this purpose can be correctly assessed it is important to understand where the concept sits within the wider topic of leadership theory, and, as a result, what value LMX has delivered to the body of management literature.

**History**

Recent leadership theory has been dominated by the ‘domains of leadership’, a classification system that identifies three elements; leader, follower and their relationship (Graen and Uhl-Bien 1995). Prior to the domains approach, research charged with improving understanding of leadership performance focussed on the leader. Lewin et al’s Styles approach provides a good illustration of this with its focus upon behavioural explanations for individual leadership performance (Yukl 1989). As research progressed, the leader domain was supplemented with the follower and, eventually, relationship domains. Inclusion of these elements reflected a recognition that followers could influence the leadership process, that their behaviours, attitudes and expectations could shape the relationship that developed (Basu 1991; Tierney 1992; Scott 1993).

Whilst Graen and Uhl-Bien maintain that leadership research has evolved to include follower and relationship domains, a number of leadership theorists have maintained an interest in the impact of
leader behaviour, considered in relative isolation. Concepts such as transactional and transformational (Bass and Riggio 2008) leadership, coupled with functional leadership theory (McGrath, 1962; Hackman and Walton 1986) have focussed on leadership behaviour with the potential to improve organizational outcomes. Whilst the follower domain is not excluded in these models, indeed, functional leadership theory theorizes that a good leader provides followers with what is necessary for them to complete their job, consideration is made from the perspective of the leader and in a context in which the leader is the operator of change. It is in this respect that LMX considers unique elements of the leadership process with its recognition of the follower and the relationship between the leader and follower as distinct entities.

Although the introduction of the three domain approach represented a shift away from the traditional leader-orientated thinking, it took some time before work was published to improve understanding of the follower or relationship elements. It is this research that formed the base and provided the support for the development of LMX as a concept. In their review paper, Graen and Uhl Bien separate the development of LMX into four distinct stages:

Stage 1: Vertical Dyad Linkage (VDL)
VDL can be seen as the precursor to LMX theory. VDL refers to a body of research that established that differing relationships exist between leaders and followers. By asking managers and workers to describe their relationships, researchers noted a number of high quality, termed in-group, and low quality, termed out-group, exchanges (Zalesny and Graen 1987). Researchers established that high quality relationships could be characterized by trust, respect and obligation and theorized that, due to constraints on time and resources, leaders could only maintain a small number of high quality relationships (Zalesny and Graen 1987). The relationship domain was established.

Stage 2: Focus on the Relationship and its Outcomes
Stage two witnessed a large number of studies validating the existence of leadership domains and relating these to a range of organizational outcomes such as communication frequency and role making (Graen 1989) and employee reactions (Hooper and Martin 2008). A number of antecedent factors were also studied, including subordinate loyalty (Scandura and Graen 1984) and job design (Graen et al 1982). These studies provided validation of LMX as a concept and indicated that good
leadership occurred when leaders and followers maintain good social exchange relationships (Graen and Uhl-Bien 1995).

Stage 3: Dyadic Partnership Building
The third stage in the development of LMX concerned the operation of the concept within the organization and the lessons learned therein. Research aimed to provide every individual with the opportunity to establish a positive LMX relationship. Work in this area focussed on the individual and the components required to maintain good social exchange relationships.

Stage 4: Expansion of Dyadic Partnerships to include Groups
As the body of LMX research grew, so did its potential reach. Researchers began to study group or network mediated LMX relationships looking to see how dyadic interactions interacted to produce network assemblies. Research of this nature remains in its infancy. (Graen and Uhl-Bien 1995)

Some academics have questioned Graen and Uhl-Bien’s account of LMX development, highlighting a number of issues. Schriesheim et al (1999) queried the multistage model highlighting Graen and Uhl-Bien’s chronologically confused use of supporting references. Schriesheim et al note that stage one, two and three all contain references from papers within the same timeframe, 1984-1987. In one specific example, Graen can be seen to have developed the LMX-7 scale, a stage two/three occurrence in the same year he continued research into VDL, a stage one occurrence. Such mixing suggest a more chaotic construct development, possibly with less direction or intention from Graen and Uhl-Bien. In addition, it has been noted that VDL split into two strands of research, LMX and Individualized Leadership (IL) theory (Schriesheim et al 1999). The significance of this was diminished, however, in the course of a meta-analysis in which Gerstner and Day (1997) were able to demonstrate that research interest in LMX has been steadily increasing, whilst interest in IL theory has effectively stalled (Schriesheim et al 1999).

**LMX Sub-Dimensions**
The controversy concerning LMX development spans from the multi-stage model outlined by Graen and Uhl-Bien through to the specification of the measures used to assess the construct. Schriesheim
et al conducted a comprehensive review of LMX, adopting an evaluative methodology that focussed on the theoretical definition of LMX employed by researchers and the sub-dimensions used to investigate the concept. This data driven approach allowed for a more complete and objective assessment of construct development than the stratified approach utilized by Graen and Uhl-Bien. For example, Schriesheim et al were able to demonstrate that no definition or explication of LMX sub-content was offered by 16 of the studies published in the 1980s, a finding that suggests LMX was a confused field of research during its infancy. This conclusion is supported by the mixed findings of review studies charged with the early assessment of LMX efficacy (Vecchio and Gobdel 1984).

Much of the confusion charted by Schriesheim et al was caused by evolving nature of LMX sub-dimensions. Once LMX had been generally recognized to be the quality of exchanges between leader and subordinates, researchers attempted to measure it using sub-dimensions as varied as attention and sensitivity (Cashman, Dansereau, Graen and Haga 1976) through to less direct supervision and greater subordinate influence in decision making (Sias and Jablin 1995). Schriesheim et al note that, during a ten year period, Graen and colleagues investigated a total of 18 potential sub-dimensions of LMX. This, in addition to 11 distinct definitions of LMX offered by 37 publications and research papers over the same time period (Schriesheim et al 1999). In some respects, it seemed that researchers had unearthed a construct with raw potential but at a stage in which specificity was extremely low.

This confusion led to a great number of scales purporting to measure LMX. Graen and colleagues began by adapting or adding to established scales such as the Leader Behavior Description Questionnaire (LBDQ), however, iterative refinements soon produced a muddled picture of events in which the same, or very similar, questionnaires were given distinct names depending upon the publication. For example, the Supervisor Attention Scale, was also termed the Supervisor Treatment, Leadership Attention, Leadership Support, Leader Attention and Support by a number of other studies that failed to publish their item or response categories (Schriesheim et al 1999).

Study continued and produced a number of precursors to dedicated LMX scales including Negotiating Latitude, studied using a two item (Dansereau et al 1975) and a four item (Graen and
Cashman 1975) scale. This evolved to form the Superior Negotiating Latitude Scale, the precursor to the first dedicated four item LMX scale (Graen and Schiemann 1978). Dienesch and Liden (1986) produced an alternative to that being developed by Graen and colleagues with a three factor scale that included effect, loyalty and contribution. This scale found use again with Settoon, Bennett and Liden (1996) who were able to confirm the dimensions identified previously and renamed the LMX-MDM. Liden and Maslyn (1993a) used the LMX-MDM when assessing the working relationships of 302 students and confirmed the factors detailed previously along with the addition of a fourth dimension, professional respect.

The LMX-7 Scale

Between 1982 and 1983, LMX was purported to be measured by seven distinct questionnaires. Clearly these levels of disparate theory making could not last and relief was eventually provided in the form of the Graen and Bien’s LMX-7 scale. The LMX-7 scale was first published by Graen et al. (1982), however, the authors failed to provide item details in this paper preferring to refer readers to Graen and Cashman (1975) and Liden and Graen (1980) as sources. The guarded launch ensured that LMX’s rise to ascendance as the scale of choice was not immediate. It appeared again in 1984 in two papers by Seers and Graen (1984) and Scandura and Graen (1984) and it is from this point that it gained traction with other researchers. LMX-7, so called as it measures LMX using seven items, consists of a three element scale including respect, trust and obligation. Trust first appeared in early LMX research (Graen 1976) and has remained a feature of many LMX scales since. Respect and obligation can be considered antecedents or outcomes of factors identified in early research, such as loyalty (Dansereau et al 1975), support (Graen 1976) and attention (Graen, Orris and Johnson 1973).

Although LMX-7 has been recognized as the scale of choice for LMX research (Gerstner and Day 1997), a number of question marks concerning the development and current status of LMX-7. Whilst the confusion concerning sub-dimensions of LMX have dissipated since the recognition of LMX-7, it seems to have been replaced by concerns regarding construct validity. Despite clear correlation with organizational outcome measures (Gerstner and Day 1997) theorists remain wary of a developmental pathway that has seen concepts slide in and out of consideration with very little academic support produced in favour of their inclusion or removal. In one example, Graen identified...
negotiating latitude, a scale developed by the researcher, as a measure of dyadic structure. Seven years later the same scale was used to assess individual leadership (Schriesheim et al 1999).

Despite criticisms regarding the developmental history of LMX, researchers have displayed a keenness to use the concept in organizational research. Studies have demonstrated significant relationships been LMX and a variety of other variables including subordinate satisfaction and organizational citizenship behaviours (Scandura et al 1986), employee reactions (Hooper and Martin 2008) and subordinate safety citizenship role definitions (Hofmann et al 2003). In a meta-analytic review, Gerstner and Day (1997) confirmed significant correlations between LMX and job performance, satisfaction with supervisor, overall satisfaction, commitment, role conflict, role clarity, member competence and turnover intentions (Gerstner and Day 1997). It is the ubiquity of LMX-7 and its meta-analytic support that identifies it as the preferable scale for use in this study. With the scale selected, the issue of operation becomes precedent. How, if at all, has LMX been operationalized alongside concepts such as organizational climate and culture and denominations such as antecedent, determinant and outcome? It is these questions that will form the next section of this review.

Models of LMX
This review has considered issues of scale definition and development, however, it is equally important to understand how researchers have represented LMX within their measures of individual, group or organizational effectiveness. In their review of LMX research conducted in 1995, Graen and Uhl-Bien separated research into two categories. Category one included research that investigated the leader-follower relationship and incorporated analysis on antecedents and/or determinants of LMX. Results from these studies identified a wide range of determinants including perceived similarity and liking (Liden et al 1993b) and demographic variance (Duchon et al 1986).

Category two focussed on how differential LMX relationships related to organizational outcomes. This category was extensively populated, with performance (Scandura and Graen 1984; Dunegan, Duchon and Uhl-Bien 1992), staff turn over (Graen and Ginsburgh 1977; Ferris 1985), job satisfaction (Turban, Jones and Rozelle 1990) and organizational citizenship behaviour (Scandura et al 1986) featuring. These studies predominantly investigated LMX as a simple determinant of the organizational outcomes detailed. In their early review of LMX efficacy, Vecchio and Gobdel (1984)
suggested researchers might expand their scope of interest to include moderating agents; that is, those elements with the potential to moderate the relationship between LMX and any outcome measure specified. This, they felt, might help clarify the inconclusive nature of early findings associated with the LMX/organizational performance relationship. Researchers responded with a string of studies. Using a two condition (experiment/placebo) Graen et al (1982) were able to identify training as moderating the relationship between LMX and role making. Wakabayashi and Graen (1984) established that individually rated career potential moderated the effect of LMX on promotion and bonus acquisition.

Whilst these studies focussed on individual differences, Seers and Graen (1984) attempted to demonstrate that task oriented factors could also moderate a LMX-outcome relationship. Their study, which looked at the effects of LMX and task characteristics on subordinate performance, failed to show a moderating relationship prompting Seers and Graen to suggest a dual attachment model with equitable input from both determinants (Seers and Grain 1984). Dunegan et al (1992) revisited this topic using a more specific measure of task characteristic, namely task analyzability and variety. Their study, based in a US hospital, involved 152 members of staff and results supported a moderating role for task characteristics in the relationship between LMX and performance (Dunegan et al 1992). A later study identified role conflict, role ambiguity and intrinsic task satisfaction as moderators of the LMX-subordinate performance relationship (Dunegan, Uhl-Bien and Duchon 2002).

Studies evaluating potential LMX relationship moderators are relatively plentiful, research considering LMX as a relationship moderator itself is comparatively scarce. Schriesheim, Neider and Scandura (1998) were interested in the relationship between LMX, delegation and subordinate performance and satisfaction. Their study, conducted in a flower importing firm, utilized a six item measure of LMX and produced 106 dyads for evaluation. Analysis of the LMX dyads showed a significant relationship with delegation and a main and moderating effect for subordinate performance and satisfaction (Schriesheim et al 1998). Van Dyne, Jehn and Cummings (2002) developed and tested a model of the links between psychological strain and work performance. Data collected from 195 hair salon stylists demonstrated a positive relationship between work strain and individual employee sales performance and a negative relationship between home strain and
employee creativity at work. LMX was found to moderate the effects of home and work strain on creativity (Van Dyne et al 2002).

In their studies, neither Schriesheim et al or Van Dyne et al supported their moderating hypotheses with prior research. This would seem to be symptomatic of a subject that has been predominantly identified as a determinant of organizational outcomes in its own right; research has considered those elements with the potential to moderate LMX relationships as opposed to the potential for LMX to moderate relationships. In addition to moderation, LMX has been studied as an outcome measure, however, this work featured in the early stages of construct development and was mainly associated with improving understanding of dimensionality (Graen and Uhl-Bien 1995). In the context of this study, it is the relationship between LMX and safety performance that is of interest and this review points to the designation of LMX as a determinant.

A feature of this review has been the direct relationship researchers have designated between LMX and organizational outcome measures. Studies of this nature reinforce the significance of LMX, however, they do not improve understanding of its operation. This criticism, similar to that voiced by Vecchio and Gobbel (1984), remains prescient despite attempts to study LMX moderators (Graen et al 1982; Wakabayashi and Graen 1984). With concerns regarding a bias towards individual moderating factors accepted (Seers and Graen 1984) and, to some extent, resolved (Dunegan et al 1992; 2002) it is the lack of understanding concerning the mechanism of LMX action that remains.

There remains a second research issue that can be best illustrated with a specific study example. Klein and Kim (1998) conducted a study of the relationship between situational constraints, LMX, goal commitment and retail performance in a US retail chain. Researchers theorized that high value LMX relationships, coupled with good goal commitment, would deliver improved retail performance. Data supported an interaction between LMX and goal commitment that accounted for a significant amount of variation in sales performance. This pattern was found to have notable exceptions, however, in which high LMX relationships were related to poor performance. Klein and Kim suggested these subordinates may be engaging in activities, such as creating displays or restocking merchandise that, while not contributing directly to their individual sales performance, may have value to the supervisor (Klein and Kim 1998). In this respect, it is perceived value of the reciprocal
behaviour at the time of reciprocation that identifies its suitability as a measure of individual or organizational performance.

This issue of context specificity raises the second research issue; how can we improve confidence in the outcome measures used? As Klein and Kim postulated, some measures of organizational performance may not capture those behaviours valued by supervisors. Dienesch and Liden (1986) have noted that an organization’s values have the potential to influence which behavioural dimensions are reinforced in LMX relationships, however, one has to look to the work of Hofmann and Morgeson and their studies of the relationship between LMX and safety climate to find peer reviewed research of this topic. The study of the relationship between LMX and safety will therefore form the last section of this chapter. Review of this research will have two distinct aims, (1) study of the issue of contextual specificity in LMX reciprocative behaviours and (2) contribute to the production of a working model of safety performance that includes LMX, safety climate, compliance, participation and accident involvement.

**LMX and Safety**
A review of Graen and Uhl-Bien’s three factor LMX-7 scale identifies multiple points of overlap between safety climate, performance and LMX. At a dimensional level, trust has already been shown to exhibit a relationship with safety climate (Flin and Burns 2004; Jeffcott et al 2006; Burt, Chmiel and Hayes 2009) whilst respect can be seen to be implicit in a number of management or leadership safety climate scales, for example ‘workers are told when changes are made to the working environment on a job site’ (Glendon and Litherland 2001, pg 170), or ‘in my workplace managers/supervisors show interest in my safety’ (Cox and Cheyne 2000, pg 121). Reciprocation has been linked indirectly through the iterative relationship between motivation and participation identified by Neal and Griffin (2006) and more directly through studies that have demonstrated safety climate’s role as a predictor of organizational citizenship behaviour (Hofmann et al 2003).

At a strategic level, safety performance and leadership have been consistently found to be the cornerstone of organizational improvement strategies (HSE 2005) and the root cause of incident and disaster (Sheen 1987; Baker 2007). Chapter 1 detailed the multitude of safety climate review studies that have linked leadership/management dimensions with variety of safety outcome measures
(Clarke 2000, Flin et al 2000; Guldenmund 2000, Clarke 2006b). It would seem natural, therefore, for a technique that allows the further understanding of leadership to gravitate to the study of safety performance.

Finally, at a conceptual level, the relationship between LMX, safety climate and safety performance has the potential to address a number of the issues concerning the suitability of LMX outcome measures identified previously. Safety climate has already been identified as a valid and reliable measure of the perceptions that individuals use to gage the suitability of their safety specific behaviour (Dedobbeler and Beland 1991). A study of the relationship between LMX and safety performance, moderated by safety climate, would provide valuable insight into the context specificity of LMX as outlined previously. In addition, whilst monetary outcome measures may be dependent upon internal valuing systems (e.g. how important is financial reward to the supervisor/individual), accident involvement can be viewed as an outcome measure that carries with it a common desire for its reduction.

Hofmann and Morgeson (1999) the first research to study the relationship between LMX and safety performance. Their study investigated the link between perceived organizational support, LMX, safety communication, safety commitment and accidents. The study was conducted at a heating and air conditioning manufacturing plant based in the United States and measured LMX using the LMX-7 scale (Graen and Uhl-Bien 1995). Although they had a limited sample size (49 dyads), Hofmann and Morgeson undertook a structural analysis which supported the model detailed in Figure 4:
Figure 4 identifies safety communication as the medium into which perceived organizational support and LMX can be fed. Safety communication is related to safety commitment and, finally, accidents. Hofmann and Morgeson measured accidents using company nurse records, a technique that they recognized to be flawed. The authors also identified weaknesses in their ‘single point in time’ data collection methodology that limited predictions of causality and the overall sample size (Hofmann and Morgeson 1999).

Methodological criticisms aside, Hofmann and Morgeson identified a number of significant relationships. The link between perceived organizational support and safety communication underlines the need for organizations to engage in actions that make clear their support for their employees. Coupled to this, the role of LMX illustrates the significance of supervisory relationships in the communication process. Hofmann and Morgeson concluded that positive exchange relationships were more likely to produce an environment in which members would raise safety concerns allowing managers to work proactively to prevent accident involvement (Hofmann and Morgeson 1999). These findings provide added credibility to models that identify the leader-supervisor relationship as a potentially significant aspect of organizational culture/climate (Clarke 2000).
Hofmann and Morgeson noted their results had linked high quality exchange relationships with subjective (i.e. safety communication and commitment) and objective (i.e. accident involvement) outcomes. These results were in contrast with Gerstner and Day’s (1997) meta-analytic review, which had concluded positive exchange relationships were more predictive of subjective as opposed to objective outcomes. The link between LMX and the objective measure of safety performance was of key significance on two levels therefore. At one level it provided evidence that LMX could be successfully linked with an objective outcome measure, and, on a second level, it provided evidence of a relationship between LMX and safety performance that underlined a requirement for further research.

Hofmann et al (2003) built upon the findings of Hofmann and Morgeson (1999) to study the relationship between role theory, social exchange, organizational citizenship and safety climate. Hofmann et al theorized that employees would reciprocate implied obligations of leadership-based social exchanges by expanding their roles and changing their behaviours in line with leadership expectations. Hofmann et al hypothesized that the relationship between LMX and safety citizenship would be moderated by safety climate, suggesting ‘within positive safety climates, safe performance will be more strongly valued, and as a result, safety will be viewed as a more legitimate avenue for reciprocating high-quality LMX relationships (Hofmann et al 2003, pg 171).

In suggesting a moderating role for safety climate, Hofmann et al drew attention to Schneider’s (1975) definitions of climate that included the kinds of behaviours that get rewarded, supported and expected in a particular organizational setting. In recognizing that safety climate and therefore safety behaviours can vary significantly between groups (Zohar 2000), Hofmann et al postulated that the degree by which individuals reciprocate high quality LMX relationships by expanding their safety citizenship role definitions could vary as well. The authors provided no previous research findings to support their designation of safety climate as a moderator of LMX relationships, perhaps because no studies had attempted to investigate contextual influences on LMX relationship outcomes. A hypothesized model was provided.
Figure 5: Hofmann et al (2003) Hypothesized Relationships

The study was conducted within a US military unit charged with the transportation of heavy equipment. LMX was again measured using Graen and Uhl-Bien’s (1995) LMX-7 scale. Findings supported the model proposed by Hofmann et al indicating that LMX was significantly related to safety citizenship role definitions, and, where a positive safety climate was found, employees were more likely to view safety behaviours as part of their formal role responsibilities. Where safety climate was not positive, this relationship was not found (Hofmann et al 2003).

Hofmann et al’s findings provided support for the conceptualization of climate as context forming, a backdrop through which individuals gauge the roles and therefore the behaviours best suited to reciprocate positive LMX relationships. As such, the discovery that safety climate can moderate the relationship between LMX and role definitions provides support for the idea of context specific behavioural reciprocation. This relationship between variables is clearly illustrated in Figure 5. The idea that individuals may choose the nature of their behavioural reciprocation using organizational cues is not one that has dominated LMX research. It has, however, featured in safety climate research, with Neal and Griffin considering a very similar mechanism when summarising the results of their longitudinal assessment of safety performance ‘these results support the claim that when individuals perceive that there is a safe working climate, they will reciprocate by allocating effort to discretionary safety activities’ (Neal and Griffin 2006, pg 952).

In a more recent study, Michael et al (2006) studied the relationship between safety communication, LMX and safety-related events, theorizing that both determinants would display a negative correlation with safety related events. Findings identified LMX as a more significant predictor of safety related events than communication but neither elements were found to be significantly related to recordable incidents (Michael et al 2006). Michael et al attributed these findings to Gerstner and
Day’s (1997) assertion that LMX often displays weak correlation’s with objective outcomes, however, the failure to replicate the relationship identified by Hofmann and Morgeson (1999) does underline the requirement for more research in this area.

Summary
This review of LMX research has identified a topic with a confused history. Despite their best efforts, Graen and Uhl-Bien (1995) have been unable to convince with their narrative that describes LMX’s deliberate and well managed conceptual development process. Instead, the reader is presented with the organic and sometimes chaotic evolution of a concept that, despite criticism, clearly adds to the wealth of knowledge regarding leadership. Of note has been the identification of LMX as a determinant of individual outcomes and the efforts to understand what, if anything, moderates LMX. Research interest in moderating effects can be considered a natural part of conceptual development, a desire to move on from simple one dimensional understanding. In the context of this chapter, it also represents a link between LMX research and safety climate.

Since its inception in the 1970s, a constant stream of publication has linked LMX with a number of organizational outcomes including performance, job satisfaction and organizational citizenship behaviours. Despite this wealth of research, little work has been done to further understand the mechanics of LMX action. For example, little is known about the specific behavioural channels through which LMX is linked with organizational and individual performance. In addition, there remains a requirement for research regarding the contextual nature of behavioural reciprocation to further understand of the role cultural or climatic cues could have of reciprocal selection strategies.

Research has already identified a positive safety climate as a trigger for the allocation of effort to discretionary safety activities (Neal and Griffin 2006) and the work of Hofmann et al (2003) has been able to isolate climate as a moderator of LMX relationships. Overall, it is possible to conclude that the relationship between LMX and safety performance is already recognized to be a significant one, however, there is a clear opportunity for further research.
Chapter Summary
This chapter has provided a summary of the role and significance of Performance Shaping Factors and LMX as determinants of safety performance. Although Performance Shaping Factors were considered in the context of their application in safety climate assessment (Glendon et al 1994; Glendon and Litherland 2001), a review of literature revealed a broad topic with significance for a number of academic disciplines including occupational psychology, ergonomics and qualitative risk assessment. Consideration of their use as a source of safety climate content revealed an assessment tool with excellent factorial stability across different industries and countries (Glendon et al 1994; Glendon and Litherland 2001). Researchers theorized that this stability could be attributed, in part, to an improvement in task and operational relevance gained from the use of Performance Shaping Factors. Whilst other climate tools attempted to investigate conceptual factors such as leadership and management that were prone to variation in individual perception, Glendon and colleagues focussed on dimensions informed by physical ergonomic considerations. Glendon and Litherland (2001) suggested these dimensions encouraged a more objective response to questioning when compared to subjective perceptual issues such as perceptions of management commitment.

Whilst Glendon and colleagues were able to provide reasonable theoretical explanations for the stability and efficacy of their questionnaire, their inclusion in this chapter and hence this study can be justified through the fulfilment of a more theses specific requirement. Chapter 1 identified a potential issue concerning the dominance of management commitment in safety climate research. This dominance was linked to the persuasive results provided by Zohar et al concerning their group level approach. At the conclusion of Chapter 1 it was argued that, however compelling the findings concerning the group level approach may be, safety climate must be more than a simple measure of management commitment to safety. The work of Glendon and colleagues gives credibility to this argument and presents the prospect that there may be a whole area of safety climate, informed by ergonomics but with clear overlap with safety climate research, that has been relatively understudied.

It is reasonable to conclude, therefore, the questionnaire developed by Glendon and Litherland (2001) represents an excellent means by which the role of factors other than management commitment may be studied.
Conclusion 1: Study safety climate using Glendon and colleagues' Performance Shaping Factors questionnaire

Whilst this approach produced five or six ‘core topics’ with universal relevance, Glendon and Litherland accepted this elements did not constitute a full assessment of safety climate. The significance of management and leadership factors was detailed in Chapter 1 and it is this requirement that linked the seemingly diverse topics of Performance Shaping Factors and LMX. As this review demonstrated, LMX represents a novel means of leadership study that draws a distinction between the domains of the leader, the follower and their relationship (Graen and Uhl-Bien 1995). LMX theory dictates that leaders have varying relationships with subordinates and that positive relationships, measures using LMX scales, trigger reciprocal behaviours from subordinates looking to repay their status (Graen and Uhl-Bien 1995). As such, there exists a fascinating theoretical bridge between the concepts of safety climate and LMX, with one providing to context through which the significance of the other can be measured. It is the potential of this bridge, combined with the stand-alone added value that LMX delivers, that provides the rationale for Conclusion 2.

Conclusion 2: The LMX-7 scale (Graen and Uhl-Bien 1995) represents a suitable means of leadership analysis in the context of this study

Working Model
In proposing the questionnaire developed by Glendon and Litherland (2001), this chapter has successfully addressed the gap in literature identified in Chapter 1. In addition, the introduction of LMX has presented a means by which leadership can be measured, ensuring the connection between safety climate and management commitment has not been severed in its entirety. With a majority of the components of a model of safety performance identified, the task of defining the relationships between these components remains. This is an essential step as the analysis of the proposed relationships will form a bulk of the results and discussion chapters of this thesis.

Hofmann and Morgeson (1999) and Hofmann et al (2003) contributed significantly to the understanding of the role that safety climate and LMX play in behavioural outcomes, however, a
number of questions remain. Research has yet to produce a fully functional model including LMX, safety climate and safety performance. In their work, Hofmann et al laid the ground for this yet the requirement for a model which combines all of these elements remains. Figure 6 presents the working model, influenced by the literature reviewed to date.

Figure 6: Working Model

LMX acts as an antecedent of safety performance, a position identified in a number of studies (Hofmann and Morgeson 1999; Hofmann et al 2003; Michael et al 2006). Safety climate, also researched as an antecedent of safety performance, adopts a moderating role in this model reflecting the framework presented by Hofmann et al (2003) and other, more general LMX research studies (Graen et al, 1982; Wakabayashi and Graen 1984).

It is at this point that the literature reviewed in Chapter 1 exerts an influence. Work by Neal et al (2000) identified compliance and participation as distinct and significant components of safety performance. In the context of this study, they represent an ideal means through which understanding of LMX action can be improved. Participation, as defined by Neal et al, can be viewed as a behaviourally linked to organizational commitment (Duchon et al 1986) and citizenship type behaviour (Scandura et al 1986), two elements already utilized as LMX outcome measures. The distinction between this and compliance, however, provides a demarcation that has the potential to shed further light on LMX operation. LMX literature has maintained an interest in reciprocal outcomes that can be viewed to be giving something extra back, perhaps a reflection of the special
nature of high LMX relationships. Compliance can be viewed as behaviour that is required and so may not be seen as a suitable route from reciprocation.

The working model goes some way to addressing the knowledge gaps identified in the literature, such as LMX’s effect on compliance, and therefore helps to fulfil the need identified for a fully operative model of safety performance that includes safety climate, LMX and distinct behavioural outcomes.

Final Note
In their longitudinal study of safety performance discussed in Chapter 1 of this study, Neal and Griffin (2006) noted a reciprocal relationship between safety motivation and safety participation over time. These findings suggested that the act of participating in safety activities could lead to further increases in safety motivation. In light of these findings, Neal and Griffin concluded that organizations wishing to improve safety should focus on changing the work environment to motivate people to actively participate in safety rather than enforcing compliance with safety rules. This statement raises a specific question; what routes are open to organizations wishing to improve participative opportunity within their company?

The next chapter of this review is intended to act as a response to this question. Chapter 3 will be split into two sections. Section one will investigate the concept of participation in more depth, providing an over view of general literature before focussing and evaluating more specific attempts to improve participation in the safety sector. At its conclusion, section one will have identified and supported brainstorming as the tool of choice to improve organizational participation in safety. Section two will provide an in depth assessment of brainstorming literature with particular attention paid to the interactive/nominal debate. With the suitability of brainstorming confirmed, section two will conclude with the proposal of a study to identify the ideal brainstorming methodology for use in the main body of this study.
Chapter 3 - Participation and Brainstorming

Chapter Preface
Chapters 1 and 2 have facilitated the identification of climate and LMX measurement tools, as well as the proposed integration of compliance and participation as components of safety performance. Although the bulk of the safety performance model has been constructed, study aims and objectives described an investigation of participation as a means of driving safety performance improvement through the reduction of near miss/accident rates. To ensure any proposed methodology is considered in light of the relevant literature, this chapter will review participation and brainstorming research. Both of these topics will be reviewed with the same target in mind, that is the judgement of the suitability of brainstorming as a means of driving improvement in safety participation.

To this end, the first section of this chapter will present a general overview of participation literature, beginning with its emergence from the post industrial workplace and following the topic development pathway through to its current prominence in organizational research. Threads of continuity will be highlighted, particularly those that are illustrative of the perceived ‘value’ of participation (e.g. improving satisfaction or productivity or responding to the ‘moral imperative’). This section will culminate in an assessment of studies in which researchers attempted to improve participation in safety. Research in which participatory activities have been introduced alongside a measure of safety culture or climate and outcome measure such as incident or accident rates will be of particular interest.

The second section of chapter will begin with a summary of prior research that has attempted to combine safety and participation, and, in doing so, will present the argument for a novel of alternative approach. The requirements of this alternative approach will be discussed alongside the characteristics of brainstorming. From this discussion, an answer to the question why brainstorming? will be formed; a judgement on the suitability of brainstorming as a medium to improve participation in safety. This chapter will then review the brainstorming literature with a focus placed upon the most significant debate in this area of research, namely the comparative productivity of interactive versus nominal brainstorming. The thesis introduction detailed a two study design and it is in the analysis of the interactive vs. nominal literature that the first study design will be formed.
This chapter will now commence with a review of the general participation literature.

**Participation**

**Introduction**

Henry Ford established the world’s first production line, and, with it, signalled a completely new way of working that focussed upon the repetition of a single task. The production line refined the manufacturing process but it also removed a degree of autonomy and variation from those who worked on it. Some claimed that changes to the manufacturing processes could impact upon employee well being, a suggestion rebutted by Ford in his autobiography ‘repetitive labor, the doing of one thing over and over again and always in the same way is a terrifying prospect to a certain kind of mind. It is terrifying to me. I could not possibly do the same thing day in and day out, but to other minds, perhaps I might say the majority of minds, repetitive operations hold no terrors’ (Ford 1922, pg 103). Organizational experts, such as Hugo Munsterberg, saw an opportunity for novel research and seized it. Using a methodology that focussed upon experiment and observation, Munsterberg investigated the impact of monotony, attention and fatigue upon working power (Munsterberg 1913). As a result of this research, Munsterberg advocated strategies designed to improve harmony between workers and managers, to increase their interaction and hence the input of the workforce. Munsterberg had indirectly identified participation as a tool with the potential to address issues arising from modern working practices.

Elton Mayo was intrigued by the potential effect that fatigue and monotony could have upon production. Mayo, who based his studies at the Western Electric Hawthorne Works in Chicago, manipulated a number of variables including illumination, rest breaks, working hours and physical conditions and measured the impact these variations had upon production rates. Findings indicated that, while positive steps such as increased breaks, shorter working weeks and the provision of hot meals all improved productivity, negative actions, such as the removal of all perks, also increased base line production (Mayo 1933). These seemingly counter intuitive results were explained by a phenomenon later termed the *Hawthorne Effect*. In a general experimental context, Hawthorne Effect refers to atypical behaviour witnessed as a result of study observation; in the case of the Western Electric study, it was claimed that participants increased production as they were aware of their ‘special treatment’ and hence responded to it.
Mayo recognized an additional possibility theorising that the six individuals had become a team and that this team had taken upon itself to co-operate with the experiment (Mayo 1933). This commitment, he suggested, was in part attributable to changes in collaboration and participative opportunities that came about as a by-product of the study design. At various stages of the investigation, subjects were able to choose the individuals who they worked with, they were also encouraged to collaborate with researcher, advising on what they felt was working and what should be improved. Mayo theorised that this increased level of collaboration and participation effected productivity and resulted in increased performance regardless of condition. Mayo’s Hawthorn Studies did much to establish the link between productivity and participation. In this regard, Mayo can be regarded as a pioneer in early participation study.

**Definitions of Participation**

Whilst participation research has been of long standing interest to academics, a degree of confusion has remained concerning exactly how participation could or should be defined. The Oxford Dictionary offers the simple phrase 'to take part' (Oxford 2006). Dachler and Wilpert observe, 'no clear set of questions, let alone set of answers, which begin to define the nature of the participation phenomenon are discernible' (Dachler and Wilpert 1978, pg 1).

For some, participation is a process in which influence is shared among individuals who would otherwise be hierarchically unequal (Locke and Schweiger 1979; Wagner and Gooding 1987). Locke and Schweiger also suggest the more simplistic 'joint decision making' (Locke and Schweiger 1979, pg 265); a statement that relates well with 'subordinate involvement in decision making process[es]' (Miller and Monge 1986, pg 727). Glew, Griffin and Van Fleet (1995) offer 'a conscious and intended effort by individuals at a higher level in an organization to provide visible extra-role or role expanding opportunities for individuals or groups at a lower level in the organization to have a greater voice in one or more areas of organizational performance' (Glew et al 1995, pg 402).

Contrasting dictionary definitions of participation with their organizational counterparts highlights the introduction of hierarchy as a significant factor. Whereas dictionary definitions state only the need to take part or be involved, organizational research details the need for ‘subordinate’ or ‘hierarchically
unequal involvement. The inclusion of hierarchy reflects realities concerning the bureaucratic arrangements of modern organizations and its consideration in any study intended to improve participation is key (Weber 1948).

**Why Participation?**

*Cotton and Colleagues*

The significance of participation has been of primary interest to researchers since Munsterberg first demonstrated the value of harmony between workers (Munsterberg 1913). Questions concerning the value of a participative approach, the types of participation available and the outcomes commonly associated with their adoption have produced a multitude of studies. In attempting to bring order to this wealth of research, Cotton, Vollrath, Froggatt, Lengnick-Hall and Jennings (1988) conducted an extensive review of participative using a novel ‘clustering’ technique. To cluster the data, researchers collected and collated relevant papers before categorising them into groups dependent upon the variables used and the outcomes found. Cotton et al claimed that, after analysis, only six distinct participation clusters could be successfully separated. These were outlined as:

- **Participation in work decisions** – formal participative decision making schemes in which workers have a great deal of influence in decisions focussing on work itself
- **Consultative participation** – refers to situations in which employees engage in long term, formal and direct participation; less employee influence that participation in work decisions
- **Short term participation** – limited to participative decision making schemes in which the duration is limited – single day training or sessions over a number of days
- **Informal participation** – studies in which no formal construct existed yet participative decision making was compared to an outcome measure performance/satisfaction
- **Employee ownership** – classified as formal and indirect. Formal as employees have the right to participate and indirect as the participative opportunities are still management using the organizational hierarchy
- **Representative participation** – situations in which employees do not participate directly, but nominate representatives through election

(Cotton et al 1988)
Results suggested informal participation and employee ownership exerted a positive influence on productivity and satisfaction whereas short term participation was found to be ineffective on both criteria (Cotton et al 1988). Participation in work decisions, also known as Participative Decision Making (PDM), was found to improve productivity, but had little effect upon worker satisfaction. Representative participation did not increase productivity but seemed to mediate satisfaction for those participating in the representative process (Cotton et al 1988). Using their clustering methodology, Cotton et al had demonstrated a link between participation, performance and satisfaction and indicated that participation could be fine tuned to deliver one or both of these desired outcomes.

The participation classification matrix created by Cotton et al has been used as a template for many research articles (Wagner 1994; Graham and Verma 1991; Yammarino and Naughton 1992) however, it has also been the subject of a number of criticisms. Leana, Locke and Schweiger (1990) conducted an extensive review of Cotton et al’s participation model and concluded ‘problems were found in how they [Cotton et al] classified, sampled and interpreted the results of the participative decision making studies’ (Leana et al 1990, pg 137). Leana et al were especially critical of Cotton et al’s clustering methodology, claiming it represented an oversimplification. Their analysis suggested clustering should, if dichotomous and missing elements were considered, produce 192 categories leading them to conclude ‘presumably, they moved from 192 possible categories to 6 largely because the remaining 186 were not descriptive of any existing studies of participative decision making’ (Leana et al 1990, pg 138).

Leana et al concluded ‘In summary, we find little support for Cotton and his coauthors’ conclusions regarding the effectiveness of participative decision making…the categorization scheme used by them was unsystematic, the sampling of the studies for inclusion in the review was selective and there were errors in how the results of many of the participative decision making studies were reported’ (Leana et al 1990, pg 141). Cotton et al (1990) issued a four page rebuttal of these criticisms suggesting that the majority of the workings required to cluster the data had been removed at the request of the journal editors. This, they claimed, had led to ‘points of misunderstandings’ and
therefore 'our original conclusion still stands. The form of participation does make a
difference' (Cotton et al 1990, pg 147).

Cotton et al (1988) decided to employ clustering techniques rather than the more statistically
demanding methods such as meta-analysis for a number of reasons. First, they argued that
clustering reduced their data set into only six distinguishable categories; this limited number would
have negated any meta-analysis that took place. Second, they argued that, although similarities
existed between categories, the differences across the studies used were too great for meta-analysis
(Cotton et al 1988). Upon review, these reasoning strategies seem questionable. To successfully
argue that the results of a particular method negate the worth of another relies upon the absolute
accuracy of the employed methodology. In this case, Cotton et al argue that their clustered findings
suggest that meta-analysis would not be suitable. When it is considered that clustering is a
qualitative technique and hence is subject to variance and that many researcher have been able to
successfully employ meta-analytical techniques in this area (Glass, McGraw and Smith 1981;
Hunter, Schmidt and Jackson 1982; Miller and Monge 1986) these conclusions seem presumptive.

Cotton et al's second argument concerning the effect that inter-study differences may have upon
meta-analysis effectiveness is a criticism that is frequently voiced in response to the meta-analytic
technique, however, the peer reviewed publications of Locke and Schweiger suggest these
assertions can be considered debatable if not questionable.

Meta-analytic Support
Locke and Schweiger (1979) undertook an extensive meta-analytic review of the relationship
between participation, performance and satisfaction and, as a result, produced a paper that is
credited to be 'the most comprehensive review of empirical research to date' (Miller and Monge
1986, pg 728). Locke and Schweiger adopted a deliberately pragmatic position when reviewing
participation research. They identified a number of methodological issues in past papers ranging
from bias in the experimental design to prejudice in the interpretation and reporting of results. All of
these inequities were found to favour the participative approach. As Tannenbaum and Schmidt
phrased it 'the question for many [...] is not whether participation works but rather how to make it
work' (Tannenbaum and Schmidt 1974, pg 105). Locke and Schweiger summarised their findings in
six key conclusions:
Point [1] considers the response to the moral requirement for participation in decision making. Locke and Schweiger conclude that this, whilst significant, does not outweigh other concerns regarding organizational performance and the application of hierarchical processes. If the evidence does not support PDM then managers should discard it. Regarding point [2] the researchers clarify their position concerning definitions of participation; it is not enough to take part, all parties must be able to contribute towards decision making to ensure that a participative approach to decision making is being adopted. Although point [3] recognizes the existence of confounding variables, point [4] provides good support for improvement in satisfaction and productivity as a result of participative decision making. Points [5] and [6] highlight the potential pitfalls in methodology and over reliance upon a particular management technique.

Locke and Schweiger’s findings have informed contemporary understanding of the merits and potential pitfalls of participation and PDM. Although their findings were considered by many to be definitive, Miller and Monge elected to take ‘one more look’ (1986, pg 727) at participation, satisfaction and productivity in a methodology chiefly influenced by Locke and Schweiger. Their meta-analysis not only provided support for Locke and Schweiger’s findings, it enabled Miller and Monge to make precise predictions concerning the magnitude of the effect of participation on satisfaction and productivity. Such statements reinforced the value of participation and PDM within the organization, however, this technique has not been without its critics.
Problems with Participation
Malone (1975) considered a case study in which an organization that had turned in exceptional growth over an eight year period adopted a completely participative approach. Through this process, middle and senior management became observers; the company became entirely democratic in its approach. The outcome, Malone reported, was disastrous. Production did not improve, sales declined, costs increased and profitability reduced. After five years, the company opted to discard the participative approach and replace it with a more traditional hierarchical method (Malone 1975).

The key error in this scenario, according to Locke and Schweiger, was, ‘the separation of responsibility from knowledge’ (Locke and Schweiger 1975, pg 326). If it is claimed that good management is ‘the rule of the best minds’ (Derber 1963, pg 69) then the diffusion of organizational responsibility to the group represents a retrograde step that could impair performance. In addition, if it is considered that production line manufacturing encourages individuals to develop specialist roles, then removal of the specialist from their function could be seen as counter intuitive in the manufacturing process. It is an irony that the impact of individual specialisation, a product of line manufacturing, could be reduced by a move to PDM, a phenomenon that rose to prominence as a result of the production line methodology.

The Ethical Argument for Participation
When Mayo elected to investigate participation through a focus upon productivity output and user satisfaction (Mayo 1933), he may have been surprised to know that his outcome measures were set to dominate participation research for the next 70 years. Whilst studies have evolved, researchers have remained fixated with the relationship, or possible relationship between participative management and productivity improvement (Frost, Wakley and Ruh 1974; Rosenberg and Rosenstein 1980). According to Marshall Sashkin, however, there exists a powerful ethical argument for the introduction of participative processes.

Sashkin suggests ‘participative management is, when properly applied, effective in improving performance, productivity, and job satisfaction. The decision to use participative management does not, however, depend solely on such evidence. Rather, it is a decision that rests equally on one’s answer to a basic question of managerial ethics’ (Sashkin 1984, pg 5). The author explains the
ethical viewpoint through the consideration of an organizational participative framework. This framework associates participative management with increased autonomy and completion of meaningful tasks. Through increases in these variables it is suggested that the workforce will become more secure, display better acceptance and commitment to change, increased satisfaction and show more innovation (Sashkin 1984). It is further argued that these improvements correlate with three recognized basic work needs; security, control and accomplishment (Sashkin 1984).

Summary
This review of participation literature has enabled a number of initial conclusions to be made. Definitions of participation linked to organizational research reference the importance of involving shop floor employees in the decision making process, so called Participative Decision Making (PDM). Any attempt to improve participation must reflect this requirement and ensure workforce involvement. The review studies conducted by Locke and Schweiger (1975) and Cotton et al (1988) introduced clear methodological differences in the categorization of PDM strategies and the measurement of their success. Despite this, both studies agreed that the controlled adoption of PDM has the potential to deliver organizational improvement. This, coupled with the ethical advantages detailed by Sashkin (1984), provides a convincing argument in favour of the introduction of participation at an organizational level.

Participation and safety is an area in which the ethical imperative detailed by Sashkin takes on a new and more significant light. Whilst good management and leadership clearly has the potential to deliver improved safety, it is an organizational reality that risk is concentrated on the shop floor. Hofmann and Morgeson (1999) noted that without shop floor involvement, safety communication, and, consequently, safety performance, suffers. In this respect, it can be argued that organizations have a moral imperative to improve levels of participation in safety decision making, however, despite this technical academic and moral support, very few organizations make clear their strategies to improve workforce participation and engagement in safety (HSE 1997). This next section of this review will outline academic and practitioner publications in which researchers have attempted to improve participation in safety. Focus will be maintained upon the methodology adopted to improve participation and the measures used to quantify success.
Participation and Safety

The concepts of participation and safety have featured in this review prior to their inclusion in this chapter. Chapter 1 featured the work of Neal et al (2000) and their successful verification of a model of safety performance that included both safety climate, as an antecedent of safety performance, and participation, as a component of safety performance. Later longitudinal findings on the same topics supported the notion that, such was the positive and cyclical association between participation and motivation, organizations wishing to improve their safety performance should focus on participative as opposed to compliant behaviours (Neal and Griffin 2006). Prior to the work of Neal and colleagues, Cheyne et al (1998) were able to demonstrate that a positive safety climate maintains safety related behaviours, including involvement in safety related activities. Similar associations between safety climate and participation have been identified in a number of other studies (Cree and Kelloway 1997; Eklof and Torner 2002; Hofmann et al 2003; Zacharatos, Barling and Iverson 2005; Dejoy, Schaffer, Wilson, Vandenberg and Butts 2004). To clarify and unify the debate, Clarke performed a meta-analytic assessment of the relationships between safety climate and safety performance [identified as safety compliance and participation] and was able to demonstrated a clear positive link between safety climate and participation (Clarke 2006b).

In the studies detailed above, and those included previously in Chapter 1, participation was identified as an outcome measure. As such, these findings allow researchers to conclude that safety climate ‘has an important influence in ensuring adherence to procedures, but, in particular, plays a significant role in the promotion of employee commitment and involvement in safety (Clarke 2000, pg 324). In addition to those studies that have attempted to link safety climate and participation, a number of researchers have attempted to use participative techniques to drive improvement in organizational safety performance. It is these action orientated studies, the bulk of which have been funded by the UK Health and Safety Executive, that will now form the focus of this review.

An HSE commissioned study published in 2008 suggested strategies to improve workforce engagement in health and safety could be divided into two approaches, traditional and new/novel. The traditional techniques, using safety reps or committee/focus groups, were characterised by their indirect and top down approaches and were perceived by organizations to be a regulatory requirement (HSE 2008). The new/novel approaches, on the other hand, were identifiable by their
attempts to interact directly with the workforce. Examples include safety climate surveys, informal discussions, participation in task risk assessments and behavioural observations (HSE 2008). The study selected four techniques, pre-task briefings with feedback cards, suggestion schemes, informal approaches using safety champions and representation in health and safety committees and investigated their impact on individual perceptions collected via interview.

Results indicated a workforce preference for direct interactions that did not require written communication. Authors felt this was potentially due to the low literacy rates among the construction worker sample, although they also identified a potential reluctance to commit to paper negative comments concerning the organizations (HSE 2008). Overall, the study identified a workforce preference for engagement driven through informal communication channels. This required a focus on management soft communication skills and a perceived need for a consistent message concerning engagement (e.g. management effort to continually provide opportunity for engagement as opposed to sporadic drives or projects) (HSE 2008).

Using involvement in Occupational Health and Safety (OHS) as an outcome variable, Shearn (2005) attempted to increase participation through a number of ‘discrete’ mechanisms. Workers were encouraged to participate in safety committees and autonomous health and safety work teams. In addition, a number of health, safety and environment work cards were distributed. These cards enabled employees to report safety issues, record near miss incidents and make recommendations for safety improvements. In addition, safety communication was improved through the increased use of safety notice boards and the introduction of plasma screens displaying important safety messages employees considered physically difficult to reach (in fume cupboards etc).

Study results indicated health and safety participation had been improved. Figures for OHS involvement in 1997, 12 people or 4% of workforce, were contrasted with those collected post intervention, 112 individuals or 35% of the workforce (Shearn 2005). Whilst these results can be considered significant, there exist a number of potential methodological concerns. As this study was conducted by the HSE, it pertinent to consider if regulatory presence or pressure could have effected organizational performance and hence the outcome measured adopted. In addition, the outcome measure utilized , involvement in OHS, could be considered intrinsically mediated by the actions taken.
The HSE are not alone in their interest of the relationship between participation and safety. Koningsveld (2005) recognized participation and a mediator in health and safety performance and proposed a participative model when attempting to analyze the effectiveness of health and safety measures. Results indicated no direct relationship between participation and accident reduction, instead the author recognized that participation could improve understanding of the value of health and safety interventions and hence increase the likelihood of such interventions in the future.

Using the background of a steel fabrication factory, Kuorinka and Patry (1995) outlined the potential for participatory ergonomics in occupational health improvement. The researchers described a bottleneck in production in which a fire resistant lining had to be replaced every few weeks leading to shortened production and the potential for human error. To resolve this issue, the organization established a preparatory group consisting of industrial engineers, occupational health services and ergonomists. The result was a technical solution that simplified the task and immediately minimised the previous risks (Kuorinka and Patry 1995).

Kogi (1993) proposed a participative approach to control neuropsychobehavioural changes occurring as a result of poor working environments, poor job content and inappropriate work organization. Participation was also successfully integrated into the health and safety policy adopted at two construction sites based in Finland. Laitinen and Ruohomaki (1996) identified that construction, although well regulated, was still prone to high accident rates. They proposed an alternative to the traditional weekly safety inspection. Instead, a baseline of safety observations was made using rules generated through a participatory process involving the organizations’ safety personnel. These rules were then indexed using a system of observations and the results displayed graphically on the wall of the workers dining room. This process had an immediate effect on behaviours. The safety index in one site rose from 60% to 89% with the second site improving from 67% to 91% (Laitinen and Ruohomaki 1996). Although no direct empirical link was made between index improvement and accident reduction, the nature of the issues identified, protection from falls, machine safety, scaffolding and the use of PPE (Personal Protective Equipment), suggested that an impact on accident rate could feasibly be predicted.
Investigating the link between participation and safety inevitably produces studies with a focus on behavioural safety. The popularity of consultancies such as Dupont, Behavioural Safety Technologies and Quality Safety Edge combined with the number of published articles advertising ‘successful behavioural change’ suggest that many organizations choose to promote participation through the behavioural model. As Laitinen and Ruohomaki demonstrate, this can be a relatively successful approach, however, concerns regarding the gap between the claims and actual delivery of behavioural safety remain (Anderson 2005). More subtle approaches, such as those detailed by Shearn and Kuorinka and Patry, highlight techniques that take a more holistic approach to the integration of participation focussing on a range of available options to improve employee engagement.

It may be significant to note that both Shearn and Kuorinka and Patry advocate a participative approach that is more likely to result in a positive interaction between the organization and the individual. For example, individuals give up their free time to participate in a focus group designed to identify areas for improvement in safety. The product of this participation is likely to be changes seen in the working environment.

**Summary**

The review of the participation literature has revealed a number of notable findings. At a strategic level, researchers have been able to establish the value of the participative approach, whether that be for moral reasons, or those associated with improvements in workforce performance and satisfaction. More specifically, increasing levels of workforce participation has been seen to be an effective means of improving safety performance (Shearn 2005). Researchers have demonstrated the efficacy of a number of techniques designed to improve participation in safety, ranging from the use of safety climate surveys, through to behavioural interventions and participative ergonomics. Although these methodologies have produced demonstrable results, it is reasonable to argue that there remains opportunity for further research in this subject area. When the bulk of research supporting the value of a participative approach is considered alongside the successes of those few researchers who have adopted this technique as a means of improving safety performance, the lack of research in this area seems surprising.

Of the research that has explicitly or implicitly used a participative approach to develop safety
performance, much has focused on behavioural or management driven methodologies. The limitations of the behavioural approach have been eloquently demonstrated, and, in the context of participation concern the individual ‘experience’ of the process. For example, using the behavioural approach, an individual may be observed behaving in a way that is inappropriate and cautioned. The individual who made the observation may feel they have participated in safety improvement but the result of this participation may have switched someone else off from the process. Coupled to this, many processes that attempt to introduce workforce participation and designed, implemented and managed from above. These techniques also miss the opportunity to maximize on the efficacy of PDM, a process that has been repeatedly single out as highly effective in both clustered (Cotton et al) and meta-analytic (Locke and Schweiger 1979) reviews.

These issues leave open the potential for a technique able to introduce participation but, through design, ensures workforce own and drive the process. To be effective, this technique must also ensure that individuals who participate in the safety improvement process have a positive experience, that participation does not lead to a negative outcome for one individual. This emphasis on the positive should not just be limited to the process but also extend to the outcome; individuals must be involved in the decision making process. In this way, individuals are not asked to identify issues or problems, rather present ideas or solutions. With these requirements in mind, a completely new approach is required. Linking the issues of participation and ideation leads the researcher to the topic of brainstorming. Brainstorming presents itself as a technique with potential to drive participation in safety whilst simultaneously addressing the issues identified in previous research. To clarify this potential, it is essential to review the brainstorming literature. This review will clarify the brainstorming approach and address some of the contentious issues in the study of this technique. At its conclusion, this review will have confirmed the suitability of brainstorming to drive participation in safety and identified any methodological issues, such as the type of brainstorming technique to be employed, that may exist.
Brainstorming

Introduction

Brainstorming centres upon the premise that a team should be more capable of producing a set of novel ideas than a group of individuals working alone. It has been recognized that individuals choose to do many things in groups, the most important of which, arguably, is decision making (Baron, Kerr and Miller 1992). It is a fact that most decisions, at least on an organizational and societal level, are made by groups rather than individuals (French 2006). We, as individuals, are exposed to the product of group decision-making on a daily basis. Groups design cars, discuss and pass legislation, perform operations and write television programmes. Group membership can aid weight loss, assist in addiction recovery and improve wellbeing.

Teams are considered by many employees to be an integral part of organizational life and success (Cohen and Bailey 1997). Research has established that groups are now the building blocks of organizations (Guzzo and Shea 1992) and, as such, group or team based activities are becoming the norm over a more traditional individualistic style (Guzzo and Shea 1992). Recent investigation has found organizational use of teams increasing (Devine, Clayton, Philips, Dunford and Melner 1999) and a growing consensus that this pattern will be followed in the future (Guzzo and Shea 1992). Research indicates that teams are considered effective on many levels, from work management through to quality and project management. If teams can deliver improved flexibility and productivity (Devine et al 1999) then it would seem reasonable to assume they can improve creative processes too.

This chapter will provide an over view of brainstorming research, from its inception in the 1950s through to its contemporary application in modern group dynamics research. In particular, this chapter will focus on the debate concerning the comparative effectiveness of interactive versus individual brainstorming processes. Not only does this debate represent one of the most keenly contested area of brainstorming research, it has particular significance for the methodology adopted as part of this study design. As this review will reveal, the decision to use brainstorming to encourage participation in safety in the context of this study carries with it a methodological choice between interactive and individual brainstorming that will have a significant effect on the participants and the results of this study.
**Applied Imagination**

Brainstorming is one of the best recognized and most utilized tools for creative problem solving (Leclef 1994). Whilst there exists a number of alternative methodologies to facilitate creativity, none have achieved brainstorming’s organizational dominance, a dominance that has strengthened over the last fifty years. Alex Osborn first publicised the process of brainstorming in the widely acclaimed book *Applied Imagination*. In it, he attempted to address issues that he perceived to be hindering the creative performance of groups. The term ‘brainstorming’ actually referred to a number of techniques that Osborn claimed could increase group creative idea production by 44%, whilst maintaining the benefits of group discussion and interaction (Osborn 1953). According to Osborn, brainstorming should be governed by four guidelines:

- Criticism is ruled out - all negative or adverse judgements should be kept for the evaluation phase. Even negative body language is undesirable.
- Freewheeling is welcome – all ideas are welcome, including ‘wild’ or ‘off the wall’ concepts
- Quantity is a requirement – more ideas mean a better chance of useful idea
- Combination and improvement – participants are encouraged to suggest how the ideas of others could be improved or combined with their own concepts

( Osborn 1953)

Osborn recognized that it may be difficult to maintain a non-judgemental environment if individuals were also required to combine their ideas with the suggestions of others. To address this, he recommended that concept or creative idea production should be separated from sorting and evaluation by a distinct period of time, ideally a minimum of 30 minutes (Osborn 1953). This time could be used to underline the change in requirement, from idea production through to assessment and evaluation. Whilst Osborn claimed his four guidelines would improve idea production, he also offered a number of other suggestions that he viewed as key to the creative brainstorming process.

First, Osborn suggested that a trained facilitator should lead the brainstorming session. Osborn specified that a trained facilitator should take at least one formal course in creative problem solving and be able to control, lead and reinforce guidelines (Isaksen 1998). Second, he advised that
participating groups should consist of individuals operating at a similar organizational level and that the group should number between five and ten ideally (Osborn 1953). In attempting to organise brainstorming groups into similar bands or levels Osborn was trying to minimise what he perceived to be one of the biggest issues of group creative problem solving, that of evaluation apprehension. This step, combined with the removal of evaluation opportunities during the idea creation stage, was designed to minimise the fear of judgement from the group, and, in doing so, aimed to stimulate creativity.

Osborn was clear that his concepts were heavily influenced by Wallas’s early work concerning creativity and as such he required that any brainstorming session should include prior time for problem framing and preparation (Osborn 1953). As a result, it was suggested that key information concerning the subject to be brainstormed should be distributed prior to the session to allow participants time to consider it. He envisaged this preparation might trigger incubation before and during the brainstorming process which itself would lead to illumination and later verification (Wallas 1926; Osborn 1953).

Consideration of Osborn’s work highlights the intricacy and attention to detail required to host a brainstorming session that meets his stringent requirements. In many cases, organizations and individuals do not follow the guidelines and suggestions highlighted in Applied Imagination, and, as such, can only be considered to be running quasi-brainstorming sessions. Understanding the core methods and inherent procedures that make up brainstorming is key to its correct evaluation as a creative technique. It is also important to understand how the misinterpretation of brainstorming as a process has impacted the research undertaken since Applied Imagination was first published. This impact can be better understood through the consideration of the studies carried out by Taylor, Berry and Block at Yale University.

When Osborn released Applied Imagination it created a huge stir in the advertising industry and academic circles alike. His claims to substantial group creativity improvement were initially welcomed, however, demands for research substantiation were soon made. Osborn was not a social scientist, it was noted, he was an advertising executive. Many academics believed that he had overstated the effectiveness of brainstorming to raise both his profile and the profile of his
method. There was also significant interest in the portability of brainstorming as a process; could it be taken out of the sphere of advertising and applied in other areas? What effect would this have upon a method that was almost a bespoke solution to a specific problem identified in the area of advertising? Osborn intended that brainstorming should be used as a creative aid in education as well as industry (Osborn 1953), a move that almost invited confrontation with ‘academic’ minds.

Establishing Process Loss

Although there existed a multitude of questions concerning brainstorming, it was the debate relating to individual versus group performance that captured the interest of the research community. In response to this debate, Taylor, Berry and Block (1958) elected to compare interactive and individual conditions, both using brainstorming methods. Two teams of male undergraduate students were randomly assigned into individual and group conditions. The individual, or nominal, brainstorming condition entailed participants writing as many ideas as possible onto a piece of paper which was collected. The interactive condition followed loosely the guidelines set out by Osborn. Both were asked to produce ideas in response to a selection of three tasks – the thumbs, teachers and tourist problems. The thumbs problem required the individuals to consider the implications of waking up with an extra thumb, the teachers problem required ideas to deal with a fictional shortage of teachers and the tourist problem requested ideas to entice more European tourists to the US (Taylor et al 1958). Each of the three presented problems were chosen not for their creative potential but because they lent themselves to logical and therefore rateable solutions (Taylor and McNemar 1955).

No time was given for preparation before the study, although participants were required to attend a lecture that outlined the effectiveness of brainstorming as an ideation tool (Taylor et al 1958). No direct facilitation was used, instead a number of nominated psychology students spent time ‘floating’ between the interactive and individual conditions to ensure work was progressing smoothly. When nominal ideas were combined and adjusted for duplication they were found to outnumber the interactive condition by a factor of two. Not only this, the nominal condition was also found to produce more unique ideas, and, using a qualitatively derived measure, better quality ideas too (Taylor et al 1958). Taylor et al had unearthed the phenomenon of interactive, or group level process loss. Such was the significance of their results that this research is still often used to support the
argument for individual over group working in contemporary research (Diehl and Stroebe 1987; Rietzschel, Nijstad and Stroebe 2003).

**Explaining Process Loss**

**Group Size**

Once Taylor et al published the concept of process loss, further research was soon forthcoming. Cohen, Whitmyre and Funk (1960) attempted to emulate the Yale studies, with the inclusion of group size as a dependent variable. Using a maximum group size of two, findings supported a comparable level of performance between the group condition and the nominal brainstormers. It is significant to note that Cohen et al elected to provide facilitation training for individuals running both sessions, a recognition of Osborn’s original stipulations concerning group guidance. Milton (1965) used a similar methodology to that established by Taylor et al with group sizes of four and found in favour of the nominal condition.

Bouchard and Hare (1970) further investigated the impact of group size with numbers ranging from five, seven and nine. Again, their methodology reflected that established by Taylor et al studies with a fictitious problem and a sample consisting of university students. In each condition, they found in favour of the nominal subjects in terms of non-redundant idea production. They found this effect strengthened as the group size increased. Recent criticism of this study underlined that the authors established no statistical trends during their analysis of results. Instead, support was provided utilising only an interaction effect, a qualitative judgement that cannot be considered statistically robust (Mullen, Johnson and Salas 1991). These findings, whilst open to statistical criticism, support the notion of decreasing group effectiveness relative to increasing size, although it should be noted that in all studies group effectiveness was measured only through non-redundant idea production and no other means.

**Evaluation Apprehension**

Evaluation apprehension refers to the concern individuals may feel that they could be viewed negatively if they voice their opinions only to find that the majority disagree or dismiss them. Collaros and Anderson (1969) attempted to investigate this phenomenon through the creation of situations designed to maximise evaluative apprehension. Their manipulation of conditions focussed upon the number of fictional experts present in each brainstorming group. In one condition, subjects
were informed their group consisted exclusively of experts in addition to themselves, in another condition subjects were informed that one expert was present and in a third condition no mention of fictional experts was made. In accordance with evaluation apprehension predictions, productivity was highest in the no expert condition and lowest in the multiple expert condition. In addition, during a post experiment questionnaire, subjects in the multiple expert condition expressed feelings of inhibition and reluctance to offer ideas relative to those in the no expert condition (Collaros and Anderson 1969).

Whilst subsequent studies have failed to replicate these findings, it should be noted that the concept of evaluation apprehension is, by its nature, subjective. Apprehension and anxiety can be caused by a variety of triggers, many of which are specific to the individuals concerned. This specificity has been expressed in research by methodological differences. Maginn and Harris (1980) attempted to investigate evaluative apprehension through the deception of subjects. They reasoned that, if brainstorming groups were inhibited by evaluation apprehension, this effect should be replicated in the nominal condition if apprehension could be introduced. To achieve this, they created two groups of nominal brainstormers, one control and a second who were informed that their performance was being monitored through a one-way glass mirror (Maginn and Harris 1980). No performance differential was discovered, indicating that it either did not exist, or it was not captured effectively. Maginn and Harris proposed that proximity to subject might be an essential element of evaluation apprehension. Through this suggestion they seemed to be discounting the possibility of evaluation apprehension in the nominal condition, however, no further work was done to investigate this.

**Individual Differences**

In a separate thread of research, studies have been conducted to evaluate the impact that individual differences have upon the brainstorming process. Since the onset of psychological treatment and assessment there has been recognition of a relationship between creativity (C) and psychosis (P) (Eysenck and Eysenk 1976; Eysenck 1992; Bleuler 1978; Claridge 1985). Furnham and Yazdanpanahi (1994) found a significant improvement in performance for P subjects, working nominally, relative to their interactive counterparts. This improvement was negated when P subjects were asked to work in groups with their performance dropping below that witnessed for normal subjects working nominally. This research supports the nominal vs. group hypothesis but also raises
the interesting question of the role of the individual within the group. Whilst group information processing theorists suggest individual input becomes a part of the group product (Hinsz, Tindale and Vollrath 1997), Furnham and Yazdanpanahi's findings support the conceptualisation of the group as a number of individuals rather than a whole.

**Group Effects**

Economic theory, in the context of brainstorming research, argues that individuals are less likely to input into a group activity as they may feel the group decreases their perceived effectiveness; their perception of the difference it would make to the group if they decided to contribute (Diehl and Stroebe 1987). Perceived effectiveness has also been related to an individual’s feeling of dispensability, that is the extent to which an individual feels their group contribution is dispensable. Kerr and Bruun (1983) suggested that dispensability depended upon the nature of the task presented to the individual. They demarcated task nature into two conditions; disjunctive, a task in which only the best contributions will count, and additive, a task in which quantity is the determining factor. Findings supported a task differential hypothesis; subjects who were graded as low ability were more likely to consider their contributions as dispensable and were subsequently found to contribute less in disjunctive tasks; these findings are normally reversed when additive standards are employed (Kerr and Bruun 1983).

Harkin and Petty (1982) manipulated task anonymity to investigate free riding effects. Subjects were asked to identify possible uses for an object. In one condition they were informed that this object was unique to them and therefore made them identifiable. In another, it was made clear that all participants were working on the same object and were therefore anonymous. Their findings supported the supposition that individuals would perform better if the task, by its nature, resulted in identification. It has also been suggested that dispensability could account for performance differentials witnessed in studies investigating other effects. Collaros and Anderson (1969) and Maginn and Harris (1980) have been considered in the context of evaluation apprehension previously, however, it has been suggested their methodologies may have had an impact upon perceived dispensability as well as evaluative concerns (Diehl and Stroebe 1987). Both studies utilized ‘judges and ‘experts’ to manipulate evaluative concern, however, it could be argued that their
presence also impacted upon the participant’s feelings of dispensability and hence task performance.

**Production Blocking**
Research over a number of decades had identified group number, evaluation apprehension, individual differences and group effects as potential explanations for process loss. Diehl and Stroebe (1987) attempted to produce a definitive understanding of process loss through the integrated analysis of assessment expectation, evaluation apprehension and production blocking. Diehl and Stroebe investigated each factor with a distinct study, numbered one through to four.

**Study One**
Using 48 male students study one attempted to understand the relationship between assessment expectation and performance. To achieve this, four conditions were created, personal and collective assessment for interactive and nominal brainstorming condition. Those in the personal assessment group were informed that their individual results would be compared to the average results, those in the collective assessment were informed all data provided for performance review would be sourced at the group level, rather than the personal. The personal/nominal group produced the most ideas (84), followed by the collective/nominal (65), personal/verbal (32) and collective/verbal (24) conditions. The personal/nominal condition also produced more good ideas although originality scoring suffered. Whilst these results provided partial support for the notion of economic considerations, Diehl and Stroebe themselves asserted ‘type of session still had a major impact on brainstorming productivity’ (Diehl and Stroebe 1987, pg 497).

**Study Two**
This section focussed upon the impact of evaluation apprehension. 36 male psychology students were required to participate as a part of their coursework assignments. Each was randomly placed into conditions that varied the degree of evaluation apprehension. For the high apprehension condition, the idea of the fictitious judge technique was borrowed from Maginn and Harris (1980). A second, lower apprehension condition was created through the use of a video camera located in the room. Subjects were informed that peers would review all footage as part of a psychology class. Finally, a no apprehension condition was used in which no mention was made concerning judges or
peer review. In addition to physical condition, Diehl and Stroebe also elected to vary the topic of the brainstorming exercise. In this case it was suggested that topic content could well effect individuals willingness to participate in debate, as subjects may well be unwilling to show certain sides to themselves i.e. lack of knowledge or ideological biases (Diehl and Stroebe 1987). All subjects brainstormed nominally and all ideas were collected through the use of microphones and tape recorders.

Results were mixed. Diehl and Stroebe did not replicate the results obtained by Maginn and Harris (1980) even through their methodology was almost identical. The introduction of evaluation apprehension had an impact upon the number of ideas produced, this effect was found to be independent of either how the apprehension was introduced (judge or peer) or the controversial nature of the subject. Along with mixed findings concerning evaluation apprehension, study two raised an interesting question. Identification of subject performance was a by-product of the introduction of evaluation apprehension (e.g. subjects were filmed brainstorming or watched by a judge). Why then did subjects not display the same uplift in performance witnessed in study one? Diehl and Stroebe considered that the answer lay in the methods applied for both experiments. In study one an emphasis was placed upon quantity of ideas as a signpost of success. In study two, the emphasis shifted to quality as a by-product of the steps taken to induce evaluation apprehension (i.e. the peer or judge review of ideas).

Study Three
In response to the findings in study two, Diehl and Stroebe designed a bespoke assessment to consider their idea quality hypothesis. 64 subjects, all psychology students, were separated into verbal and nominal brainstorming conditions. Each group was further divided into low and high evaluation conditions using methods adopted from study two. Groups were also informed their work would be analyzed at either the group (collective) level or at the individual level. Results were varied. Of all conditions, low evaluation nominal personal assessment produced the largest number of ideas; nominal out performed real group by a factor or two regardless of evaluation or free riding condition. Results also indicated that evaluation apprehension only seemed to effect performance when it was made clear that a personal assessment would be employed (Diehl and Stroebe 1987).
The three studies suggested that productivity loss was significant, but did not account for its occurrence in verbal brainstorming session.

Study Four
The final study investigated the effect of production blocking upon idea generation rates. Production blocking refers to the physical inability of all individuals to verbally engage in a brainstorming session simultaneously. Lamm and Trommsdorff (1973) recognized the potential effect that blocking could have upon group performance, however, little work was done to understand this effect in more detail until the efforts of Diehl and Stroebe (1987). Whilst it may be straightforward to consider production blocking as an inability to voice opinion due to limited opportunity, further investigation suggests this may be an oversimplification. In most comparative studies, brainstorming groups are given as much time as their nominal counterparts; during this time groups normally run dry, suggesting all participants have had contributed to their fullest extent. If participants run out of ideas during their allotted time, it can be concluded that blocking effects take place adhoc as a direct result of the group process itself. There have been a number of potential explanations for these observed blocking effects.

Diehl and Stroebe (1987) suggested that individuals could forget their ideas or may dismiss them if they did not match the conceptual direction to which the group was travelling in. Study four looked to understand the impact that production blocking could have, if any, upon performance. Subjects were separated into four person groups. Five conditions were created, control, blocking with communication, blocking with no communication, no blocking and no communication and individual control. Blocking and communication opportunities were manipulated through the separation of individuals into different rooms and the use of microphones that indicated when one individual was speaking. Using this system, researchers could instruct subjects to communicate or not use microphones or when to communicate using the microphones to indicate who was speaking.

The results obtained from the fourth study supported the argument that process loss could almost exclusively be explained though production blocking effects. All subjects reported that the time allocated was sufficient for the task, however, those subjects for whom blocking effects and communication were permitted produced only 38 ideas in comparison to the 103 ideas produced by
those who were neither permitted to communicate or block each other. In their complex, literature
driven, comparative approach Diehl and Stroebe could claim to have discovered the missing piece of
the puzzle that explained process loss.

Diehl and Stroebe produced a second study designed to ‘track down the blocking effect’ (Diehl and
Stroebe 1991, pg 392). Again, using a four study design, the authors were able to ascertain that
productivity loss could not be explained through the reduction in speaking time associated with
standard verbal brainstorming when compared to the nominal approach (Diehl and Stroebe 1991).
Instead, a focus was maintained on waiting time, or dormant periods, in which subjects were not
thinking of new ideas. This, it was argued, would agree with earlier studies that had witnessed a
growing divergence in performance between nominal and verbal groups as the group size increased
(Bouchard and Hare 1970). It would seem that any factor that increased the time between ideation
and verbalisation would have a negative impact upon performance. Diehl and Stroebe explained this
relationship by highlighting the excessive cognitive loading placed upon individuals who were
attempting to hold their ideas, interact with others and choose an opportune moment to intervene in
discussion.

Many studies of group productivity loss have found production blocking to be one of the key
contributors to performance degradation (Diehl and Stroebe 1987; Diehl and Stroebe 1991; Gallupe,
Bastianutti and Cooper 1991; Nijstad 2003). Gallupe et al (1991) and Gallupe, Cooper, Grise and
Bastianutti (1994) considered that blocking effects could be separated into idea generation and idea
production phases. Idea generation referred to blocking effects that effected an individual’s ability to
think of ideas, for example distraction effects and time taken away from primary task. Idea
production effects referred to incidents that effected an individual’s ability to express the ideas they
had generated; potential issues cited included production delay and turn taking (Gallupe et al 1991;
Gallupe et al 1994). In essence, this approach represented a sequential refinement of earlier work
carried out by Diehl and Stroebe (1987; 1991). By attempting to further separate the model of
ideation Gallupe and colleagues were looking to understand process loss and through this
understanding offer a solution to its occurrence.
**Social Psychological Mechanisms**

When Mullen et al (1991) conducted a meta-analytic investigation of previous brainstorming studies, the concept of group process loss was established. Although Mullen et al were not the first to attempt to collate group and individual performance differential studies (Jablin and Sussman 1978; Diehl and Stroebe 1987) they were one of the first to do so using powerful meta-analytic techniques. Their findings suggested that, in general, interactive brainstorming groups were significantly less productive than their nominal counterparts in terms of both quantity and quality of ideas. Their interest in the causal explanation of process loss pointed towards group size, experimenter presence and the written recording of contributions as significant in the degradation of performance (Mullen et al 1991). Using this data, Mullen et al concluded that future brainstorming research should focus upon which specific facets of social interaction that were impacting upon group performance. In addition to the statistical significance of the study, Mullen et al also contributed to the understanding of process loss through their assessment of potential explanations. They divided causality into procedural, social psychological and economic segments, details of which are outlined below:

Procedural mechanisms – explanations concerned with the ‘mundane’ task of splitting individual performance into the time available i.e. production blocking

Social psychological mechanisms – basic underlying processes engaged by the presence of others and by the individual’s membership of a group i.e. drive arousal; self attention

Economic mechanisms – motivated, intentional withdrawing of effort i.e. social loafing; free riding

(Mullen et al 1991)

Their findings strongly supported the concept of social psychological mechanisms but also provided marginal support for procedural explanations. They were able to discount economic mechanisms, negating the impact of social loafing and free riding upon group process (Mullen et al 1991). The effective elimination of social loafing and free riding effects had a profound effect upon understanding of group process loss. Previously outlined models of group brainstorming had included the concepts of perceived effectiveness (Stroebe and Frey 1982) and dispensability (Kerr and Bruun 1983); their removal created as many questions as it did answers.
Summary
Osborn could be forgiven for feeling persecuted given the forensic deconstruction and dismissal of *Applied Imagination* received in academic circles. Taylor et al (1958) dictated the group versus individual approach and isolated the phenomenon of process loss. Bouchard and Hare (1970) highlighted the role of group numbers on process loss, Diehl and Stroebe (1987;1991) underlined the critical effect that blocking effects could have on process loss whilst Mullens et al (1991) considered social factors in addition to other physical elements. Although researchers disagreed concerning the mechanics of process loss, all agreed upon its presence in Osborn’s interactive brainstorming. As a result, research almost unanimously supported the use of nominal brainstorming to maximise ideation.

The Failure of Nominal Brainstorming
The majority of the studies published concerning brainstorming have supported the effectiveness of the nominal approach. Yet, despite the overwhelming evidence in favour of nominal brainstorming, traditional verbal brainstorming has remained the method of choice for organizational ideation. As Dennis and Reinicke note, and with the advantage of hindsight, the much predicted and expected research guided shift to a nominal approach never happened (Dennis and Reinicke 2004). Research has suggested that most people continue to believe that group brainstorming yields more ideas than nominal; a belief that has been termed the *illusion* of group effectivity (Stroebe, Diehl and Abakoumkin 1992; Paulus, Dzindolet, Poletes and Camacho 1993). Yet this simplistic explanation seems insufficient when held up to the reality of the market economy in which process improvement is rapidly identified and adopted.

The continued preference for interactive brainstorming has produced two significant explanations. First, that the use of groups delivers an outcome that has not yet been captured by researchers but is of such value as to ensure the preference for interactive brainstorming; termed ‘group added value’. Second, that the research which has found in favour of the nominal technique has contained within it a flaw that has delivered systematically inaccurate findings; termed systemic issues. The relative support for these explanations will be considered in sequence, beginning with the concept of group added value.
Group Added Value

Idea Quality and Selection

Previous studies have suggested that the quality of orally derived ideas exceed that of those produced nominally (Graham 1977) and, although these claims have subsequently been challenged (Mullen et al 1991) it could be argued that it is the perception of group added quality that facilitates organizational preference for this methodology. Further investigation of interactive performance finds some interesting anomalies, some of which can be traced back to the very inception of brainstorming research. During their initial studies, Taylor et al discovered that, in one topic condition, the interactive team produced a higher degree of uniqueness in their responses than that found for the nominal condition. Possibly concerned that this finding may undermine their overall message, the researchers explained ‘to avoid any possible confusion at this point, it may be worth stating again the more important finding reported above that with respect to the number of unique responses the nominal groups were superior to the real groups on all three of the problems’ (Taylor et al 1958, pg 44).

There can be no doubt that, at the time of discovery, process loss was the significant finding that emerged from Taylor et al’s studies. The current situation regarding brainstorming utilisation, however, could encourage researchers to revisit the uniqueness debate. A review of contemporary brainstorming research does suggest a subtle switch to the issue of quality as opposed to quantity. Rietzschel et al (2005) elected to investigate idea generation and selection strategy. Findings indicated that nominal groups generated more ideas than interactive; these ideas were found to be more original but less feasible than those generated through the interactive condition. When groups were asked to select ideas, however, an interesting pattern emerged. Analysis showed no difference in quality of ideas selected in either the nominal or interactive condition. Even more surprising was that nominal and interactive idea selection performed no better than the ‘random’ method employed as a control. This led the researchers to conclude ‘high productivity in brainstorming is not sufficient to lead to better solutions’ (Rietzschel et al 2005, pg 254).

Whilst the selection study represent an interesting diversification from the standard nominal versus interactive debate, a number of methodological weaknesses have been detected. The researchers offered participants no criterion for success even through they had decided upon a model based on
feasibility and originality prior to the study. This left the subjects to develop their own methods ad
hoc, a process that could perceivably have generated an additional cognitive load and therefore
degraded performance. Whilst it has been noted that individuals are notoriously bad at identifying
their own good ideas (Simonton 2003) it is clear that the provision of a criterion for success could
effect selection performance.

Despite this, it is worth remembering that Osborn envisaged brainstorming as a two stage process,
idea generation followed by idea selection. This demarcation, he argued, would prevent criticism
during ideation and therefore encourage quantity (Osborn 1953). Findings concerning evaluation
apprehension failed to support this methodology (Diehl and Stroebe 1987), but researchers have
established it is the division between ideation and selection that is most likely to dissolve during a
brainstorming session (Nijstad and De Dreu 2002). It is possible that idea selection may provide
opportunity for individuals to exhibit their wisdom and authority (Sutton and Hargadon 1996) and so
may present too attractive a proposition to delay as Osborn specified. Limited research in idea
selection strategies identifies it as a concept with potential, but in need of further study. Further
more, selection strategy does not explain the phenomenon of process loss and so can only ever be
seen as a theory with limited prospects.

The Romance of the Team
When attempting to explain our continual reliance upon interactive ideation, Allen and Hecht (2004)
looked to the ‘romance of teams’. This was a concept that can be traced back to Meindl, Ehrlich and
Duckerich (1985) who first considered the ‘romance of leadership’. Meindl, et al suggested ‘it has
become apparent that, after years of trying, we have been unable to generate an understanding of
leadership that is both intellectually compelling and emotionally satisfying. The concept of leadership
remains elusive and enigmatic' (Meindl et al 1985, pg 78). Allen and Hecht (2004) followed a similar
thread suggesting there exists an assumption that teams are high performance without credible
academic understanding and support. West, Brodbeck and Richter (2004) countered this line of
reasoning, suggesting that team and group working exists due to a necessity rather than a collective
illusion. This necessity can be traced from group hunting strategies through to contemporary
situations such as fire fighting, in which the operation of the group is an essential by-product of task
complexity.
Whilst the romance argument seems a plausible explanation for the dominance of interactive brainstorming, it does not seem practical. Most successful organizations tend to learn as they develop, and through this learning optimise their processes (Senge 1990). Business is competitive by nature and any organization that adapts new and more efficient processes soon finds their competitors emulating their success. Yet few organizations have adapted their brainstorming methods suggesting a reluctance to use nominal processes as opposed to a romantic attachment to more traditional methods.

**Process Gain**
Recent research has suggested a softening of attitudes towards the conceptualisation of the group as an information processor (Hinsz et al, 1997). West et al (2004) outlined scenarios in which group working has come about as a response to physical demands such as construction and emergency services, however, it is now recognized that groups are required to complete increasingly cognitive tasks (Roberts and Weick 1993). Of these, brainstorming represents one of the most demanding. Studies have supported the concept that groups process, encode, store and recall information in ways that separates it from individuals working alone. In essence, it has been argued that group membership not only changes behaviour, but also changes the way in which members think. These changes could be expressed through the information that is processed and hence the outcomes that groups reach. When this concept is applied to brainstorming research it would seem plausible that the group could provide an added element to the process, an element that is not possible to emulate using nominal techniques.

Whilst the concept of process loss is established within the research community, there exists a recent and growing argument for the existence of process gain within group working (Hertel, Kerr and Messe 2000). The concept of process gain has been in circulation since the 1920's, albeit in a physical as opposed to psychological context. Noting a lack of research in the area, O. Kohler designed a study in which individual performance could be compared to that of two and three member groups. Kohler asked a number of male rowing club members to complete a weight lift task working either individually or as part of a group. The weight for individuals was held constant at 41Kg and was increased according to the number of participants in the group condition; two member
groups would lift 82Kg and so on. Kohler found evidence for what he termed motivational gain - individuals lifting more when in groups than when working alone. There appeared to be a distinct pattern to this distribution. Groups in which members had a similar ability profile tended to exhibit a reduction in performance relative to individual scores; however, groups in which ability profiles were mixed were found to exhibit reliable process gain effects (Kohler 1926).

In an attempt to contextualise Kohler’s effect within contemporary psychology, Hertel et al investigated whether selective process gain effects could be replicated and explained. Using a two-factor study design, researchers asked 84 undergraduate students to hold a metal bar above a flexi glass sheet until the task became uncomfortable. The dimension and weight of the bar was varied depending upon the number and gender of participants to ensure each subject experienced a similar task difficulty. Results suggested that process gain was in fact present for the group condition; however, it was not mediated by participant ability as Kohler had initially suggested. Instead, it was suggested that gain effects could be witnessed when a task was conjunctive - when the performance of the group was limited to the performance of the least capable member (Hertel et al 2000). Whilst the data produced by Kohler and Hertel does have limits in relation to generalizability, it also places an emphasis upon the role that group membership can have upon the individual and as such has heightened interest in group process gain.

Liang, Moreland and Argote (1995) investigated process gain using task performance as a dependent variable. Subjects were required to assemble a transistor radio, either as a member of a group or working alone. One week later, participants were required to repeat their task in their respective groups or, in the case of individuals, in newly allocated groups. Findings confirmed that group members who had trained together previously recalled more than those who had trained individually. These groups made fewer errors although they did not complete the task any quicker than those subjects who had initially worked alone (Liang et al 1995). A review of videotape data led researchers to explain the observed performance differential using a transactive memory model. The concept of transactive memory was first proposed by Wegner (1987), who suggested that shared experiences could encourage groups to encode, store and recall information more effectively than individuals working alone.
The concepts of process gain and group information processing can be linked through their shared identification of task nature as a key component in outcome findings. Whilst it may appear obvious to argue that task influences outcome it is important to consider that all brainstorming processes have a shared outcome goal; number and quality of ideas. In essence, therefore, only the task and the processes that occur when attempting to achieve that task can be recognized as potentially variable. The issue of process has been the focus of attention in brainstorming research to date (verbal versus nominal) however, integration of process gain and information processing concepts highlights an increasing realisation that the task itself may have a profound impact on the process and therefore performance.

So it could be possible that, to date, brainstorming research has failed to recognize underlying performance advantages offered by direct group interaction? This argument is at least partially supported when business trends are analyzed. Research has suggested that many employees consider group or team working to be an integral part of organizational life, and more importantly, success (Cohen and Bailey 1997). As such, the use of teams is increasing (Devine et al 1999) with a growing consensus that they are more creative and productive than individuals working alone (Kurtzberg 2005). There exists, therefore, an obvious divide between brainstorming research and organizational behaviour. The former casts doubt upon the efficiency and effectiveness of the group whilst the latter seems engaged in the promotion and the integration of group working.

Summary
The competing theories of idea quality and selection, romancing the team, and process gain provide much in the way of potential explanation for the added value that interactive brainstorming may provide at an organizational level. Although these explanations are comprehensive, none seem to provide a definitive answer, each can be extensively criticised. Allen and Hecht provide no evidence of ‘romance of the teams’, probably as this would be extremely difficult to investigate. The evidence for process gain has focussed primarily on physical tasks; indeed, efforts to introduce cognisance have been unconvincing in terms of group added value (Liang et al 1995).
All of which leaves the unlikely proposition that a majority of brainstorming research since Osborn has carried within it systemic issues, and, as a result, has produced results that do not match with organizational experience. It is this hypothesis that will inform the next section of this review.

**Systemic Issues**

**The task**

Brainstorming was always intended as a practical tool for use in industry and education to aid in problem identification and creativity. It should be considered key, therefore, that any study wishing to investigate brainstorming ensured the topic used to initiate the session was relevant to the participants. Due to the limitations of the sample and environment used, a majority of the studies conducted investigated brainstorming using an abstract question rather than a relevant subject as Osborn stipulated. A review of 50 studies found 19 utilising the ‘thumbs’ problem, a dilemma that asks individuals what changes would have to come about it we all woke with an extra thumb (Beaton 1990).

Research indicates that task relevance effects performance (Watson, Michaelsen and Sharp 1991). Green (1975) requested subjects to generate problems rather than ideas using nominal and verbal brainstorming conditions. The nominal performance differential was found to disappear for all measures including total number of responses generated, number of unique responses and quality of problems generated. Whilst opinion cannot depend upon a single data set, much of the brainstorming research to date has neglected to investigate the process as intended, as a specific idea generation technique applied in situ. Instead, researchers have worked within constraints intended to ensure continuity, reliability and validity, and, in doing so, have let themselves open to criticism that their studies were contrived.

**The Sample**

The relationship between academic rigour and business applicability has been strained since the inception of management sciences. This relationship effects experimental design, highlighted above, as well as a myriad of other considerations. One of the most significant issues in contemporary research is that of the sample used. A major issue in brainstorming research concerns what constitutes a ‘real group’ (Hackman and Morris 1975). This is of particular significance to brainstorming as it is a concept that was designed and is primarily used in an organizational
environment. Despite this, Isaksen’s review of over 50 significant studies found that only four used an adult audience. College students were used in 45 of the 50 examples and exclusively male participants were used in 11. In one study, researchers used children (Isaksen 1998). Whilst it has been recognized that this problem is by no means exclusive to brainstorming research, the intended business applicability of ideation investigation make it highly significant.

The selection methodology, how individuals were asked to participate in the study and subsequently separated into groups, is linked to the overall sampling methodology. Osborn designed brainstorming to be used by real groups. Most studies failed to recognize this distinction, instead choosing to select participants and group membership at random. Gryshiewicz notes this random selection replicates the conditions of the nominal group, defeating many of the potential value added elements of real group interaction (Gryskiewiez 1987).

**Procedural Issues**

Brainstorming was presented as a solution to perceived problems inherent in group performance. Osborn recognized that, for a majority of organizations, creative processes normally took place in groups. Osborn attempted to deal with group creative working as a reality. In doing this, he attempted to design steps that dealt with behaviours already present in organizations. Researchers have recognized that many studies have failed to follow these stages as required. To illustrate, it was found that of the 50 studies analyzed, only seven provided Osborn’s minimum 30 minutes of training prior to undertaking a brainstorming session (Isaksen 1998). This is significant not only because it contravenes best practice but also because research has suggested a positive correlation between brainstorming performance and prior training (Smith 1993).

In addition, there exists an issue with the provision of facilitation for a majority of studies published. Osborn spoke extensively regarding the need for a trained facilitator to be present during brainstorming. Most group problem solving processes rely upon trained leadership and the role of the facilitator is brainstorming is recognized (Clawson, Bostrom and Anson 1993; Oxley, Dzindolet and Paulus 1996). Again, however, only seven of the 50 studies investigated made proper use of a facilitator (Isaksen 1998).
Chapter Summary
Recent brainstorming reviews have looked to critically assess the methodology used in the seminal study conducted by Taylor et al (1958), arguing they failed to understand the basic tenets of the brainstorming process. Their interest was specifically recognized to be group versus individual performance differentials and their narrow focus in this area resulted in recognized methodological oversight. For each condition, group versus individual, participants were randomly selected, however, no allowances were made for the group condition. This is a specific requirement of brainstorming that Osborn emphasised on more than one occasion; the group should be selected, prepared, orientated and facilitated in order to operate effectively (Osborn 1953). In addition, no members of Taylor et al’s team were trained in brainstorming best practice, meaning they were unable to intervene if problems arose (Isaksen 1998). If brainstorming was designed to moderate group specific problems such as evaluation apprehension, it should come as no surprise that the removal of the group but the maintenance of a number of brainstorming procedures should result in improved individual performance.

The methodological oversights highlighted in Taylor et al’s study have implications for the results obtained, however, the study itself became a template for future research. The errors made by Berry et al were replicated in a majority of subsequent research studies suggesting the pool of brainstorming data available is subject to a collective slant towards the nominal condition. It could be argued that research of this nature does not recognize the perceived added value of the group and as such makes no allowances for our desire to operate in a group when attempting to solve complex tasks (West et al 2004). As mentioned previously, Osborn created brainstorming as a process to deal with the reality of an organizational approach that favoured the group as a creative conduit. It is interesting that a majority of research has responded to the reality of group working by suggesting the individual is more effective. It could be argued that nominal brainstorming has not become the creative tool for use as it neglects our desire as social beings to interact with those around us. It is clear that brainstorming provides more than an opportunity to create non-redundant ideas and Osborn had an understanding of that. He attempted to work within social constraints to produce a tool that could be utilized in the real conditions of a working creative organization. After all, he worked in one.
From this review of brainstorming literature, a number of research questions clearly present themselves. The Yale studies and the wealth of subsequent studies provide significant support for nominal brainstorming. However, their findings must be treated with a degree of scepticism considering the conspicuous failure of nominal brainstorming to dominate the organizational ideation landscape. Of the two explanations of this failure, systemic issues are identifiable as the most improbable yet most likely explanation. Research questions therefore relate to the organizational reality of brainstorming. If this process is taken out of controlled conditions and studied in-situ will it be possible to:

1. Witness an equivalence in performance between the interactive and nominal condition
2. Differentiate between the nominal and interactive condition using a measure of individual or group added value

An equivalence in performance can be simply measured using idea production rate for nominal and interactive brainstorming. In a predictive form, this statement can be identified as the first hypothesis for the brainstorming study (to be identified as 'Study 1):

**Hypotheses 1: Interactive brainstorming will produce the same number of ideas as nominal brainstorming**

A measure of individual or group added value presents a slightly more complex proposition. Individual added value can be captured with a simple satisfaction scale, tailored to reflect the content of the brainstorming session. Details of this process are provided in the methodology section of this study. Measuring group added value, on the other hand, requires the capture of a group mediated element with the potential to improve performance or another benefit felt at the individual level. Of the available concepts, cohesion presents a particularly good case. Not only is cohesion a group mediated construct, it can be reliably measured at an individual level using Bollen and Hoyle’s (1990) Perceived Cohesion Scale (PCS). Improved cohesion levels have been consistently linked with positive outcomes such as improved productivity (Summers, Coffelt and Horton 1988), improved task performance (Bakeman and Helmreich 1975) and group formation (Lott and Lott 1965). Measuring cohesion therefore investigates an element of the societal explanation for the dominance of
interactive brainstorming but also presents a medium through which any performance differential in favour of interactive brainstorming may be explained.

Hypotheses 2: Interactive brainstorming participants will report significantly higher levels of cohesion than their nominal brainstorming counterparts

Whilst there has been a wealth of literature investigating the link between participation, performance and satisfaction, articles researching the relationship between participation and safety have been relatively rare. Meta-analytic reviews performed by Locke and Schweiger (1979) and Miller and Monge (1986) both supported the link between participation, performance and satisfaction and researchers such as Sashkin (1984) have eloquently argued for the moral imperative. Such support would seem to select participation as an ideal means by which safety performance may be improved yet few researchers have attempted to investigate this potential.

Hypotheses 3: Interactive brainstorming participants will report significantly higher levels of satisfaction than their nominal brainstorming counterparts

Final Note
Although participation has featured as part of safety culture and climate assessments, few researchers have attempted to use it as a vehicle to improve safety. Looking at the work of those who have attempted to investigate this link provides an indication of the potential hazards of this type of study. Shearn identified a number of discrete techniques to improve participation sourced from focus groups and literature reviews. This study was sponsored by the HSE, however, and it is questionable whether organizations would be willing to invest the same time and money into a programme that cannot demonstrate a clear track record of safety performance improvement. Perhaps more significant are the issues concerning the potential diffusion of responsibility and subsequent degradation of performance witnessed in some participative interventions (Malone 1975). Whilst outcomes of this nature may make companies nervous about the impact that a participative approach could have on the bottom line, high risk organizations have to deal with the potential for serious incidents or even loss of life. In this light, the reasons for the relative paucity of literature become understandable.
To solve this issue, organizations need a technique by which participation may be encouraged that does not effect operational decision making and so will not promote diffusion of responsibility. In addition, it must be relatively quick to roll out and require a limited commitment in terms of time and money. In a related requirement, it must also be universal, allowing organizations in different sectors to be able to benefit from its correct application. Finally, this technique must also encourage participation meaning it must produce a positive interaction between the organization and the individual. Very few tools or techniques match this list of requirements, however, brainstorming can be identified as a candidate with clear potential.
Chapter 4 - Study 1

Methodology

Introduction

Chapters 1, 2 and 3 have identified a number of avenues of interest, however, the task of knitting together these multiple strands of research remains. Chapter 1 provided a summary of safety culture and climate literature and presented a number of questions concerning the current position of climate research. These questions focussed upon the need for improved understanding of elements, other than perceived management commitment, able to account for variance in recorded safety climate data. Chapter 2 responded to some of these questions through the introduction of Performance Shaping Factors and the task oriented approach utilized by Glendon and colleagues. In addition, the concept of LMX was introduced and its relevance to and relationship with safety climate considered.

Chapter 3 introduced participation and brainstorming, and, through the literature review conducted, identified a requirement for further research in each of these areas. Participation research identified a clear relationship between PDM and satisfaction and productivity, through cluster and meta-analysis. Additionally, a variety of techniques designed to improve participation in safety were seen to be effective, from behavioural safety through to participative ergonomics. Despite this, it was noted that few, if any, studies attempted to improve workforce engagement in safety using PDM. Moreover, a number of issues were identified with the more traditionally employed engagement techniques including the potential for negative experience or excessive management input/interference. As such, it was argued that a requirement for a new tool or methodology existed, one able to encourage a positive participative process with a clear link to organizational decision making. Ideation was proposed and brainstorming, the dominant ideation tool, reviewed.
Figure 7 helps to picture how ideation might drive reduction in near miss/accident involvement though the medium of participation. Although Figure 7 provides a steer concerning the potential role of ideation, it does not identify the means by which ideation can be introduced. This task was tackled in Chapter 3 through the in depth consideration of the ideation process. Such is its reach and dominance, any review of ideation soon centres upon brainstorming and the controversy of interactive versus nominal productivity. This review recognized the opposing conditions of interactive and nominal brainstorming and posed a number of questions concerning the consensus supporting the effectiveness of the nominal condition. These questions concerned the appropriateness of the methodologies used to support the nominal condition and supported the argument that researchers had become detached from the organizational realities of ideation.

These questions were turned into research hypotheses, the details of which are provided below.

**Hypotheses 1:** Interactive brainstorming will produce the same number of ideas as nominal brainstorming
Hypotheses 2: Interactive brainstorming participants will report significantly higher levels of cohesion than their nominal brainstorming counterparts

Hypotheses 3: Interactive brainstorming participants will report significantly higher levels of satisfaction than their nominal brainstorming counterparts

This study has presented ideation as a means by which participation in safety and participative decision making can be introduced. The hypotheses detailed above are designed to ensure that the medium of ideation utilized in this study, nominal or interactive, reflects the most appropriate methodology in terms of idea production rate. Crucially, the hypotheses also consider the potential positive spins offs that may be associated with interactive ideation, such as improved levels of satisfaction and cohesion. Significant findings in this area would support the theory that organizations are positively selecting interactive brainstorming because of its benefits as opposed to a general ignorance of the data in favour of nominal brainstorming. Results of this nature would have significance for the ideation literature as well as the choice of ideation technique employed in this study.

Study Design
This study was designed to address some of the issues associated with controlled conditions experimentation identified in the brainstorming literature review. Key concerns highlighted included the participants used, the problems presented, the training provided and the environment in which previous studies have been conducted. To address these issues, this study was designed to reflect best practice as detailed by Osborn (1953). Most importantly, however, this study was designed to replicate the conditions in which brainstorming is predominantly used; within organizations. Key decisions concerning the use of groups, the facilitation and collection of ideas and the scales used to collect data are described in this chapter. Throughout the design and delivery of this study, the researcher was required to balance the assumptions made by those individuals who studied brainstorming in controlled conditions, such as Taylor et al (1958), against the value and validity of the results they gained.
Company
The participating company was one of the largest road building, quarrying and concrete manufacturing organizations in the UK. All could be described as high risk occupations with quarrying and road building identifiable as particularly hazardous according to HSE RIDDOR figures (HSE 1999a). Structurally, the company was arranged to reflect their three core areas of business. Personnel below senior management level tended to specialize in their area of work with little, if any, movement between sectors. The organization had a mixed workforce with varying levels of education. In the road construction and concreting sector, older supervisor/managers tended to have little formal education but retained good levels of experience and knowledge. The quarrying section of the business, like all UK quarries, came under the inspection regime of the HSE Mines Specialists. The company recognized that this attention had improved organizational management of training and competence with nearly all quarrying personnel in possession of some form of occupational qualification, and many of the supervisors/managers degree qualified. Due to a company wide initiative to drive up standards of training and competence, recent supervisor/management level recruits to all sections were ideally to be qualified to HND or degree level.

The company had recently been bought by a larger overseas competitor who had began a series of changes designed to improve efficiency and performance. Safety performance had been highlighted as a key target and an initiative had recently been launched to reduce the levels of incident and accident occurrence to zero within five years. Whilst the internal health and safety department were charged with driving technical or physical changes, a behavioural safety consultancy firm were drafted in to conduct training courses that focussed on the effective identification and removal of occupational incidents and accident root causes. These courses were two days in length and run in hotels away from the normal working environment. They were designed to highlight the role of the individual in safety performance and raised issues such as behaviour and leadership. It was during these courses, and with the companies permission, that the facilitator was able to collect study data.

Subjects
All those who took part in this study were employed on a full time basis by the participating organization. Subjects were sourced from all three areas of the organizations’ core business, concreting, quarrying and road building/maintenance. Whilst there was a degree of variance in job
descriptions and day-to-day activities, all participants could describe their working environment as high risk. All participants given the opportunity to take part in the study elected to do so. A total of 43 participants took part in the interactive condition, split into five groups. A total of 45 participants took part in the nominal condition. According to best practice (Diehl and Stroebe 1987), 43 nominal participants were chosen at random to compare with the interactive condition. Of these 86 selected respondents, 82 were male and 4 were female. Age range 36-45 accounted for 44.2% of respondents, with a total of 81.4% of respondents covered in the age brackets 25-55.

**Equipment**

**Room**

Both conditions required a room and white board to display the relevant rules for the brainstorming type. A copy of the relevant rules displayed for each brainstorming condition is included in Appendix I. Nominal participants were handed paper and pencils to record ideas whilst interactive participants had their ideas recorded on a white board by the facilitator.

**Questionnaire**

A review of the brainstorming literature revealed one key question. If nominal brainstorming is more effective than its interactive counterpart, why have so few organizations elected to use it? This unsettling question was answered in two parts. One, the data used to support nominal brainstorming originated from studies that had neglected to operationalize interactive brainstorming effectively. This explanation focused on the use of student as opposed to organizational samples, the poor application of interactive brainstorming rules concerning facilitation and a number of other oversights. This study will attempt to address these issues.

The second answer concerned the idea that interactive brainstorming produced something more than ideas, that the process itself added value. The concept of added value is not one that has been studied in depth in the context of brainstorming, and, in the absence of a prior methodological steer, a simplistic approach was adopted. A questionnaire was designed to investigate two elements, satisfaction and cohesion. The rationale for the assessment of satisfaction was straightforward, that individuals taking part in interactive groups would be more satisfied with the brainstorming process than their nominal counterparts. With other variables controlled, increased individual satisfaction could provide some evidence for the concept of group added value.
The introduction of cohesion represented a more complex step. The concept of cohesion has been at the forefront of sociological and psychological research for many years. Festinger described group cohesiveness as “the resultant forces, which are acting on the members to stay in a group” (Festinger 1954). Shaw (1981) highlighted that the most salient characteristics of highly cohesive groups are reduced inter-member friction, high inter-member trust and greater interpersonal coordination. Mullen and Copper reduced cohesiveness to three inter-related components; interpersonal attraction, liking for or commitment to the task and group prestige or pride (Mullen and Copper 1994). Their studies found a clear link between cohesiveness and performance (Mullen and Copper 1994).

Studies that have considered group cohesion have often been accused of neglecting how an individuals perceptions of his/her cohesion to a particular group impact upon the overall group cohesion rating (Bollen and Hoyle 1990). In attempting to investigate this apparent discrepancy Bollen and Hoyle proposed that individual perceived cohesion could be broken down into two key dimensions; a sense of belonging and feelings of morale. Their experimental findings supported this assertion (Bollen and Hoyle 1990) and provide excellent support for their Perceived Cohesion Scale (PCS). The PCS consists of six questions centred upon two identifiable dimensions, sense of belonging and feelings of morale. It was confirmed that this measure correlated well with one of the best-known indices of cohesion, Seashore’s scale developed in 1954 for use in industrialised work groups. The PCS can therefore be viewed as one of the most accurate means of measuring perceptions of group cohesion at the individual level.

If, as is predicted in the study hypotheses, interactive brainstorming produces significantly higher levels of cohesion than its nominal counterpart, this finding will have a number of implications. The first implication concerns the improved productivity associated with higher cohesion levels and so provides a potential mechanism through which interactive brainstorming may counter the process constraints identified by Taylor et al. The second implication provides a reason, other than ideation, that individuals may choose to adopt interactive brainstorming (i.e. to improve group cohesion). In their ethnographic study of brainstorming, Sutton and Hargadon (1996) touched upon the idea that brainstorming might have uses other than ideation. Whilst their work focused on opportunity to exert
and reinforce organizational hierarchy, the idea that interactive brainstorming might present a means by which group cohesion levels are improved is far from unsubstantiated speculation.

The questionnaire, distributed to both groups, contained the following sections:

**Demographics**
Study participants were asked to indicate gender ‘Male’ and ‘Female’ and position on a standard age group scale ‘18-24’, 25-35’, 36-45’, 46-55, 56-65 and 65+. Responses were recorded using check boxes.

**Satisfaction Scale**
A three item satisfaction scale was used with responses recorded on a ten point scale. This scale was designed according to best practice in the assessment of satisfaction (Salisbury, Burgess, Lattimer, Heaney, Walker, Turnbull and Smith 2005). Verbal anchors ‘not satisfied’, ‘neutral’ and ‘very satisfied’ were located at points zero, five and ten on the responses scale respectively. All items were worded in the same direction with high responses indicating positive satisfaction. The satisfaction scale included the following items ‘Number of ideas generated’, ‘Quality of ideas generated’ and ‘The brainstorming process itself’.

**Cohesion Scale**
An adapted version of Bollen and Hoyle’s Perceived Cohesion Scale was used (Bollen and Hoyle 1990). A five item scale was utilized with responses recorded on a ten point scale. Verbal anchors ‘strongly disagree’, ‘Neutral’ and ‘Strongly Agree’ were located at points zero, five and ten on the response scale respectively. All items were worded in the same direction with high responses indicating positive cohesion. The cohesion scale included the following items ‘I feel a sense of belonging to this team’, ‘I feel that I am a member of this team’, ‘I see myself as a part of this team’, ‘I am enthusiastic about this team’ and ‘I am happy to be with this team’. The item ‘My team is one of the best performing in the company’, normally included as part of the Perceived Cohesion Scale, was not included in this study as the brainstorming teams consisted of groups formed temporarily for the purposes of training.
Unfortunately, due to time constraints, it was not possible to run a pilot study with the questionnaire. This issue was mitigated, in part, by the nature of the scales used (e.g. established and peer reviewed). A copy of the questionnaire is included in Appendix II.

**Procedure**

On the first day of their training course, subjects were advised that brainstorming could be a useful tool to aid in the generation of ideas. Participants were also informed that idea generation could assist in the reduction of incidents through the provision of solutions to accident root causes. On the second day, the facilitator introduced themselves as a PhD student with an interest in the relationship between safety ideas, group effectiveness and brainstorming. The following statement, previously approved by the organization, was then read out:

‘Significant improvements in health and safety have been made in the last five years, but there still room for further injury prevention. Your task is to use your knowledge and experience to brainstorm ideas to that could prevent people getting hurt’

Participants were advised that the study required the collation of ideas and the completion a short questionnaire which would investigate their perception of the process. All trainees were given the option to not participate.

At this point, the groups were treated either as interactive or nominal brainstorming teams. During the planning stages of this study, it was decided to treat the groups as a whole (i.e. all group members treated as nominal or interactive as opposed to splitting them into nominal and interactive sub-groups). This approach represented a clear methodological compromise; in treating each group as a distinct entity it was impossible to disprove the argument that any variation found in outcome measures was due to more than between group differences. This compromise had to be offset against the desire to produce a brainstorming experience as close as possible to that an organization would required. For the participants, the exercise should feel like a purposeful process designed to improve safety performance, rather than a study designed to collect data. This decision has at its roots the observations of Isaksen (1998) and others who advocated that, in their efforts to disprove the efficacy of brainstorming, Taylor and colleagues had applied methodological controls to such an
extent that the process itself had become an abstraction. The use of student samples and theoretical problems sets are of particular note.

Whilst using ‘whole’ groups opened the study to criticisms concerning methodological design, researchers were able to point to a number of controls designed to mitigate the possibility of a type 1 false positive error.

1. All groups were sourced from the same organization and contained a very similar mix of subjects. For example, all were supervisors and all three areas of the business (tarmac, concrete and quarrying) were equally represented
2. All groups had experienced the same course, in the same hotel with the same facilitator. The sessions were all conducted at the same time on the second day of the course
3. Group members were only aware of one condition and were encouraged to perform to the best of their abilities

It was therefore felt that the continuity of the sample and the conditions of the study provided effective controls to mitigate the decision to use ‘whole’ rather than ‘split’ group samples.

**Interactive**
After completing the above steps, subjects were informed they were going to take part in an interactive brainstorming session. The following rules were then presented:

1. As many ideas as possible
2. No criticism
3. Crazy ideas welcome
4. Freewheeling to be encouraged

Each rule was explained as it was introduced and subjects were given the opportunity to ask questions regarding aspects that they felt were not clear. Once this stage had been completed, the brainstorming session began. During this phase, the facilitator provided encouragement and ensured that the brainstorming rules were obeyed; a particular emphasis was placed on the
management of criticism to ensure that individuals did not react negatively to ideas as they were suggested. When the rate of idea production slowed, the facilitator gave three opportunities for the group to continue. Once it became clear that no ideas were forthcoming at the third prompt, the facilitator drew the session to a close and asked the participants to complete the perception questionnaire.

At the conclusion, all participants were given the opportunity to discuss how they felt about the session. In addition, the facilitator distributed a business card and encouraged individuals to contact them if they had any further comments or concerns about the process.

**Nominal**

After the introduction, subjects were informed they were going to take part in a nominal brainstorming session. The following rules were then presented:

1. As many ideas as possible
2. Crazy ideas welcome

Again, each rule was explained as it was introduced and participants were given the opportunity to raise any points they felt had not been clarified. When this was complete, subjects were invited to write as many ideas as possible using the paper and pencils that had been distributed to them. When all participants had completed writing, the facilitator collected the completed ideas sheets and distributed the questionnaire. When all participants had handed in their idea list and completed their questionnaire, the facilitator announced the session had finished. Each group was given as much time as was required to debrief the brainstorming process. Following this, the facilitator distributed a business card and encouraged individuals to contact them if they had any further comments or concerns about the process.

**Analysis Techniques**

The raw idea data was collected by the facilitator. For the nominal condition, this data was presented as individual sheets of paper, for the interactive condition the ideas were recorded on A2 sheets. For the interactive condition, each group was allocated a unique code that was copied onto the original data (A2 sheet). For the nominal condition, each sheet produced by each individual was
allocated a unique code. This allowed identification during later analysis.

Analysis of the raw data was conducted in a number of stages:

1. Assigning groups - interactive groups were assigned as they presented themselves to the training course. For example, if 12 individuals attended training, these individuals would be randomly assigned as either interactive or nominal. If the group was allocated interactive, the total number of ideas produced would be recorded and tagged to the group. This group would then be allocated a number (e.g. Group 1 - Interactive). For the nominal condition, each idea sheet was given a unique code. During analysis, the interactive group was compared to a randomly selected equivalent number of nominal participants. For example, if the interactive group consisted of 12 individuals, this would be compared to 12 randomly selected nominal participants. The 12 randomly selected nominal participants would be allocated the same number as the interactive group (e.g. Group 1 - Nominal). This process reflected best practice (Diehl and Stroebe 1987).

2. Pooling ideas and removing duplication - as nominal subjects were, by default, unaware of the contributions of others, they frequently duplicated ideas. Once the nominal and interactive groups were prepared for analysis, all nominal ideas were pooled and duplications removed. Duplications were identified as identical ideas, for example ‘improve PPE’ and ‘better PPE’ would be identified as a duplication, however, ‘improve PPE’ and ‘introduce Kevlar lined trousers’ would be identified as two distinct ideas.

3. Identification of themes - once the total number of nominal and interactive ideas was ascertained, each condition was analyzed by theme. Each idea was allocated a strategic theme, for example PPE, Procedures or Management Commitment. Once this had been completed, the themes were contrasted and common topics blended. For example, Improve PPE, New PPE and PPE Choice would all be organized under the PPE theme. Only themes with 2 or more ideas were counted as valid.

4. Final analysis - the total number of themes and ideas for each group were contrasted. The mean number of ideas and themes for each condition were calculated and the results presented in Table 4.
Study 1 Results

Software information
All data were analyzed using SPSS (version 17) for Macintosh (OSX version 10.4.11).

Data
A total of 86 respondents were used. Mean, standard error and Cronbach’s Alpha information are provided in Table 3. All results are within permissible tolerances, however, the alpha figure of .749 for interactive satisfaction does raise some concerns. As detailed in the methodology section, this scale consisted of three items. Traditional statistical theory suggests short scales often struggle to display the same levels of inter-correlation as larger scales, and, as a result, a value of .7 has been suggested as an acceptable rule of thumb. This figure falls within this guideline.

The frequency distribution for satisfaction and cohesion data were both assessed with the resulting bell shaped curve confirming a normal distribution. As such, analysis using a parametric test, such as the independent samples t-test, was deemed appropriate.

Table 3: Scale Mean, Standard Error and Cronbach’s Alpha

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SE</th>
<th>Cronbach’s A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interactive Satisfaction</td>
<td>8.06</td>
<td>0.19</td>
<td>0.75</td>
</tr>
<tr>
<td>2. Interactive Cohesion</td>
<td>8.25</td>
<td>0.23</td>
<td>0.96</td>
</tr>
<tr>
<td>3. Nominal Satisfaction</td>
<td>6.38</td>
<td>0.3</td>
<td>0.88</td>
</tr>
<tr>
<td>4. Nominal Cohesion</td>
<td>7.27</td>
<td>0.35</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Hypotheses
Hypotheses 1: Interactive brainstorming will produce the same number of ideas as nominal brainstorming

Researchers collated all data into nominal and interactive conditions. Interactive groups were numbered and ideas analyzed for duplicates and themes. Theme analysis was an iterative process in which ideas were categorized according to headline areas. For example, ‘better gloves’, ‘high visibility clothing’ or ‘new boots with toe caps’ would all come under the ‘PPE’ theme. After ideas
were categorized into suitable themes, the themes themselves would be analyzed to see if they could be reduced. For example, ‘training’ could be combined with ‘competence’. Once complete, interactive groups were contrasted with an equal number of nominal participants. For example, five interactive participants would be compared with five nominal participants, chosen at random. The nominal group had ideas pooled and analyzed for duplicates and themes. The total number of themes and ideas for each condition was calculated, details of which are provided in Table 4.

Table 4: Summary of Theme and Idea data for Nominal and Interactive conditions

<table>
<thead>
<tr>
<th>Group Number</th>
<th>Interactive</th>
<th>Nominal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Themes</td>
<td>Total Number of Ideas</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>47</td>
</tr>
<tr>
<td>Average</td>
<td>6.6</td>
<td>30</td>
</tr>
</tbody>
</table>

The results indicated the same average number of themes were produced for both interactive (6.6) and nominal (6.6) conditions. The interactive condition produced an average of 30 ideas per group whereas the nominal condition produced 30.2. This data provides support for hypothesis 1.

Hypotheses 2: Interactive brainstorming participants will report significantly higher levels of cohesion than their nominal brainstorming counterparts

The mean scores for cohesion, interactive (M=8.25 SE=0.23) and nominal (M=7.32 SE=0.36) were calculated. An independent samples t-test was used to compare means as the data was found to be normally distributed, the study had two experimental conditions (interactive vs. nominal) and different participants had been used in each condition. The independent samples t-test reported t (69.68) = 2.19, p = .030 (equal variances not assumed) for cohesion. This finding supports the hypothesis that interactive brainstorming participants will report significantly higher levels of cohesion that their nominal brainstorming counterparts.

Hypotheses 3: Interactive brainstorming participants will report significantly higher levels of satisfaction than their nominal brainstorming counterparts
The mean scores for satisfaction, interactive (M=8.06 SE=0.19) and nominal (M=6.47 SE=0.3) were calculated. Again, an independent samples t-test was chosen as the data was normally distributed, the study had two experimental conditions (nominal vs. interactive) and different participants were used in each condition. The independent samples t-test reported t (67.71)=4.74, p=.000 (equal variances not assumed) for satisfaction. This finding supports hypotheses 3 indicating that participants reported a significantly higher level of satisfaction after interactive brainstorming session relative to their nominal counterparts.
Study 1 Discussion and Conclusions

Discussion

Study 1 has produced a number of significant findings. First, interactive brainstorming has been shown to provide the same or a similar number of ideas as its nominal counterpart. This study provides some support for those theorists who have suggested that the controlled conditioned studies pioneered by Taylor et al (1958) and developed by researchers such as Diehl and Stroebe (1987) have missed some of the constituent elements of brainstorming. Whether it be the worker as opposed to student sample group, the introduction of a problem with meaning for the participants, the careful management of the group to ensure realism or the training undertaken by the facilitator before the study, but these elements detailed by Osborn and others have produced a data set that supports the use of interactive brainstorming.

Second, interactive brainstorming has been shown to produce significantly higher levels of satisfaction and cohesion when compared with its nominal counterpart. Improved individual perceptions of cohesion and satisfaction suggest that interactive groups will be more likely to enjoy interactive brainstorming and hence gain value from it. This value can be seen in simple terms of improved group process (e.g. a more cohesive and satisfied group is more likely to perform well) but can also be viewed from a safety specific perspective. Research has identified links between cohesion and positive safety performance (Birkbeck 2005) suggesting the potential for spin off benefits of interactive brainstorming, in addition to the ideas generated.

Design Weaknesses

In attempting to mirror organizational conditions, study designers sacrificed a number of methodological processes; these sacrifices have implications for the findings and for the conclusions that can be drawn from them. First, the use of the whole group in a single condition as opposed to the separation of the same group into two distinct conditions leaves the findings open to criticism concerning confounding variables. The researcher accepts this criticism and suggests that the advantages to be gained from this methodology outweigh the obvious issues in its application. The researcher would also highlight efforts that were made to control variables; for example, each group was from the same organization, attending the same course in the same hotel with the same facilitator.
Second, this study did not consider the quality of ideas produced. A review of the complete ideation data set indicated that many of the ideas produced were similar in nature, regardless of condition. This led researchers to conclude that an assessment of idea quality would provide little distinction between the nominal and interactive conditions.

**Conclusion**
In a significant contribution to knowledge in the field of ideation, findings indicated interactive brainstorming could match its nominal counterpart, under certain conditions. These conditions were intended to match the initial procedures detailed by Osborn (1958) but also the likely use of brainstorming in organizations. In addition to improved ideation, interactive brainstorming was seen to produce significantly higher levels of satisfaction and cohesion. These findings, coupled with the participative decision making literature, made a compelling argument for the use of brainstorming as a tool to aid participation in safety.

Findings in Study 1 also have significance for any published research that has exclusively relied upon a student sample. Although this practice has been reduced due to journal editorial pressure, there remains an issue with assumptions, such as those concerning brainstorming, which rely upon research findings published a number of years previously. Coupled to this, the increasing trend for meta-analysis has seen older studies re-exerting influence on contemporary findings. Whilst the use of older research should not be considered problematic per se, this study underlines the value in the careful consideration of the methodological assumptions used to underpin such research.

Overall, this study provides support for the selection of interactive brainstorming as a medium through which participative opportunity can be introduced. Unlike other participative techniques, brainstorming is relatively simple to organize and administer and the product of the sessions can be used to draw management into the safety decision making process (i.e. through the assessment and implementation of workforce ideas). In addition, brainstorming can be distinguished from other techniques, such as behavioural safety, used to develop workforce participation as there is little opportunity for a negative outcome from individual participation. For these reasons, interactive brainstorming has been selected as the medium through which participation will be introduced in this study.
Defining the Research Model
Much of the research and analysis conducted in the preceding chapters has been undertaken in the knowledge that, if a cohesive thesis is to be produced, there will be a requirement to knit together the contrasting strands of work to produce a meaningful study narrative. In the context of this study, it is the research model, the distribution of specific elements such as safety climate, LMX, compliance and participation, that will dictate the research questions poised and so the narrative of the study. In their identification and discussion of various constructs, each of the preceding chapters has played a key role in defining the content of this study. Before discussions concerning the structure of the research model begin, it is appropriate to provide a brief overview of the constructs identified. This process will help to provide background to the study and serve to remind the reader of the explanations and expectations attached to each of the concepts involved.

Safety Climate
Chapter 1 commenced with a review of safety culture definitions and research before widening the remit to include the concept of safety climate. Key points of differentiation were discussed and the research implications of the ‘catchall’ nature of safety culture considered. Safety climate, measured using a perceptual questionnaire, was identified as a more stable and effective means of assessing aspects of organizational safety performance. The link between safety climate and accident involvement was discussed. Some significant issues associated with safety climate research were considered, including the move to group level measurement, the perceptual approach and the dominance of management commitment scales. Each of these issues was discussed in detail with the dominance of management commitment in safety climate measurement influencing the content of the following chapter. Attention was paid to models of safety performance with a particular focus on the integrative approach adopted by Neal, Griffin and colleagues. Their model, which included safety climate, compliance and participation, provided a comprehensive assessment of the mechanics through which climatic elements could influence behavioural outcomes.

LMX and Performance Shaping Factors
Chapter 2 identified LMX and Performance Shaping Factors, two predictors of safety performance that have displayed excellent promise in prior research. In introducing these concepts, Chapter 2 was also charged with explaining what value they could bring to a study of organizational safety
performance. The link between Performance Shaping Factors and issues concerning the dominance of management commitment identified previously was made clear. In Performance Shaping Factors, it was argued, the researcher had a ready made alternative to management commitment that, in the form presented by Glendon and colleagues, already possessed good structural validity. If safety climate was to be found to reliably consist of more than management commitment, then Performance Shaping Factors, and the safety climate scale developed by Glendon et al, could be regarded as the most appropriate place to begin looking.

Arguments concerning the inclusion of LMX were more complex. At first glance, LMX could be seen as a prefabricated replacement for the management commitment scale, absent from Glendon et al’s safety climate survey. Whilst this viewpoint may have been convenient, it did not allow for the distinctions between these constructs. Whereas a majority of management commitment scales simply measured worker perceptions of management commitment to safety, LMX, in the form of the LMX-7 scale, measured respect, trust and obligation. None of these sub-dimensions explicitly mentioned safety; indeed, a review of literature revealed a limited overlap between LMX and safety, with theorists such as Hofmann found to be working in relative isolation.

LMX was clearly distinct from measures of management commitment to safety, however, it was also distinct from other measurements of leadership style (e.g. Transformational Leadership). Literature review revealed LMX to be one of the only measures to consider the role of the follower and the leader in the measurement of leadership performance. The idea that, through their decision and behaviours, the follower could influence the nature of the leadership relationship resonated well in the field of safety performance where the roles of the supervisor and manager had come under scrutiny. Most significantly, LMX and safety climate were seen to be linked by way of reciprocation with theorists arguing that individuals would look for climatic cues when selecting behavioural reciprocation for positive LMX relationships. Findings produced by Hofmann and others underlined the potential of LMX and provided vindication for its inclusion in this study.

**Participation and Brainstorming**

The role of participation in organizational performance was considered and the distinction between general participation and the participative decision making literature made. A focus on participation
and safety provided a link between research conducted by Neal, Griffin et al and broader studies intended to improve participation and engagement in safety. Once the critical role of participation was established, the review finally considered the merits of brainstorming as a means of introducing participation at an organizational level. No assessment of brainstorming could be considered complete without consideration of the nominal and interactive debate. Hypotheses were produced and a study conducted. Conclusions identified interactive brainstorming, with its blend of productivity and positive group effects such as improved satisfaction and cohesion, as an ideal medium through which participative opportunity could be introduced.

Near Miss/Accident Involvement
Chapters 1, 2 and 3 all provided examples of an association between LMX, safety climate, compliance, participation and the most frequently nominated measure of organizational safety performance, accident involvement. Hofmann and Morgeson (1999) noted a significant relationship between LMX and accident involvement using company records to gather data for analysis. The meta-analytic review conducted by Clarke (2006b) provided evidence for a relationship between safety climate and accident involvement, especially when accident rates were measured following the measurement of safety climate. In their longitudinal study of safety perceptions and accident involvement, Neal and Griffin (2006) discovered a link between average levels of safety behaviour and accident involvement at the group level. When this finding was combined with the link between safety climate, motivation and safety behaviours, the potential value of a focus upon compliance, participation and accident involvement becomes clear.

Figure 8 provides an illustration of how the independent concepts of LMX, safety climate, compliance, participation, brainstorming and near miss/accident involvement may interact. This model predicts that LMX will exert an effect on both compliance and participation. Exponents of LMX suggest that positive relationships, captured by way of a LMX scale, exert a requirement upon followers to reciprocate. This model suggests that, when looking for a cue with which to identify a suitable behavioural reciprocation, safety climate will influence decision making and so consequent compliance and participative behaviours. Hence safety climate will moderate the relationship between LMX, participation and compliance.
Figure 8 also identifies brainstorming sessions as a means of intervention to improve levels of participation. In a sense, this process short cuts the LMX/safety climate route by providing a direct means through which participation in safety can be achieved. The model concludes with the relationship between the predictor variables, LMX, safety climate, participation and compliance and the outcome variables, near miss/accident involvement.

Figure 8: Functional Model

The first and most basic research questions to be answered in this study concern the relationship between safety climate and the measures of safety performance, near miss/accident involvement. As detailed in Chapter 1, researchers have attempted to link these constructs with a varying degree of success for a number of year so findings in this area would be of significance to the general safety climate debate. As such, the following research questions can be proposed:

**Research Question 1:** Individuals providing a favourable Safety Climate scores will be less likely to have been involved in a near miss

**Research Question 2:** Individuals providing a favourable Safety Climate scores will be less likely to have been involved in an accident
The first research question concerns the structural stability of the safety climate questionnaire developed by Glendon and Litherland (2001). As this study will be conducted over two measurement points, the following hypothesis can be proposed:

**Hypothesis 1: Safety climate factor structure recorded at measurement point 1 and measurement point 2 will be identical to that obtained by Glendon and Litherland (2001)**

The second and third hypotheses concern the relationship between LMX and the outcome measures used in this study, near miss and accident involvement. These hypotheses look to replicate Hofmann and Morgeson’s findings (1999) regarding the link between LMX and accident involvement.

**Hypothesis 2: Individuals providing a favourable LMX scores will be less likely to have been involved in a near miss**

**Hypothesis 3: Individuals providing a favourable LMX scores will be less likely to have been involved in an accident**

The research questions and hypotheses outlined to this point are intended to establish the basic relationships between predictor and outcome variables. Whilst the functional model detailed above clearly identifies near miss/accident involvement as the outcome variable, a number of other relationships are separable by their identification as variable moderators or mediators. Baron and Kenny (1996) suggest a moderator should be a qualitative or quantitative variable that effects the direction and/or strength of a relationship between an independent or predictor variable and a dependent or criterion variable. This model proposes the relationship between LMX and compliance and participation will be moderated by safety climate. Argument to support this arrangement of variables can be sourced from previous research conducted by Hofmann and Neal and Griffin and was considered in some depth in Chapter 2 of this thesis. Although previous researcher has been able to establish links between LMX and safety climate and between safety climate and compliance/participation, this study represents the first attempt to combine these elements. In order to assess the accuracy of the model and of the prediction of a moderating relationship, the following hypotheses are proposed:
Hypothesis 4: Safety climate will moderate the relationship between LMX and safety compliance

Hypothesis 5: Safety climate will moderate the relationship between LMX and safety participation

Following the prediction of a moderating relationship between LMX, climate, participation and compliance, focus now moves to mediation. Baron and Kenny suggest that a variable may be said to function as a mediator to the extent that it accounts for the relationship between a predictor and the outcome variable. Applying this definition, it is possible to identify participation and compliance as potential mediators of the relationship between LMX and near miss/accident reporting. Mediation can be separated into two categories, partial and full. Full mediation suggests that the relationship between the predictor and outcome variable is wholly accounted for through the mediator pathway. Full mediation is rare in social research (Baron and Kenny 1986) and so the relationship between LMX and near miss/accident performance will be predicted to be partially mediated by compliance and participation.

Hypothesis 6: The relationship between LMX and near miss involvement will be partially mediated by safety compliance

Hypothesis 7: The relationship between LMX and near miss involvement will be partially mediated by safety participation

Hypothesis 8: The relationship between LMX and accident involvement will be partially mediated by safety compliance

Hypothesis 9: The relationship between LMX and accident involvement will be partially mediated by safety participation

The final hypothesis concerns the use of brainstorming to improve levels of participation. This
relates to one of the core aims in this thesis, to provide an effective means through which participation can be introduced at an organizational and individual level.

**Hypothesis 10:** Brainstorming sessions will produce a significant improvement in participation between measurement point 1 and measurement point 2
Methodology

Introduction
This study was designed to test the assumptions made in the model detailed in Figure 8. Study 1 effectively demonstrated the utility and added value of interactive brainstorming as a tool to encourage participation in safety performance improvement through the process of ideation. These findings were then linked into the model structure, derived through the literature review process in Chapters 1 to 3. The final product saw a fully operative model proposed, including LMX, safety climate, participation, compliance and near miss/accident outcome. Study 2 was therefore charged with the effective analysis of this model through the design and delivery of a suitable methodology.

Literature review revealed a large number of studies that had adopted a simple climate measurement methodology. Researchers, such as Zohar (1980), Brown and Holmes (1986) and Dedobbeleer and Beland (1991) used climate questionnaire to capture individual views concerning organizational safety. As time passed, however, methodologies refined and researchers began to broaden their outlook to include climate and other variables, such as job security (Probst and Brubaker 2001), LMX (Hofmann and Morgeson 1999; Hofmann et al 2003) and compliance (Neal et al 2000; Probst and Brubaker 2001). This expansion of climate research raised complex issues concerning the nature of climate as a perceptual, attitudinal or mixed construct (Clarke 2006a), however, research that carefully considered these issues has been successful in the study of operative models of safety climate (Neal and Griffin 2006). Using this research as a template, a study methodology could be proposed.

Study Design
To investigate the relationship between brainstorming and participation, a longitudinal methodology was proposed. Researchers would measure LMX, safety climate, compliance and participation using a self-report questionnaire. Brainstorming sessions would then be arranged to collect ideas for safety improvement. These ideas would be fed to senior management to consider, and their responses communicated back to the workforce. After a reasonable time period, questionnaire would be distributed again and responses collated. This methodology, it was proposed, would allow
the relationship between brainstorming and participation to be investigated, alongside the other variables detailed in the operative model. This study, therefore, was separated into three distinct phases:

**Phase 1:** A questionnaire was designed and distributed to all Aylesbury Vale Waste Department employees. The Corporate Health and Safety Manager ran open sessions to provide support to those employees who faced reading or writing issues. Questionnaire data was collected and collated. This stage was termed Measurement Point 1.

**Phase 2:** Researcher designed a one hour training session to highlight the risks inherent in the waste sector, explain the brainstorming process and allow time to run a single brainstorming session. Courses were rolled out approximately one month after questionnaires had been returned. Session content was approved by Aylesbury Vale and courses ran over a two day period. All waste department employees attended, including loaders, drivers, supervisors and management.

**Phase 3:** Questionnaires were redistributed to employees approximately seven months after the first set and six month since brainstorming sessions. In this time the Health and Safety Commercial Manager had provided feedback from senior management concerning the ideas produced in the interactive sessions. Again, assistance was provided to any employees with reading or writing issues. This stage was termed Measurement Point 2.

This study design had a number of considerations. Primary among these was the period of time to allow between phase 2 and phase 3. Literature review identified a number of repeated measures studies in which safety climate surveys were used. These tended to separate into longitudinal studies (Neal and Griffin 2006; Tharaldsen and Rundmo 2007) and intervention based studies (Probst and Brubaker 2001; Lingard et al 2002). Trending methodologies identified larger gaps between measurement points in longitudinal studies (between one to five years) than in intervention type studies (three to twelve months). As this study was designed around an intervention (e.g. brainstorming sessions) it was decided that a six month gap was sufficient, however, operational requirements pushed this period to over seven months.
A second issue concerns common method variance. Common method variance concerns the amount of unrepresentative covariance shared among variables due to the common method used in their collection (Buckley, Cote and Comstock 1990). The exclusive use of the questionnaire to collect data in this study opened the methodology to accusations of potential common method variance. Studies with similar potential issues (Neal and Griffin 2006) have used a measure of dispositional negative effectivity to control for potential common method issues, however, due to the size of the questionnaire used, this was not possible in this study. Instead, the issue was noted and its potential effect considered in the discussion of results.

**Company**

The study was conducted at Aylesbury Vale District Council Waste Department. This organization was selected for a number of reasons, the foremost being the hazardous nature of refuse collection in the UK. The BOMEL Report, commissioned by the HSE, reported waste sector fatal incident rates of over ten times the national average and overall accident rates of over four times the national average (BOMEL 2004). BOMEL noted most incidents occurred as a result of manual handling and waste sorting tasks, however, serious incidents were normally classified in 'struck by objects' or 'transport related' categories. The risk of vehicle strikes made waste collections the most hazardous occupation in the waste sector (BOMEL 2004). BOMEL argues that the combination of risks associated with the waste sector singles it out as one of the most hazardous occupations in the UK. Whilst it can be classified as hazardous, the waste sector has attracted little safety performance research. Indeed, the main purpose of the BOMEL report was to ascertain the true nature of incident and accident rates rather than detailing routes for improvement. From a research perspective, therefore, the waste sector can be recognized as trailing sectors such as construction, manufacturing or energy. The researcher felt that the immature state of waste sector safety performance research created an ethical imperative for study in this area.

As a whole, Aylesbury Vale District Council employed over 615 core members of staff. The male/female ratio was 48/52 with an average age of 44. Staff turnover was 9% in 2008 and 18% of employees earned over £35,000 per annum. The District Council consisted of 49 councillors, 37 Conservatives, 21 Liberal Democrats and one independent. The Conservative and Liberal Democrats each had a Group Leader, and, due to their majority, the Conservative Group Leader also
served as the District Council Leader. The role of Council Leader retained many of characteristics of a company Chief Executive. As such they were responsible for financial, personnel and health and safety decisions. The District Council Leader was aware of the purpose of this study and agreed to participate in the review of health and safety ideas produced by the waste collections workforce (detailed in phase 2 of the study design). Ideas were considered during Full Council Meetings, which occurred every two months and were chaired by the Chairperson of the Council. At this point, it is important to emphasise that decision making in UK local authority environments is often a lengthy process. Each councillor, including the Group Leaders, were working on a voluntary basis and so had limited time to dedicate to matters other than core policy or statutory issues. In addition, aspects of waste collections were, and remain, highly politicised meaning service levels changes required majority approval before they could be enacted.

In addition to the hazardous nature of refuse collection, Aylesbury Vale were selected as they were able to demonstrate a consistent and positive incident and accident reporting culture. Local authority workers are offered no incentives to reduce accident figures and management at Aylesbury Vale were seen to actively encourage incident reporting. As a result, researchers were able to use self report incident and accident figures as a reliable outcome measures of intervention effectiveness. This study focussed on waste collections operatives and their support staff/management. BOMEL singled out waste collections as the highest risk occupation in the waste sector, due to the combination of organizational, task and individual hazards (BOMEL 2004). In this respect, the participants were ideal for the purposes of this study.

Subjects
Study participants were separable by operative and management categories. Operative staff had responsibility for the physical collection of waste whereas management oversaw the process and were predominantly based in the depot in Aylesbury. Operative personnel could be further divided into loader and driver subcategories.

Loader: responsible for loading waste wheelie bins into trucks. Spend majority of collections round moving from property to property to collect bins and getting into/out of waste trucks
**Driver:** responsible for driving the waste truck and dictating the pace of the collections round. In most teams, drivers were promoted from the loader position and normally took on some informal supervisory responsibilities.

Operative personnel worked in teams of three to four, with one driver and two or three loaders. Aylesbury estimated to have around 115 waste operatives, of which 30-40 were trained drivers.

Management included:

**Supervisor:** responsible for day to day activities of waste collections teams. Based in depot but with good operational knowledge of jobs/environment etc.

**Management:** included specialists (Health and Safety Manager) and more general business managers. Based away from depot but with some operational knowledge of routes and tasks. Charged with the design and delivery of any strategic improvement programmes.

The site had two supervisors and an undetermined number of managers with influence on day to day activities (e.g. Operations, Technical, Health and Safety). Only the Health and Safety Manager took part in this study. The issue of supervision was raised during an initial review of the questionnaire. The Health and Safety Manager explained that, although the identities of the supervisors had been made clear to loaders, some considered their driver to be their informal supervisor. This issue linked with criticisms of the group level approach adopted by some researchers (Zohar 2000; Zohar and Luria 2004; Neal and Griffin 2006) concerning the identification of formal and informal supervisory role models.

As a solution, it was decided to include a question concerning individual perception of supervisor identify. As such the questionnaire asked individuals to circle their main job role (Management/Supervisor/Driver/Loader); following this they were asked ‘Who do you consider to be your supervisor?’ (Management/Supervisor/Driver/Loader). When asked to circle their main job role, measurement point 1 participants replied management (4%) supervisors (3%) driver (40%) and loader (52.5%). Measurement point 2 participants replied driver (43.3%) and loader (56.7%). When asked ‘who do you consider to be your supervisor?’ measurement point 1 participants responded
management (25.7%) supervisors (34.7%) driver (33.7%) and loader (5.9%); measurement point 2 respondents reported management (17.3%) supervisor (44.2%) driver (36.5%) and loader (1%).

Figures for main job roles for measurement points 1 and 2 broadly met expectations, however, responses concerning perceived identity of supervisor confirmed initial concerns. Whilst the official organizational structure suggested loaders and drivers, together constituting 92.5% and 99.3% of total responses, should have perceived their supervisor to be exactly that, responses indicated a spread of perceptions that included management, supervisors and drivers. Drivers polled over 33% of the responses concerning perceived supervision, and, when this is contrasted with the total number of loader responses for measurement points 1 and 2 (52.5% and 56.7% respectively) it becomes clear that a significant number of respondents did not agree with the organizational designation of supervisor roles. It should be emphasized that, at point of completion, the author knows of no other studies that have attempted to investigate individual perceptions of supervisor identity.

The wider research implications of this finding will be considered in more depth in the discussion section of this thesis, however, in the immediate term, these results had implications for the statistical analysis employed in this study. The poor identification of supervisor identity made a group level measurement methodology impossible, as such the LMX scale would have to be employed on a one dimensional level, rather than attempt to second guess who individuals perceive to be their supervisors. In addition, this finding vindicated the decision not to employ a group level scale for the analysis of safety climate.

All subjects were Aylesbury Vale District Council employees or agency staff. When planning the survey, researchers were concerned regarding the number of agency staff and the possible effect this group could have upon the data. Aylesbury were able to reassure researchers that, due to its policy as a local government employer, agency staff were used infrequently to cover staff illness or holidays or during busy periods. As such, the ratio between agency and core staff rarely reduced beyond 1:10. Data were collected at two separate points, measurement point 1 and measurement point 2. Measurement point 1 recorded 101 responses. Measurement point 2 recorded 104 responses. Waste collections staff numbered more than 115 employees; staff were unsure of the
exact figure for both measurement points due to agency numbers at that time. Using the estimate of 115 produced a response rate of 87.82% and 90.43% respectively, although this is excluding management and supervisors who are known to have participated in the first session. Measurement point 1 recorded 100 male and one female respondents whilst measurement point 2 recorded 103 male and one female respondents. Measurement point 1 respondents reported age ranges from 15-65+. The most frequently occurring age range was 25-34. The range from 15-44 accounted for 72.3% of the respondents. Measurement point 2 respondents ranged from 15-64. The most frequently occurring age range was 35-44. The range 15-44 accounted for 79.8% of the respondents.

Due to the constraints placed upon the researcher regarding anonymity, it was not possible to track individual questionnaire responses over the two measurement points. The inability to match individuals reduced the options available to the researcher to make inferences about individual attitude change over time.

**Equipment**

**Room**

Brainstorming sessions were held at the Aylesbury Vale Waste Collections depot. The room used contained tables in a horseshoe arrangement and one white board, used to capture ideas as they were produced. In addition to the brainstorming sessions, participants also completed a questionnaire with the following scales.

**Questionnaire**

The core questionnaire sections, including safety climate, LMX, cohesion and participation were all designed to analyze individual perceptions. A copy of the questionnaire is included in Appendix III of this report. LMX could be described as a group level scale (Zohar 2000) as it studied individual perceptions of supervisor actions and hence separated the organization into ‘workforce’ and ‘supervisor’ groups. Safety climate, cohesion and participation could all be described as individual level scales. As questionnaires were completed by a range of personnel (manager, supervisor, driver, loader) no group level analysis was attempted.
Demographics
Participants were asked for simple demographic information including gender ‘male’ ‘female’ and age ‘15-24’ ‘25-34’ ‘35-44’ ‘45-54’ ‘55-64’ ‘65+'. In addition, respondents indicated job role ‘Management’ ‘Supervisor’ ‘Driver/Crew Leader’ and ‘Other’ and who they considered to be their supervisor using the same scale ‘Management’ ‘Supervisor’ ‘Driver/Crew Leader’ and ‘Other’.

Accident Involvement
Accident involvement was measured using a simple yes/no question ‘have you been involved in an incident/accident in the last three years?’. If respondents answered yes, they moved to the seriousness scale ‘how serious was the this incident/accident?’ with responses ‘no action was taken’ ‘first aid was administered (personally)’ ‘first aid was administered (by team)’ ‘further medical treatment required (at depot)’ and ‘immediate medical assistance required (ambulance)’. In addition, participants were asked ‘have you ever been involved in or seen a work related near miss?’. If respondents answered positively, they moved to the serious scale, details of which are provided above. The accident involvement scale was designed in partnership with Aylesbury Vale for specific use in this study. The first scale draft was supplied to both the Operations and Health and Safety Managers who made a number of changes to ensure the seriousness sub-scale reflected the actions detailed in the accident response training provided to all employees (e.g. no action, personally and team administered first aid, depot medical treatment and immediate medical treatment).

It was decided to include a seriousness scale for near miss involvement to provide a means of assessing individual perceptions of near miss potential.

Safety Climate Scale
This study employed an adapted versions of Glendon and Litherland’s safety climate scale (Glendon and Litherland 2001). To keep the questionnaire manageable, it was decided to only include the items identified as contributory to the six factor structure. This represented 40 items from a total pool of 58. Although Glendon and Litherland’s safety climate scale offered a good match with the requirements of this study, a number of changes were required by both the Health and Safety and Operations Manager at Aylesbury. Both individuals were presented with the 40 item draft and invited to make changes as deemed appropriate. The Operations Manager presented the draft questionnaire to a number of operatives who provided feedback concerning usability/understanding.
As a result of this process, a number of changes were made. These are illustrated in Table 5. Although only six questions remained unaltered, the majority of the items underwent only minor changes mostly to simplify language or improve understanding. For example, question 11 saw the term ‘consequences’ removed and replaced with ‘end results’. In addition, all questions were changed to replace the term ‘workers’ with ‘staff’. This was at the request of the Council who felt the term workers was unsuitable.

As Table 5 illustrates, 6 questions included in Glendon and Litherland’s original questionnaire were not included in this study. Each of these questions was removed at the Council’s request, mainly as they felt they were either unsuitable to the industry (i.e. training includes skills practice for emergencies) or problematic for political reasons (i.e. workers trust the management in this organization). It should be noted that, due to logistical reasons, it was not possible to run a pilot study to measure the significance of the changes made to the original questionnaire developed by Glendon and colleagues. This is a topic that is discussed in more depth as part of the hypotheses testing and discussion of results in later chapters.

All safety climate questionnaire responses were recorded on a five point Likert scale with the terms ‘never’ ‘sometimes’ and ‘always’ located at number one, three and five respectively.

Table 5: Illustration of Questionnaire Differences

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Glendon and Litherland Questionnaire</th>
<th>Study Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety rules are followed even when a job is rushed</td>
<td>Safety rules are followed even when the job is rushed</td>
</tr>
<tr>
<td>2</td>
<td>Safety rules can be followed without conflicting with work practices</td>
<td>Safety rules can be followed without getting in the way of the job</td>
</tr>
<tr>
<td>3</td>
<td>Safety rules are always practical</td>
<td>Safety rules and procedures are always practical</td>
</tr>
<tr>
<td>4</td>
<td>Workers can express their views about work problems</td>
<td>Staff can put across their views about work issues</td>
</tr>
<tr>
<td>5</td>
<td>Workers can discuss important policy issues</td>
<td>Staff can discuss important work issues</td>
</tr>
<tr>
<td>6</td>
<td>Workers are spoken to when changes in working practices are suggested</td>
<td>Staff are spoken to when changes in work practices are suggested</td>
</tr>
<tr>
<td>7</td>
<td>Work problems are openly discussed between workers and supervisors</td>
<td>Work problems are openly discussed between staff and supervisors</td>
</tr>
<tr>
<td>8</td>
<td>Changes in working procedures and their effects on safety are effectively communicated to workers</td>
<td>Changes in working procedures and their effects on safety are explained to staff</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>Workers are told when changes are made to the working environment on a job site</td>
<td>Staff are told when changes are made to the working environment</td>
</tr>
<tr>
<td>10</td>
<td>Effective training is provided on skills specific to individual tasks and equipment</td>
<td>Potential risks and end results are identified during training eg route risks such as reversing or blind spots</td>
</tr>
<tr>
<td>11</td>
<td>Potential risks and consequences are identified in training</td>
<td>Arrangements are made so staff are not working by themselves</td>
</tr>
<tr>
<td>12</td>
<td>Training includes effective skills practice for normal work</td>
<td>Training includes skills practice for emergencies</td>
</tr>
<tr>
<td>13</td>
<td>Training is carried out by people with relevant experience</td>
<td>Training is carried out by people with relevant experience</td>
</tr>
<tr>
<td>14</td>
<td>Arrangements are made so workers are not working by themselves</td>
<td>Arrangements are made so staff are not working by themselves</td>
</tr>
<tr>
<td>15</td>
<td>Workers are encouraged to support and look out for each other</td>
<td>Staff are encouraged to support and look out for each other</td>
</tr>
<tr>
<td>16</td>
<td>Company policy is effectively communicated to workers</td>
<td>Council policy is effectively communicated to staff</td>
</tr>
<tr>
<td>17</td>
<td>Workers trust the management in this organization</td>
<td>Management trust the workers in this organization</td>
</tr>
<tr>
<td>18</td>
<td>Management trust the workers in this organization</td>
<td>Management trust the workers in this organization</td>
</tr>
<tr>
<td>19</td>
<td>Workers are confident about their futures with the organization</td>
<td>Staff are confident about their future within the organization</td>
</tr>
<tr>
<td>20</td>
<td>Good working relationships exist in this organisation</td>
<td>Good working relationships exist in this organisation</td>
</tr>
<tr>
<td>21</td>
<td>Morale is good</td>
<td>Morale is good</td>
</tr>
<tr>
<td>22</td>
<td>Workers have enough time to carry out their tasks</td>
<td>Staff have enough time to carry out their tasks</td>
</tr>
<tr>
<td>23</td>
<td>There are enough workers to carry out the required work</td>
<td>There are enough employees to carry out the required work</td>
</tr>
<tr>
<td>24</td>
<td>There is sufficient thinking time to enable workers to plan and carry out their work to an adequate standard</td>
<td>There is sufficient ‘thinking time’ to allow staff to plan and carry out work to a good standard</td>
</tr>
<tr>
<td>25</td>
<td>Problems arising from factors outside of workers’ control can be accommodated without negatively effecting safety</td>
<td>Problems arising from things outside staff control can be dealt with without effecting safety i.e. route changes</td>
</tr>
<tr>
<td>26</td>
<td>Time schedules for completing work projects are realistic</td>
<td>Time allowances for completing work tasks are realistic</td>
</tr>
<tr>
<td>27</td>
<td>Workload is reasonably balanced</td>
<td>Workload is reasonably balanced</td>
</tr>
<tr>
<td>28</td>
<td>Changes in workload which have been made at short notice can be accommodated without negatively effecting safety</td>
<td>Changes in workload which have been made at short notice can be accommodated without negatively effecting safety</td>
</tr>
<tr>
<td>29</td>
<td>Personal protective equipment use is enforced</td>
<td>PPE use is enforced</td>
</tr>
<tr>
<td>30</td>
<td>Relevant workers are specifically trained in the use of emergency personal protective equipment</td>
<td>Relevant workers are specifically trained in the use of emergency personal protective equipment</td>
</tr>
<tr>
<td>31</td>
<td>Personal protective equipment users are consulted for suggested design improvement</td>
<td>PPE users are asked for suggested design improvements e.g. new boots</td>
</tr>
<tr>
<td>32</td>
<td>Personal protective equipment use is monitored to identify problem areas</td>
<td>PPE use is monitored to identify problem areas e.g. uncomfortable boots</td>
</tr>
<tr>
<td>33</td>
<td>Findings from personal protective equipment monitoring are acted upon</td>
<td>Findings from PPE monitoring are acted upon</td>
</tr>
<tr>
<td>34</td>
<td>Workers can easily identify the relevant procedure for each job</td>
<td>Staff can easily identify the right procedure for each job</td>
</tr>
<tr>
<td>35</td>
<td>An effective documentation management system ensures the availability of procedures</td>
<td>An effective documentation management system ensures the availability of procedures</td>
</tr>
<tr>
<td>36</td>
<td>Work procedures are technically accurate</td>
<td>Work procedures reflect the job</td>
</tr>
<tr>
<td>37</td>
<td>PPE use is enforced</td>
<td>Work procedures reflect the job</td>
</tr>
</tbody>
</table>
Compliance and Participation Scale
Compliance and participation scales were sourced directly from Neal and colleagues (2000; 2006) with no alterations. Compliance items included 'I use all the necessary safety equipment to do my job' 'I use the correct safety procedures for carrying out my job' 'I make sure of the highest levels of safety when I carry out my job'. Participation items included 'I support the health and safety rules within the organization' 'I put in the extra effort to improve the safety of the workplace' 'I voluntarily carry out tasks or activities that help improve workplace safety'. Both compliance and participation responses were recorded using a five point Likert scale with 'strongly disagree' 'disagree' 'neither' 'agree' and 'strongly agree' located at point one, two, three, four and five respectively.

Qualitative Feedback Items
Participants were able to provide qualitative feedback to a number of open questions intended to investigate identification of risk, barriers to safe working and potential routes to improvement. Questions included ‘What are the biggest risks to your day to day safety at work?’, ‘Can you think of anything that stops you doing your work safely?’ and ‘Can you think of any improvements that could be made that would help you do your job safely?'

LMX Scale
The Leader-Member Exchange scale was sourced directly from Graen and Uhl-Bien, whose extensive research produced the industry standard LMX-7 scale (Graen and Uhl-Bien 1995). Although this scale offered a good match for study requirements, it was necessary to make a number of changes to ensure a good level of participant understanding. These changes are detailed in Table 6. Changes were minor in nature, the most significant being the switch from the term ‘leader’ to ‘supervisor’. Other changes concerned simplification of language to improve understanding, for
example ‘characterize’ to ‘describe’. The requirement for change was detailed by the Operations and Health and Safety Managers, in partnership with a number of waste operatives.

Table 6: LMX Scale Alterations

<table>
<thead>
<tr>
<th>Graen and Uhl-Bien (1995)</th>
<th>Study Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you know where you stand with your leader...do you usually know how satisfied your leader is with what you do?</td>
<td>Do you know where you stand with your supervisor...do you usually know how happy your supervisor is with the work you do?</td>
</tr>
<tr>
<td>How well does your leader understand your job problems and needs?</td>
<td>How well does your supervisor understand your job problems and needs?</td>
</tr>
<tr>
<td>How well does your leader recognize your potential?</td>
<td>How well does your supervisor recognize your potential?</td>
</tr>
<tr>
<td>Regardless of how much formal authority he/she has built into his/her position, what are the chances that your leader would use his/her power to help you solve problems in your work?</td>
<td>What are the chances that your supervisor would use their power to help you solve problems at work?</td>
</tr>
<tr>
<td>Again, regardless of the amount of formal authority your leader has, what are the chances that he/she would ‘bail you out’ at his/her expense</td>
<td>What are the chances that your supervisor would ‘bail you out’ at his/her expense if you had a problem?</td>
</tr>
<tr>
<td>I have enough confidence in my leader that I would defend and justify his/her decision if he/she were not present to do so?</td>
<td>I have enough confidence in my supervisor that I would defend and give reasons for his/her decision if they were not present to do so</td>
</tr>
<tr>
<td>How would you characterize your working relationship with your leader?</td>
<td>How would you describe your working relationship with your supervisor?</td>
</tr>
</tbody>
</table>

The LMX-7 scale was designed to be used in two sections, workforce and leaders. Questions are altered slightly to reflect this change i.e. ‘how well does your leader recognize your potential?’ Is changed to ‘how well do you recognize potential?’ In this study it was decided to use only the workforce element of the LMX scale (e.g. one half of the dyad). This decision was mainly due to the issue of supervisory role variation detailed earlier (e.g. drivers assuming informal supervisory responsibilities) and the issue this may have presented when attempting to create dyadic sets for analysis. Single dimension analysis using the LMX-7 scale was identified as commonplace, with a number of published articles detailing the same methodology (Dunegan et al 1992; Dunegam et al 2002; Hofmann et al 2003; Michael et al 2006). Indeed, such was the prevalence of the single dimension approach it raised questions concerning the operability of dyadic investigation in organizational settings. It was therefore decided to capture perceptions of supervisory roles as part of the questionnaire and record only one dimension of the LMX scale.
A complete copy of the questionnaire is included in Appendix III.

**Procedure**
This study was conducted in three phases.

**Phase 1: Distribution of questionnaires (Measurement Point 1)**
Questionnaires were distributed before collections rounds on 7th April and the 11th April, 2008. On each occasion, work teams were invited into the depot meeting room and asked to complete a questionnaire; individuals who did not want to participate were able to leave if they wished. A facilitator was present to read through the front page of the questionnaire, provide assurances regarding anonymity and assist those with reading or writing difficulties. Participants were given as much time as was needed to complete the questionnaire, and, when finished, were instructed to place them in envelopes provided and seal them. Completed questionnaires were sent directly to the researcher.

**Phase 2: Brainstorming sessions**
Brainstorming sessions ran on the 28th April and 1st May 2008. Participants entered the meeting room in mixed work teams. The facilitator introduced themselves and explained the purpose of the session. A short presentation explained the risks inherent in the waste sector and employees were invited to compare their occupation with other perceived high risk jobs (e.g. offshore worker, chemist, nuclear technician). A majority of participants failed to correctly identify their role as one of the highest risk occupations in the UK. Once this exercise had been completed, the facilitator explained they were going to be given the opportunity to identify ideas intended to improve their company’s health and safety performance. The following statement was then read out:

‘Aylesbury Vale District Council is committed to the reduction of accidents and incidents across its range of activities. Waste collections and handling is recognized to be one of the most hazardous activities. Your task in this session is to use your knowledge and experience to brainstorm ideas to that could prevent people getting hurt’

The facilitator then introduced the concept of brainstorming and explained the four brainstorming rules:
1. As many ideas as possible
2. No criticism
3. Crazy ideas welcome
4. Freewheeling to be encouraged

If participants had no further questions, the session began. As the session progressed, the facilitator provided encouragement and asked for clarification on any ambiguous ideas. As the rate of idea production slowed, the facilitator provided three opportunities for participants to contribute further ideas before announcing the session to be complete. An opportunity was provided for participant feedback and the facilitator distributed contact details to allow direct contact in the event of questions or queries once the session had been completed. At the end of the session it was clearly explained that these ideas would go forward to the Council who would provide feedback concerning their potential implementation.

Once the ideas had been collected and collated, they were distributed to the Health and Safety Corporate Manager at Aylesbury Vale District Council, who presented them to the governing council. The governing council considered the impact/benefit of each suitable idea and provided feedback concerning its likely adoption. The Health and Safety Corporate Manager then arranged 11 feedback sessions with depot staff to present the feedback and explain what changes were going to be made. These sessions occurred from the 3rd September to the 7th November 2008.

**Phase 3: Redistribution of questionnaires (Measurement Point 2)**
Questionnaires were redistributed to employees during sessions held on the 2nd, 3rd, 5th, 8th and the 10th December 2008. Employees were invited into the meeting room and were asked to complete the questionnaire. Those who did not wish to participate were able to leave. The facilitator explained the questionnaire was going to be used to assess how perceptions had developed over the last eight months. Assurances were made concerning confidentiality and assistance was provided for those with reading or writing difficulties. Participants were given as much time as needed to complete the questionnaire. Once completed, participants were provided with envelopes
and were instructed to place the questionnaires in the envelopes and seal them. The facilitator then collected the envelopes and the session was complete.

**Analysis Techniques**
The hypotheses detailed in the Defining the Research Model section of Chapter 5 predicted moderating and mediating relationships between variables. Before the results can be presented, it is important to explain the nature of these relationships and the means by which they can be analyzed. This section details definitions for both moderating and mediating hypotheses plus a summary of the measurement techniques employed. The moderation information is relevant to hypotheses six and seven whilst the mediation information is relevant to hypotheses eight through to 11.

**Moderation**
As detailed previously, Baron and Kenny describe a moderator as a variable that effects the direction and/or strength of the relation between and independent or predictor variable and a dependent or criterion variable. These pathways can be best illustrated, as follows:

![Figure 9: An Illustration of Moderation](image)

1. Predictor or Independent Variable (LMX) - Outcome (compliance) (a)
2. Moderator (safety climate) - Outcome (compliance) (b)
3. [Predictor (LMX) x Moderator (safety climate)] - Outcome (compliance) (c)
When a test for moderation is run, the main effects of the predictor and moderator on the outcome variable plus the interaction between the predictor and moderator are analyzed. Baron and Kenny suggest the moderating hypothesis can be accepted if path three, termed the interaction path, is significant. Whilst there may be significance in pathways 1 and 2, these are not directly relevant to the moderator hypothesis.

**Mediation**

Mediation concerns the relationship between three variables, the Predictor (or IV), the Outcome (or DV) and the proposed Mediator. Mediation is often represented using the following diagram:

![Diagram of Mediation](image)

In simple terms, mediation describes a process in which two causal paths feed into the outcome variable, represented here by b and c, whilst a causal path, identified as a, exists between the independent variable and the proposed mediator (Baron and Kenny 1986). Although it is possible to have full mediation, in which all the change in the outcome variable is accounted for through the a-b causal pathway, most social research looks to find partial or significant mediation in which change in the outcome variable is seen to be shared between the a-b and c pathways.

Baron and Kenny (1996) describe the test for mediation using regression as follows. First, regress the mediator on the independent variable; second, regress the dependent variable on the independent variable; and, third, regress the dependent variable on the independent variable and on the mediator. For the hypothesis of mediation to hold, the following conditions must be found. First, the independent variable must effect the mediator in the first equation; second, the independent variable must be shown to effect the dependent variable in the second equation; and, third, the mediator must be effect the dependent variable in the third equation. If all these conditions all hold in the predicted direction, then the effect of the independent variable on the dependent variable must
be less in the third equation than in the second. Perfect mediation holds if the independent variable has no effect when the mediator is controlled.

Baron and Kenny’s technique was intended for use with continuous variables, however, some researchers attempted to apply the same techniques for the assessment of dichotomous variables, either mediators or outcomes. Issues with this application were identified by MacKinnon and Dwyer (1993) who argued that scale differences between DV and mediating variables could cause inaccuracies in the mediation analysis. To counter these inaccuracies, MacKinnon and Dwyer suggested an alteration to the mediation equation that separated those coefficients and variables with categorical scales from those with continuous scales.

Following this, the next step is to make the coefficients comparable across the equations. This is achieved by multiplying each coefficient with the standard deviation of the predictor variable and then dividing by the standard deviation of the outcome variable. Logistic regression, where appropriate, is then conducted, however, this only provided a raw test for mediation. To obtain a p figure for the probability of mediation, it is necessary to carry out the Sobel test (Sobel 1982; Baron and Kenny 1986). The Sobel test uses the following data:

\[ a = \text{raw (unstandardized) regression coefficient for the association between the independent variable and the mediator} \]
\[ S_a = \text{the standard error of } a \]
\[ b = \text{raw coefficient for the association between the mediator and the dependent variable (when the independent variable is also a predictor of the dependent variable)} \]
\[ S_b = \text{the standard error of } b \]

For the purposes of this thesis, SPSS was used for the following steps:

Step 1. Calculate the standard deviations of the independent variable, mediator and outcome
Step 2: Multiple each coefficient with the standard deviation of the predictor variable then divide by the standard deviation of the outcome variable
Step 2: Correlate the independent variable with the mediator variable
Step 3: Run Logistic or Standard Regression depending upon the data type to obtain $a$, $b$, $c$ and $c'$ variables plus their standard errors.

This information was then fed into a spreadsheet developed by Herr (http://nrherr.bol.ucla.edu/Mediation/logmed.html) that generated:

- comp a (standard error compa)
- comp b (standard error compb)

These figures were then fed into an online Sobel calculator (http://www.people.ku.edu/~preacher/sobel/sobel.htm) that produced p-values drawn from the unit normal distribution under the assumptions of a two-tailed z-test that the mediated effects equal zero in the population. Put simply, Sobel calculates the critical ratio as a test of whether the indirect effect of the independent variable on the dependent variable, via the mediator, is significantly different from zero. This study used the Sobel Aroian test, as popularized by Baron and Kenny (1986), as it did not assume that the product of $S_a$ and $S_b$ was vanishingly small and so was less likely to yield a negative variance estimate (Preacher and Hayes 2004). It should be emphasized that care should be taken when considering the p-value of the Sobel Aroian test, as significance indicates the likelihood that mediation effects equal zero (e.g. there is no mediation). As each hypothesis is testing for partial mediation, the reader is in the counter intuitive position of searching for non-significance to confirm the mediation hypothesis.

As a final note, Preacher and Leonardelli warn of the potential pitfalls using the Sobel test in small samples. As an alternative, they suggest bootstrapping as it imposes no distributional assumptions, however, this technique is not suitable for the logistic data set used in this study. It is possible that smoothed bootstrapping could be applied (Simonoff 1996), however, no research has supported this technique as a means of assessing mediation. As a result, it was decided to continue with the Sobel analysis with the proviso that the sample size used would require attention in any future studies.
In terms of presentation, the data used to test each hypothesis will be detailed. This, coupled with the links provided above is sufficient to allow researchers to replicate the analysis and so test the assumptions and therefore the findings made.
Main Study Results

Software information
All data were analyzed using SPSS (version 17) for Macintosh (OSX version 10.4.11).

Data

Normality
The response pattern for each item in the safety climate, LMX, compliance and participation scales was analyzed using histograms. Results indicated a slight negative skew, although this was not significant and reflected a similar pattern detected by the scale authors (Glendon and Litherland 2001). The identification of skewed distributions in safety climate data is not a new phenomenon. In their efforts to create a new safety climate scale, Williamson et al (1997) detected highly skewed distributions, prompting the removal of a number of items. These items tended to focus on safety responsibility and priority as well as management commitment (Williamson et al 1997). In addition, Williamson et al noted a particular tendency towards a skewed distribution for perceptual/reality based items, similar to those used in this study (Williamson et al 1997). None of the questions displayed significant kurtosis. A review of literature revealed a number of reviews in which safety culture and climate data was treated as normal (Lee and Harrison 2000; Glendon and Litherland 2001; Cabrera et al 2007; Tharaldsen et al 2007). As such, the data was treated as normal and, as such, parametric tests were selected.

Treatment of Scales
Although Glendon and Litherland (2001) were able to provide evidence of a stable factorial distribution for the questionnaire used in this investigation, these findings were not replicated in this study (detailed in hypothesis 1). As a result, the safety climate scale will be treated as a single scale in the following section. Later chapters will discuss the meaning of the single factorial distribution and the implications for future research.

Scale Reliability
Table 7 provides scale reliability Cronbach’s Alpha figures for measurement point 1 and 2. These figures have been provided for safety climate, compliance, participation and LMX scales.
**Table 7:** Cronbach's Alpha

<table>
<thead>
<tr>
<th>Measure</th>
<th>Measurement Point 1</th>
<th>Measurement Point 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Climate</td>
<td>0.94</td>
<td>0.95</td>
</tr>
<tr>
<td>Compliance</td>
<td>0.92</td>
<td>0.92</td>
</tr>
<tr>
<td>Participation</td>
<td>0.82</td>
<td>0.88</td>
</tr>
<tr>
<td>LMX</td>
<td>0.89</td>
<td>0.94</td>
</tr>
</tbody>
</table>

**Correlation**

Table 8 provides details of correlation between safety climate, compliance, participation, LMX, accident and near miss involvement. Safety climate, compliance, participation and LMX were correlated used a standard bi-variate Pearson technique whereas accident and near miss involvement were correlated using a point bi-serial technique.

**Table 8:** Mean, Standard Deviation and Correlations for Measurement Point 1

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Safety Climate</td>
<td>3.65</td>
<td>0.64</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Compliance</td>
<td>4.36</td>
<td>0.72</td>
<td>.556**</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Participation</td>
<td>4.02</td>
<td>0.72</td>
<td>.589**</td>
<td>.724**</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. LMX Mean</td>
<td>3.18</td>
<td>0.85</td>
<td>.571**</td>
<td>.326**</td>
<td>.304**</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Accident Involvement</td>
<td>---</td>
<td>---</td>
<td>.323**</td>
<td>.213*</td>
<td>0.178</td>
<td>.259**</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>6. Near Miss Involvement</td>
<td>---</td>
<td>---</td>
<td>.227*</td>
<td>.249*</td>
<td>0.039</td>
<td>0.16</td>
<td>.253*</td>
<td>---</td>
</tr>
</tbody>
</table>

**Table 9:** Mean, Standard Deviation and Correlations for Measurement Point 2

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Safety Climate</td>
<td>3.62</td>
<td>0.64</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Compliance</td>
<td>4.39</td>
<td>0.76</td>
<td>.585**</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Participation</td>
<td>4.00</td>
<td>0.90</td>
<td>.611**</td>
<td>.788**</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. LMX Mean</td>
<td>3.18</td>
<td>0.93</td>
<td>.387**</td>
<td>.341**</td>
<td>.347**</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Accident Involvement</td>
<td>---</td>
<td>---</td>
<td>0.143</td>
<td>0.095</td>
<td>0.054</td>
<td>.280**</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>6. Near Miss Involvement</td>
<td>---</td>
<td>---</td>
<td>0.174</td>
<td>0.034</td>
<td>0.036</td>
<td>.280**</td>
<td>.267**</td>
<td>---</td>
</tr>
</tbody>
</table>

* *significant at .05  ** significant at .01

bold typeface = point bi-serial correlation
**Accident and Near Miss Data**

When asked ‘Have you been involved in an accident in the last 3 years?’ 30.7% of measurement point 1 respondents replied ‘Yes’ and 69.3% responded ‘No’. For measurement point 2, 27.9% respondent ‘Yes’ and 72.1% responded ‘No’. When asked ‘Have you been involved in or seen a work related near miss’, 33.7% of respondents at measurement point 1 replied ‘Yes’, whereas 66.3% responded ‘No’. For measurement point 2, 31.7% replied ‘Yes’ and 68.3% replied ‘No’. It is possible to conclude that, given the relatively stable sample size for measurement points 1 and 2, roughly a third of respondents had been involved in an accident or near miss in the last three years. The size of this sample for both accident and near miss conditions was regarded as significant and therefore suitable for statistical analysis, however, it should be noted that the accident and near miss ‘involved’ population was relatively high when contrasted with comparative studies. For example, Zohar (2000) detected a micro-accident involvement rate of around 20%, however, this study was conducted at the team level in a military environment and relied upon records kept by occupational nurses. Additionally, the measurement period was five months, reducing the time in which the samples could become accident or near miss exposed (Zohar 2000).

It is possible to explain the relatively high accident and near miss involvement data collected in this study through two routes (a) the refuse collection industry has a high accident rate relative to other industries - a theory supported by the BOMEL report, commissioned by the HSE, and (b) the extended accident and near miss reporting time boosted involvement figures. It is possible to conclude, therefore, that a three year reporting period produced a good sample size and so improved confidence in the statistical analysis of this sample. It did, however, also present a number of methodological issues and it is these that are discussed in the study limitations section of the Discussion chapter.

**Notable Results**

When asked to circle their main job role, measurement point 1 participants replied management (4%) supervisors (3%) driver/crew leader (40%) and loader (52.5%). Measurement point 2 participants replied driver/crew leader (43.3%) and loader (56.7%). When asked ‘who do you consider to be your supervisor?’ measurement point 1 participants responded management (25.7%) supervisors (34.7%) driver (33.7%) and loader (5.9%); measurement point 2 respondents reported management (17.3%) supervisor (44.2%) driver (36.5%) and loader (1%). These figures reinforce the decision to run the
LMX at a one dimensional level rather than attempt to second guess who individuals perceive to be their supervisors.
Hypotheses

Research Question 1: Individuals providing a favourable Safety Climate scores will be less likely to have been involved in a near miss

Mean safety climate scores for those individuals who reported involvement in a near miss were compared with those who had reported no near miss involvement. This process was repeated for measurements points 1 and 2. For measurement point 1, participants who confirmed near miss involvement reported a lower mean safety climate score (M=3.45 SE=0.10) than those who reported no near miss involvement (M=3.76 SE=0.08), t(99)=-2.32, P<.05. For measurement point 2, participants who confirmed near miss involvement reported a lower mean safety climate score (M=3.46 SE=0.11) than those who reported no near miss involvement (M=3.70 SE=0.07), t(102)=-1.78, P>.05. This provides partial support for research question 1.

Research Question 2: Individuals providing a favourable Safety Climate scores will be less likely to have been involved in an accident

Mean safety climate scores for those individuals who reported involvement in an accident were compared with those who had reported no accident involvement for measurement points 1 and 2 using an independent samples t-test. For measurement point 1, participants who confirmed accident involvement reported a lower mean safety climate score (M=3.34 SE=0.13) than those who reported no accident involvement (M=3.79 SE=0.07), t(99)=-3.40, P<.05. For measurement point 2, participants who reported accident involvement reported a lower mean safety climate score (M=3.48 SE=0.12) than those who reported no accident involvement (M=3.68 SE=0.07), t(102)=-1.46, P>.05. This provides partial support for research question 2.

These results indicated a trend for lower safety climate scores relative to accident or near miss involvement. Significantly lower mean safety climate scores were recorded for those reported accident involvement when compared to those who did not. The overall trend and significance detected provide good evidence of a relationship between low safety climate scores and self report accident and near miss involvement. This relationship has been detected in a number of other studies, however, questions remains regarding the meaning of these findings. Whilst it is possible that safety climate has acted as an antecedent to behaviour, a context that encouraged individuals to gage their behaviour in ways that favored a positive safety outcomes, it is also possible that accident
involvement and the subsequent inaction of the organization influenced the individuals perceptions of safety. This reverse causation hypothesis was considered in the literature review and will feature in the discussion of these results.

**Hypothesis 1:** Safety climate factor structure recorded at measurement point 1 and measurement point 2 will be identical to that obtained by Glendon and Litherland (2001)

Glendon and Litherland produced a six factor safety climate structure that accounted for 69.2% of the variance in their safety climate measure (reduced to 32 items). Their factors were detailed as follows:

- Factor 1 - Communication and Support
- Factor 2 - Adequacy of Procedures
- Factor 3 - Work Pressures
- Factor 4 - Personal Protective Equipment
- Factor 5 - Relationships
- Factor 6 - Safety Rules

(Glendon and Litherland 2001)

The 32 item scale was amended to suit the purposes of this study. As a number of changes had been made to some scale items, researchers elected to first perform a principal components analysis. Principal axis factoring assumes the sample used is the population and so results can not be extrapolated beyond the particular sample. Conclusions, therefore, would be restricted to this to the samples collected. Field suggested a minimum sample size of 300 cases for factor analysis (Field 2009), however, a number of researchers have focussed instead upon case-to-variable ratio as a measure of data set suitability. Glendon and Litherland (2001) published with a ratio of 5:1, although ratios as low as 2:1 have been used (Kline 1994). The case-to-variable ratio for measurement point 1 was 3.1:1 and 3.25:1 for measurement point 2.

**Measurement Point 1**

A principal axis factor analysis was conducting on the 32 items with direct oblimin rotation. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO=.87 ('great'
according to Field 2009), however, the KMO value for item nine ‘safety rules are followed, even when the job is rushed’ was found to be .47 and so below the minimum recommendation (Field, 2009). When item nine was removed, all individual KMO values were found to be above .73 hence the analysis was run with 31 items. Bartlett’s test of sphericity Chi-Square (465)=1945.85, p<.001, indicated that correlations between items were sufficiently large for principal axis factoring. An initial analysis was run to obtain eigenvalues for each component of the data. Seven components had eigenvalues over Kaiser’s criterion of 1 and in combination explained 68.97% of the variance. The scree plot, included in figure 11, was clear showing a point of inflexion that would just justify retaining only factor 1. Given the limited sample size, the clear convergence on the scree plot and the weak eigenvalues for all but one factor, it was concluded there was little evidence for a factorial model of the safety climate items. This opinion was confirmed when Oblimin rotation failed to converge after the maximum number of rotations.

Figure 11: Scree Plot - Measurement Point 1
Measurement Point 2

A principal axis factor analysis was conducted on the 32 items with direct oblimin rotation. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO=.87 (‘great’ according to Field 2009). All individual KMO values were found to be above .71 meeting recognized expectations (Field 2009). Bartlett’s test of sphericity Chi-Square (496)=2223.59, p<.001, indicated that the correlations between items were sufficiently large for principal axis factoring. An initial analysis was run to obtain eigenvalues for each component of the data. Eight components had eigenvalues of over Kaiser’s criterion of 1 and in combination explained 72.47% of the variance. The scree plot, included in Figure 12 was clear showing a point of inflexion that would justify retaining only one factor. Oblimin rotation with Kaiser Normalization produced a broad pattern matrix with little to support the identification of more than one factor.

Figure 12: Scree plot - Measurement point 2
The results of the principal component analysis for measurement points 1 and 2 point to a single factor structure. The researcher considered confirmational factor analysis to further analyze the factorial relationships, however, a review of literature indicated the sample sizes for each measurement point were below the minimum accepted standard of 300 or more for this technique (Field 2009). Although it was not possible to conduct a confirmational factor analysis, the categorical nature of the principal component analysis findings for both measurement points 1 and 2 supported the rejection of hypothesis 1.

**Hypothesis 2: Individuals providing a favourable LMX scores will be less likely to have been involved in a near miss**

Mean LMX score for those individuals who reported near miss involvement were compared with those who had reported no near miss involvement using an independent samples t-test. This process was repeated for measurement points 1 and 2. For measurement point 1, participants who confirm near miss involvement reported a lower mean LMX score (M=2.99 SE=0.14) than those who reported no near miss involvement (M=3.28 SE=0.1), t(99)=-1.61, P>.05. For measurement point 2, participants who confirmed near miss involvement reported a lower mean LMX score (M=2.86 SE=0.14) than those who reported no near miss involvement (M=3.32 SE=0.11), t(102)=-2.43, P<.05. This provides partial support for hypothesis 2.

**Hypothesis 3: Individuals providing a favourable LMX scores will be less likely to have been involved in an accident**

Mean LMX scores for those individuals who reported accident involvement were compared with those who had reported no accident involvement using an independent samples t-test. This process was repeated for measurement points 1 and 2. For measurement point 1, individuals who confirmed accident involvement reported a lower mean LMX score (M=2.85 SE=0.15) than those who reported no accident involvement (M=3.32 SE=0.10), t(99)=-2.67, P<.05. For measurement point 2, participants who confirmed accident involvement reported a lower mean LMX score (M=2.76 SE=0.16) than those who reported no accident involvement (M3.33 SE=0.11), t(102)=2.95, P<.05. This provides full support for hypothesis 3.
Hypothesis 4: Safety climate will moderate the relationship between LMX and safety compliance

Before regression analysis could be conducted, the case-to-variable ratio for both measurement points had to be calculated. Measurement point 1 produced 101 respondents, giving a case to variable ratio of 50:1; measurement point 2 produced 104 respondents, giving a case to variable ratio of 52:1 - both could be considered adequate for multiple regression (Hair, Anderson, Tatham and Black 1998). None of the variables violated the assumptions for the analysis and no outliers were found. A linear data relationship was assumed. Moderation was analyzed using an established stepwise technique detailed by Baron and Kenny (1986).

Baron and Kenny present a number of appropriate means by which moderating hypotheses can be tested depending upon the nature of the variables used. In this case, both variables were continuous and it was assumed that the effects of the independent variable (LMX - denoted as X) on the dependent variable (compliance - denoted as Y) varied linearly. For the purposes of this example, the moderator (safety climate) was denoted Z. With these assumptions established, Baron and Kenny recommend that Y is regressed on X, Z and XZ respectively. Moderator effects were indicated by the significant effects of XZ whist X and Z are controlled.

Before moderation could be assessed, the independent variable (LMX) and proposed moderating variable (safety climate) had to be ‘centred’. A centred variable is the product of the original variable minus the variable mean - this produces a variable with a mean of a zero. A number of researchers assert that centring helps to prevent multicollinearity effects (Aiken and West, 1991; Frazier, Tix and Barron 2004) and therefore improves confidence in findings. Variables were centred using an automated SPSS script.

Once centred, moderating effects were tested using the stepwise technique detailed by Baron and Kenny (1986). Results, including B, SE B, Beta and $R^2$ figures for measurement points 1 and 2 are included below.
Table 10: Hierarchal Regression testing for Moderation

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Step 1</th>
<th>B</th>
<th>Standard Error Beta</th>
<th>Beta</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>Compliance (constant)</td>
<td>4.360</td>
<td>0.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point 1</td>
<td>LMX Mean</td>
<td>0.010</td>
<td>0.090</td>
<td>0.010</td>
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<tr>
<td></td>
<td>Safety Climate Mean</td>
<td>0.619</td>
<td>0.110</td>
<td>.548***</td>
<td>0.300</td>
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<tr>
<td></td>
<td>Step 2</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compliance (constant)</td>
<td>4.428</td>
<td>0.067</td>
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<td>LMX Mean</td>
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<td>0.085</td>
<td>0.004</td>
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<tr>
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<td>0.583</td>
<td>0.114</td>
<td>0.517***</td>
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</tr>
<tr>
<td></td>
<td>LMX Mean x Safety Climate Mean</td>
<td>-0.220</td>
<td>0.101</td>
<td>-.183*</td>
<td>0.340</td>
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<td>Measurement</td>
<td>Step 1</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Point 2</td>
<td>Compliance (constant)</td>
<td>4.391</td>
<td>0.060</td>
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<td>LMX Mean</td>
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<td>0.071</td>
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<td></td>
<td>Safety Climate Mean</td>
<td>0.629</td>
<td>0.102</td>
<td>.533***</td>
<td>0.350</td>
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<td></td>
<td>Step 2</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compliance (constant)</td>
<td>4.439</td>
<td>0.062</td>
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<tr>
<td></td>
<td>LMX Mean</td>
<td>0.112</td>
<td>0.069</td>
<td>0.137</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety Climate Mean</td>
<td>0.610</td>
<td>0.100</td>
<td>.518***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LMX Mean x Safety Climate Mean</td>
<td>-0.208</td>
<td>0.089</td>
<td>-.182**</td>
<td>0.391</td>
</tr>
</tbody>
</table>

Note: *p< .05  **p< .01  ***p< .001

Results for measurement points 1 and 2 present a similar picture. As Baron and Kenny suggested, the significance of the beta values in step 1 can be dismissed as it is the significance of the combinatorial value in step 2 that provides support for the moderating hypothesis. Interpretation of the results can be separated by measurement points:

**Measurement point 1**
The standardized beta value (-.183) for the interaction term (LMX x safety climate) was significant at the .05 level (p=.032) meaning significant support for the moderating hypothesis. This result indicated that an increase in compliance by one standard deviation would produce a reduction in the interaction term by -.183 standard deviations. The $R^2$ change associated with the interaction term was .341 for measurement point 1 meaning the interaction between LMX and safety climate explained 34.1% of the variance in compliance scores an increase of 3.2% above the 30.9% explained by the first order effects of LMX and safety climate alone.

To understand the form of the interaction, it was necessary to explore it further. One means of doing this recommended by Cohen, Cohen, West and Aiken (2003) was to plot a graph of the IV (LMX) on the x-axis and DV (compliance) on the y-axis. The moderator (safety climate) was added to this at low (-1 SD from mean) and high (1SD from mean) values. This provides a visual indication of relationship direction, detailed in Figure 13. Results indicated that high LMX relationships were associated with higher compliance levels in low safety climate environments. This effect was found to be reversed for more positive safety climate environments in which the highest level of compliance was reported alongside low LMX relationships. Overall, high climate environments were associated with higher levels of compliance.

Figure 13: LMX, Compliance and Safety Climate - Measurement Point 1
Measurement point 2

The standardized beta value for the interaction term (-.182) provided stronger support for the moderating hypothesis (p=.022) than measurement point 1. An increase in compliance by one standard deviation would produce a reduction in the interaction values of LMX x Safety Climate by -0.183 standard deviations. The $R^2$ change associated with the interaction term was .391 meaning the interaction between LMX and safety climate explained 39.1% of the variance in compliance scores, an increase of 3.3% above the 35.8% explained by the first order effects of LMX and safety climate alone.

These results are displayed graphically using best practice detailed by Cohen et al (2003). Figure 14 indicates that high LMX levels were associated with high compliance levels in low safety climate conditions. The relationship between compliance and LMX was found to be negligible in more positive safety climate conditions. Overall, more positive safety climates were associated with higher levels of compliance than low climate conditions.

Figure 14: LMX, Compliance and Safety Climate - Measurement Point 2
Summary
Overall, the significance of the standardized beta values for the interactive terms at measurement points 1 and 2 provide support the moderating hypothesis, however, analysis of directionality produced some interesting questions. Whilst more positive safety climates were found to be associated with high compliance levels, LMX was found to only positively influence in low safety climate condition with this effect reversing or becoming negligible in more positive safety climates. In essence, in positive safety climate, good relationships with perceived supervisors were associated with reduced compliance relative to poor relationships. Implications will be covered in the discussion section of this thesis.

Hypothesis 5: Safety climate will moderate the relationship between LMX and safety participation
Before a test for moderation could be undertaken, the case to variable ratios had to be calculated. Case to variable ratios remained unchanged at 50:1 and 52:1 for measurement points 1 and 2 respectively. Data assumptions were acceptable for multiple regression and no outliers were found. Moderation was again tested using the technique developed by Baron and Kenny (1986) and previously applied to test hypothesis 4. The only changes concerned the designation of the regression elements e.g.

1. Predictor (LMX) - Outcome (participation)
2. Moderator (safety climate) - Outcome (participation)
3. [Predictor (LMX) x Moderator (safety climate)] - Outcome (participation)

In this case, both variables were continuous and it was assumed that the effects of the independent variable (LMX - denoted as X) on the dependent variable (participation - denoted as Y varied linearly. For the purposes of this example, the moderator was denoted as Z. As previously, Y was be regressed on X, Z and XZ. Moderator effects were indicated by the significant effects of XZ whist X and Z are controlled. The independent variable and proposed moderating variable were centred to assist in the prevention of multicollinearity. Results are presented in Table 11.
Table 11: Hierarchal Regression testing for Moderation

<table>
<thead>
<tr>
<th>Measurement Point 1</th>
<th>Step 1</th>
<th>B</th>
<th>Standard Error Beta</th>
<th>Beta</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation (constant)</td>
<td>4.020</td>
<td>0.059</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LMX Mean</td>
<td>-0.041</td>
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<td>-0.048</td>
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<tr>
<td>Safety Climate Mean</td>
<td>0.694</td>
<td>0.112</td>
<td>0.616***</td>
<td>0.348</td>
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<tr>
<td>Measurement Point 2</td>
<td>Step 1</td>
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<td>Standard Error Beta</td>
<td>Beta</td>
<td>R²</td>
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<tr>
<td>Participation (constant)</td>
<td>4.112</td>
<td>0.063</td>
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<td></td>
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<tr>
<td>LMX Mean</td>
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<td>-0.061</td>
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<tr>
<td>Safety Climate Mean</td>
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<td>0.108</td>
<td>0.573***</td>
<td>0.388</td>
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<tr>
<td>LMX Mean x Safety Climate Mean</td>
<td>-0.299</td>
<td>0.096</td>
<td>-0.250**</td>
<td>0.408</td>
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</tbody>
</table>

<table>
<thead>
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<th>Measurement Point 2</th>
<th>Step 2</th>
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<th>Standard Error Beta</th>
<th>Beta</th>
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<td>0.561***</td>
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<td>Standard Error Beta</td>
<td>Beta</td>
<td>R²</td>
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<td>0.081</td>
<td>0.132</td>
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<td>0.117</td>
<td>0.550***</td>
<td>0.403</td>
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<tr>
<td>LMX Mean x Safety Climate Mean</td>
<td>-0.168</td>
<td>0.104</td>
<td>-0.125</td>
<td>0.403</td>
<td></td>
</tr>
</tbody>
</table>

Note: *p< .05 **p< .01 ***p< .001

Again, interpretation of findings can be separated by measurement point.

**Measurement point 1**

The standardized beta value (-.25) for the interaction term (LMX x safety climate) was significant at the .01 level (p=.002) meaning significant support for the moderating hypothesis. This result indicated that an increase in participation by one standard deviation would produce a reduction in the interaction term by -.25 standard deviations. The R² change associated with the interaction term...
was .408 for measurement point 1 meaning the interaction between LMX and safety climate explained an additional 6% of the variance in compliance scores over and above the 34.8% explained by the first order effects of LMX and safety climate alone (e.g. 40.8-34.8).

Data was further analyzed using techniques detailed by Cohen et al (2003). The graph indicated a complex picture. High LMX levels were found to be associated with higher participation in low safety climate environments, however, this effect was reversed in positive safety climate environments where low LMX was associated with high levels of participation. More positive safety climate conditions were associated with higher levels of participation when contrasted with lower climate conditions.

Figure 15: LMX, Participation and Safety Climate - Measurement Point 1

Measurement point 2

The standardized beta value for the interaction term (-.125) did not support the moderating hypothesis (p=.110). An increase in compliance by one standard deviation would produce a reduction in the interaction values of LMX x Safety Climate by -0.125 standard deviations. The $R^2$ change associated with the interaction term was .403 meaning the interaction between LMX and
safety climate explained an additional 1.5% of the variance in compliance scores over and above the 38.8% explained by the first order effects of LMX and safety climate alone.

Again, this data was further analyzed graphically using the technique detailed by Cohen et al (2003). Results, illustrated in Figure 16, indicated that high LMX levels were associated with higher participation in low safety climate environments, however, little relationship was seen between the variables in more positive safety climate environments. Overall, more positive safety climates reported higher levels of participation than low climate environments.

Figure 16: LMX, Participation and Safety Climate - Measurement Point 2

Summary
The significance of the beta values for measurement point 1 provided support for the moderating hypothesis whilst the beta values for measurement point 2 did not provide support for the moderating hypothesis. Perhaps the most interesting finding mirrors that discovered in previously, the reverse effect of LMX in high climate environments. Whilst research should never be undertaken based on expectation, the high/low climate LMX variation requires explanation as it contravenes previous research in this area (Hofmann et al 2003).
Note for Hypotheses 6-9

The assessment for mediation for hypotheses 6-9 employs the Sobel test. Full details of this assessment, the terms used, the techniques employed and the results produced can be found in the methodology section of this study. It should be emphasized that care should be taken when considering the p-value of the Sobel Aroian test, as significance indicates the likelihood that mediation effects equal zero (e.g. there is no mediation). As each hypothesis is testing for partial mediation, the reader is in the counter intuitive position of searching for non-significance to confirm the mediation hypothesis.

Hypothesis 6: The relationship between LMX and near miss involvement will be partially mediated by safety compliance

Hypothesis 6 predicted that the relationship between LMX and near miss involvement would be partially mediated by compliance. The results of the Sobel Aroian analysis indicated significance for measurement point 1 and non-significance for measurement point 2. Recalling the reverse characteristics of the Sobel statistic, this data indicated compliance acted as a mediator at measurement point 2, however, it was statistically unlikely that compliance acted as a mediator at measurement point 1. This provides partial support for hypothesis 6.

Table 12: LMX, Near Miss and Compliance Sobel Results

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Variable</th>
<th>Standard Deviation</th>
<th>IV Mod corr</th>
<th>a (se)</th>
<th>b (SE)</th>
<th>c (SE)</th>
<th>c' (SE)</th>
<th>Compa (SE)</th>
<th>Compb (SE)</th>
<th>Sobel Aroian p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP1</td>
<td>LMX</td>
<td>0.853</td>
<td>.326**</td>
<td>.277 (0.08)</td>
<td>.664 (0.33)</td>
<td>.407 (0.26)</td>
<td>.235 (0.27)</td>
<td>.12917 (0.04)</td>
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<td>Compliance</td>
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<td>Near Miss</td>
<td>0.475</td>
<td></td>
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</tr>
<tr>
<td>MP2</td>
<td>LMX</td>
<td>0.93057</td>
<td>.341**</td>
<td>.278 (0.07)</td>
<td>-.161 (0.30)</td>
<td>.578 (0.25)</td>
<td>.627 (0.27)</td>
<td>.14119 (0.04)</td>
<td>-.06466 (0.12)</td>
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</tr>
<tr>
<td></td>
<td>Compliance</td>
<td>0.75961</td>
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<tr>
<td></td>
<td>Near Miss</td>
<td>0.468</td>
<td></td>
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</table>

Hypothesis 7: The relationship between LMX and near miss involvement will be partially mediated by safety participation
Hypothesis 7 predicted that the relationship between LMX and near miss involvement would be partially mediated by participation. Results of the Sobel test confirmed this hypothesis with p-values in excess of .9 suggesting a strong mediating effect at measurement points 1 and 2. Implications of this finding will be considered in the Discussion.

Table 13: LMX, Near Miss and Participation Sobel Results

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Variable</th>
<th>Standard Deviation</th>
<th>IV Mod corr</th>
<th>a (SE)</th>
<th>b (SE)</th>
<th>c (SE)</th>
<th>c' (SE)</th>
<th>Compa (SE)</th>
<th>Compb (SE)</th>
<th>Sobel Aroian p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP1</td>
<td>LMX</td>
<td>0.85342</td>
<td>.304**</td>
<td>.257</td>
<td>-.037</td>
<td>.407</td>
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<td>.11998</td>
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<td>Participation</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Near Miss</td>
<td>0.475</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP2</td>
<td>LMX</td>
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<td>.347**</td>
<td>.334</td>
<td>-.127</td>
<td>.578</td>
<td>.622</td>
<td>.16889</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Near Miss</td>
<td>0.468</td>
<td></td>
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Hypothesis 8: The relationship between LMX and accident involvement will be partially mediated by safety compliance

Hypothesis 8 predicted that the relationship between LMX and accident involvement would be partially mediated by compliance. Hypothesis 8 represented a departure from the previous hypotheses that had been concerned with near miss reporting. Results provided support for this hypothesis, however, the variation in the Sobel statistic over measurement points 1 and 2 indicated a degree of fluctuation in the mediating effect. The concept of mediating fluctuation will be considered in the discussion.
Table 14: LMX, Accident Involvement and Compliance Sobel Results

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Variable</th>
<th>Standard Deviation</th>
<th>IV Mod Corr</th>
<th>a (se)</th>
<th>b (SE)</th>
<th>c (SE)</th>
<th>c' (SE)</th>
<th>Compa (SE)</th>
<th>Compb (SE)</th>
<th>Sobel Aroian p</th>
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<tr>
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<td>.326**</td>
<td>.277 (.08)</td>
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</tr>
<tr>
<td></td>
<td>Accident</td>
<td>0.464</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MP2</td>
<td>LMX</td>
<td>0.93057</td>
<td>.341**</td>
<td>.278 (.07)</td>
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<td>.739 (.27)</td>
<td>.745 (.29)</td>
<td>.14119 (.04)</td>
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<tr>
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<td>Accident</td>
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<td></td>
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</tbody>
</table>

Hypothesis 9: The relationship between LMX and accident involvement will be partially mediated by safety participation

Hypothesis 9 predicted that the relationship between LMX and accident involvement would be partially mediated by participation. Again, this hypothesis was concerned with accident outcome data. The results of the Sobel test were positive for the partial mediation hypothesis, however, data again indicated a level of fluctuation between measurement points 1 and 2. In a similar pattern to that illustrated in hypothesis 9, this fluctuation pointed to increased mediation over time.

Table 15: LMX, Accident Involvement and Participation Sobel Results

<table>
<thead>
<tr>
<th>Measurement Point</th>
<th>Variable</th>
<th>Standard Deviation</th>
<th>IV Mod Corr</th>
<th>a (se)</th>
<th>b (SE)</th>
<th>c (SE)</th>
<th>c' (SE)</th>
<th>Compa (SE)</th>
<th>Compb (SE)</th>
<th>Sobel Aroian p</th>
</tr>
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<tbody>
<tr>
<td>MP1</td>
<td>LMX</td>
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<td>.304**</td>
<td>.257 (.08)</td>
<td>.303 (.32)</td>
<td>.701 (.28)</td>
<td>.614 (.29)</td>
<td>.1200 (.03)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Accident</td>
<td>0.464</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>MP2</td>
<td>LMX</td>
<td>0.93057</td>
<td>.347**</td>
<td>.334 (.09)</td>
<td>-.127 (.26)</td>
<td>.739 (.27)</td>
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<tr>
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<td>Accident</td>
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Hypothesis 10: Brainstorming sessions will produce a significant improvement in participation between measurement point 1 and measurement point 2

The full working model detailed in the Defining the Research Model section of Chapter 5 proposed opportunities to participate, presented through brainstorming sessions, should have increased participation levels, which subsequently should have effected individual safety performance measured by self report accident and near miss involvement scales. Hypothesis 10 partially tested this theory through the assessment of the effect the brainstorming sessions had upon participation. Participation was measured at two time points, separated by a seven month period. Mean participation scores from measurement point 1 were compared with those from measurement point 2. Participants at measurement point 1 reported a higher mean participation score (M=4.02 SE=.07) than those at measurement point 2 (M=3.99 SE=.09), t(100)=.22, P>.05. This provides no support for hypothesis 10 and suggested the brainstorming sessions did little to improve individual perceptions of participation, as captured by the item scale.

To further analyze this relationship, accident and near miss involvement data for measurement point 1 and measurement point 2 were considered. Respondents for measurement point 1 reported 34 near miss incidents (33.7% of respondents) and 31 accidents (30.7%). Respondents for measurement point 2 reported 33 near misses (31.7%) and 29 accidents (27.9%). These findings indicate a 2% and 2.8% drop respectively but these findings could not be explained through the brainstorming/participation route detailed above.
Chapter 6 - Discussion

Chapter Preface
The purpose of this Chapter is to consider in depth the results detailed in Chapter 5. This chapter is intended to be less prescriptive than those detailed previously, however, the size and complexity of this study does make necessary a simple framework onto which the discussion can be placed. This chapter will commence with a summary of the main study findings detailed in Chapter 5. A particular focus will be maintained on those findings demonstrating a particular contribution to knowledge in the area of safety performance research. Additionally, the summary section will consider how the study results responded to the initial aims and objectives detailed in the introduction of this thesis.

Following the summary of headline findings, this chapter will be separated into key themes, the contents of which will be informed by each significant result detailed in Chapter 5. Themes will provide the opportunity to discuss the results in more depth. They will provide a considered view of the contribution to knowledge, implications for theory and research and implications for policy and procedure associated with each significant finding. Finally, this chapter will conclude with a review of the specific limitations of this study. The purpose of this section is to demonstrate an awareness of the weaknesses inherent in this study design and present potential solutions to these weaknesses, either retrospectively, in the form of improvements intended to improve the design of the study already conducted, or prospectively, in the form of design improvements with the potential to improve repeat study.

As detailed, this chapter will begin with a summary of the headline study findings.

Summary of Findings
Headline Findings
The analysis of data conducted in Chapter 5 provided broad support for the model of safety performance presented in the literature review of this thesis. Compliance and participation were seen to be mediating the relationship between LMX and near miss/accident involvement and safety climate was identified as a moderator of the LMX-compliance and participation relationship. Whilst these results represent a significant contribution to knowledge in the area of LMX and safety performance research, it is counter-intuitive relationship between safety climate, LMX, compliance
and participation, that attracts particular attention. Multiple regression of these factors indicated that, in high safety climate environments, good LMX relationships were associated a reduction in compliance and participation relative to poor LMX relationships. This effect was particularly evident at measurement point 1 - measurement point 2 indicated a slightly negative or null effect for high safety climate environments. In low safety climate environments, good LMX relationships were predictive of higher levels of compliance and participation. This effect was witnessed at measurement point 1 and 2. These results directly contradict findings from Hofmann et al (2003), although this study used organizational citizenship behaviours as an outcome measure as opposed to compliance and participation, and can be considered a highly significant contribution to knowledge in this area of research.

The idea that good relationships in positive safety climates could be rewarded with a reduction in compliance and participative behaviours not only provides a poor match with LMX research, it runs contrary to the representation of safety climate as a context forming backdrop through which individuals gage the suitability of their behaviours (Dedobbeleer and Beland 1991). These results point to a more complex situation in which other factors, linked to the relationships individuals have with their supervisors and possibly also climate derived, shape behavioural outcomes. These potential explanations and their implications for theory and research will be discussed in more depth in the LMX theme detailed below.

Alongside the counter-intuitive relationships between safety climate, LMX, compliance and participation, LMX demonstrated a direct and significant relationship with the outcome measure used in this study, namely self report near miss/accident involvement. Again, this relationship can be identified as a significant contribution to knowledge with researchers such as Hofmann and Morgeson (1999) electing to focus on the relationship between LMX and an objective measure of safety performance, nurse accident records. Indeed, in discussing their results, Hofmann and Morgeson recommended the study of LMX alongside a more subjective and detailed outcome measure, this study and hence this finding can be regarded as a response to this recommendation.

The argument in favour of using Glendon and Litherland’s safety climate survey in this study centred on two core points. One, that a systemic focus upon the role of management commitment in climate
assessment had led to a paucity of information about the nature of other contributory factors, and, two, the factorial stability of the questionnaire presented a significant research opportunity. Investigation of the second point using principal components analysis indicated no significant factor structure match with that produced by Glendon and colleagues (Glendon et al 1994; Glendon and Litherland 2001). Despite this, results indicated a direct relationship between safety climate and near miss/accident outcome. This relationship presents a minor contribution to knowledge as this is the first time this scale has demonstrated a significant relationship with near miss/accident data. More significantly, perhaps, these results also produce an interesting debating point concerning the significance of factorial structure in safety climate measurement and the links between this and Zohar’s global view of climate measurement. This debate will be discussed in more detail in the safety climate theme outlined below.

**Aims and Objectives**

In the introduction section of this thesis, a number of study aims and objectives were outlined. Although discussion of these will feature in the themes detailed below, this section will provide an overview of the extent to which this study can be perceived to have met its aims and objectives as detailed.

1. Ascertain which form of brainstorming, nominal or interactive, would be better suited to improving participation in safety performance. Base this judgement on:
   a. Number of ideas produced
   b. Level of satisfaction with process
   c. Level of group cohesion following process

This was considered in the discussion and conclusion section of Study 1.

2. Ascertain whether brainstorming can be used to improve levels of perceived participation in safety, and, if effective, whether this improvement has a subsequent impact upon near miss/accident involvement
Results indicated a slight decrease in perceptions of participation from measurement points 1 to 2. This suggests, subject to caveats concerning study design and risk associated with generalising from sample to population, that brainstorming does not improve perceptions of participation in safety. Although results did not indicate a relationship, this aim can be considered to have been met in terms of the successful design and delivery of a suitable investigative study.

3. Ascertain the relationship, if any, between LMX, safety climate and compliance/participation

This can be viewed as a success with analysis indicating a complex interaction of moderating and mediating relationships. Investigation of these relationships produced the most significant contribution to knowledge concerning the interactions between safety climate, LMX, compliance and participation.

4. Ascertain the relationship, if any, between LMX, safety climate, compliance/participation and near miss/accident involvement

Again, can be viewed as a success with mediating and direct relationships between antecedent, determinant and outcome variables detected.

The study objectives detailed in the introduction section of this thesis mainly concerned the review of literature required to successfully (a) choose a suitable safety climate and LMX measurement tool, and (b) feed these variables, along with compliance, participation and brainstorming into a suitable functional model of safety performance. The review of literature presented in Chapters 1 and 2 provided a suitable summary of research in the areas of safety climate, Performance Shaping Factors and LMX, and, as a result, enabled an informed choice of safety climate and LMX assessment tools to be made. Likewise, the review of literature concerning participation and brainstorming provided a foundation of knowledge that supported the model of safety performance proposed and provided a pathway for the development of a methodology able to analyze these factors.
The thematic analysis presented below will provide a more detailed assessment of the extent to which this study achieved its aims and objectives, however, this high level analysis suggests the combination of the literature review, methodology design and results obtained enabled the study aims and objectives to be suitably met. This chapter will now consider in detail the findings presented in the results section. As outlined previously, this in depth analysis will consider the contribution to knowledge made, the implications of this knowledge for theory and research as well as policy and practice.

**Theme 1: Moderating Hypotheses**
The literature review conducted prior to this study identified LMX, more specifically the LMX-7 scale (Graen and Uhl-Bien 1995), as one of the most stable means of leader-member relationship analysis available (Gerstner and Day 1997). LMX-7 has been used in a diverse range of studies, across a wide spectrum of industries underlining its broad appeal to researchers. As well as general research, the role of LMX in safety performance has been studied in detail; Hofmann and Morgeson (1999) and Hofmann et al (2003) have been particularly active in this area. Hofmann and Morgeson (1999) were able to demonstrate a role for LMX as an antecedent to safety communication, safety commitment and accidents whilst Hofmann et al (2003) illustrated a link between LMX, safety citizenship role definitions and citizenship behaviours, moderated by safety climate. Despite these studies, however, the literature review presented in this thesis argued there remained a need for a fully operable model that included LMX, safety climate and a reliable outcome measure of safety performance. This recommendation can be viewed as a reaction to the study objectives concerning the need for a full understanding of literature and the creation of a functional model of safety performance that reflected this understanding. This study represented a response to this requirement and findings present a complex picture of the role LMX plays in organizational safety performance.

Hypotheses 4 and 5 predicted the relationship between LMX, compliance and participation would be moderated by safety climate. This prediction was based, in part, on the findings of Hofmann et al (2003) detailed in the literature review, who detected a moderating role for safety climate between LMX and safety citizenship role definitions. In addition, the review of literature revealed LMX had been identified as a relationship moderator by a number of other studies (Scandura and Graen,
Contrasting this position, Zohar and Luri (2004) detected a moderating role of transformational leadership, an alternative measure of the leader-member relationship, when analyzing the link between safety scripts and group level safety climate. Although Zohar and Luria’s findings had merit, methodological similarities between this study and Hofmann et al’s approach underlined the argument in favour of a moderating role for climate. This was supported by the contextual argument, the concept that safety climate provides the backdrop through which individuals gage the suitability of behavioural response (Dedobbeleer and Beland 1991) and hence behavioural reciprocation routes (Hofmann et al 2003).

Results provided partial support for the moderating hypotheses, with significance detected for the interaction variable at both measurement points for compliance, and a single measurement point for participation (although the non-significant interaction figure missed p=.1 significance by a small margin). It was the analysis of the directionality of the moderating effect that identified an unexpectedly juxtaposed relationship between safety climate, LMX, compliance and participation. Whilst both compliance and participation were seen to be higher in more positive climates, good LMX relationships were predictive of improved compliance and participation only in low safety climate conditions. Indeed, LMX produced either no effect, for measurement point 2, or a reduction in compliance or participation in more positive safety climates. This reduction effect was seen predominantly for measurement point 1. These results are directly contrary with those produced by Hofmann et al (2003) and, hence, represent one of the key contributions to knowledge made by this study.

The context argument detailed in Chapter 1 suggests safety climate provides the cues that help workers identify suitable behavioural reciprocation for positive LMX relationships, however, these results indicate a counter-relationship. Low LMX relationships were seen to predict the lowest (when coupled with poor safety climate) and highest (when coupled with a positive safety climate) levels of compliance and participation. In suggesting climate plays a contextual role in the identification of suitable reciprocal behaviours, Hofmann and colleagues essentially extended the theoretical basis of previous models that explained the climate-behaviour relationship (Zohar 1980; Dedobbeleer and Beland 1991). The findings detailed in this study, however, suggest an alternative model in which supervisors play a more active role in the management of worker behaviour. This conceptualization...
of the LMX-outcome relationship is not uncommon in research with many theorists relating LMX directly with outcome factors such as a sales performance (Klein and Kim 1998). In these studies, supervisors make clear their requirements for success (e.g. sales) and workers respond accordingly, without the contextual influence of climate to identify adequate behavioural responses.

To understand how supervisors could play a role in selecting those behaviours deemed suitable for reciprocation of positive LMX relationships, the results presented have to be analyzed in some depth. Before the analysis, however, it is important to discuss exactly who the term supervisor is referring to. Chapter 5 detailed some surprising findings in this area. When asked ‘who do you consider to be your supervisor?’, a third of respondents identified their driver. If it is considered that drivers made up between 30-40% of the participants, these results suggest that most, if not all, of loaders considered their driver to be their supervisor. This, despite their driver possessing no official line management responsibilities. The term supervisor, in this context, therefore refers to a mix of drivers and supervisors depending upon the job role of the respondent. The implications of this finding for future group level analysis is considered later in this discussion.

When attempting to understand how supervisors could influence behavioural reciprocation for positive LMX relationships, it is significant to note that, in more positive climates, positive relationships were not reciprocated with behaviours that resulted in improved compliance or participation. In these situations, supervisors may be diffusing responsibility for safety to the organization, which they perceive to be able to protect their workers. Research has indicated that, in group environments, individuals make economic judgements concerning their actions, electing to contribute less where they believe their efforts will not change group outcomes (Diehl and Stroebe 1987). It is possible that supervisors target their focus according to the same model, electing to prioritise areas in which they feel they can usefully influence the group outcome. These areas may be context dependent. For example, waste sector workers operate ‘task and finish’ arrangements that allow teams to go home when they have completed their rounds. It is possible that, in positive climates, supervisors feel they can exert an influence on group finish times and so focus their attention in this area. In this scenario, workers would reciprocate good relationships by reducing compliance and participation type behaviours, such as walking rather than running or looking in bins before they are loaded, which are recognized to slow the team down.
Conversely, in poor climates, supervisors may feel that the responsibility for safety lies with them. In this scenario the supervisor makes clear their expectations by word and action and workers reciprocate accordingly. Zohar has highlighted the impact that supervisor behaviour can have upon worker actions (Zohar 2000; Zohar and Luira 2004), however, the model being outlined here demands that workers respond to supervisory expectation despite the underlying presence of a negative safety climate.

Although the economic theory detailed above provides a plausible explanation of the data collected in this study, it does not represent a good fit for the wider safety climate literature. Requiring individuals to dismiss climatic cues in favour of direct supervisor instruction represents a step away from research that has represented the process of behavioural reciprocation as cue driven and tacitly derived (Hofmann et al 2003). As mentioned previously, the cue driven approach matches well with those theorists who see climate as a backdrop through which individuals gage the suitability of behaviour. In addition, safety climate researchers have consistently identified pressure for production as a factor that is negatively associated with safety performance (Zohar 1980; Janssens, Brett and Smith 1995; Mearns et al 1997; Glendon and Litherland 2001). As a result, a model in which supervisors focus on productivity whilst maintaining a positive safety climate may be viewed as counterintuitive, despite the findings outlined in this study.

With these issues in mind, it is worth looking at routes by which the economic theory can be refined. One such possibility lies in the recent work of Dov Zohar. In his argument in favour of a multi-level, multi-climate framework, Zohar suggests safety climate may interact with other climates to produce a multi-climate framework (2008). To illustrate, Zohar describes an interaction between safety climate and a ‘climate for work ownership’ (Zohar 2008). Zohar suggests the climate for work ownership ‘concerns the extent to which supervisory and/or senior leaders allow work issues to become ownership targets, and the recognition of such ownership once it develops’ (Zohar 2008 pg 382). Zohar uses the interaction of safety climate and work ownership climates to derive a four element framework, detailed below.
The multi-climate framework makes allowances for variation within a particular climate. For example, in high safety climate conditions it is possible to have a low work ownership climate and hence safety compliance as an outcome. Conversely, in high climate, high work-ownership environments, Zohar predicts good levels of safety citizenship. The provision of variation within climates, the concept that a positive climate does not ‘just’ deliver improved safety performance, is a key aspect of the multi-climate model and, in the context of this study, it provides a blueprint to aid the understanding of the moderating results produced. Zohar suggests that the climate for work ownership forms a link between climate research and studies of High Reliability Organizations (HRO) and mindfulness. This link, he argues, is cemented by attributes of HROs, such as balancing the competing demands of efficiency vs. safety/reliability, which are better achieved through the provision of work ownership. It is this connection between a climate for work ownership and the ownership of issues such as competing work demands that forms a clear association between Zohar’s research and the findings in this study.

Combining economic theory with the multi-climate/multi-level approach detailed by Zohar produces a complex yet authoritative account of the moderation data captured in this study. The combination of these elements produces a two tier system, the mechanics of which are detailed in Figure 18. Tier one functions very much as Hofmann and others have suggested with climate forming a context, a backdrop, through which workers gage the suitability of their behavioural reciprocation. In the multi-climate environment, however, this process is complex with interwoven cues and a variety of

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Figure 17: Zohar Multi-climate Framework

![Zohar Multi-climate Framework](image-url)
potential outcome measures. For example, high safety climate and high work ownership climate environments produce a spectrum of cues through which workers may reciprocate high LMX relationships, including compliance for high safety climate and productivity for high work ownership climates.

The second tier in this process concerns those exerting a supervisory influence. In competing climate environments, workers rely on their ‘perceived’ supervisor to indicate the desirability of one behavioural reciprocation over another. Economic theory suggests the supervisor will be most likely to look to areas in which their input produces a meaningful change in group outcome. In an almost paradoxical scenario, the supervisors selection strategy is likely to be influenced by competing climates, as they identify the most likely route for influence. This influence can be an element of a particular climate, for example, choosing productivity in high work ownership climates, however, when it is chosen it provides the workforce with a clear picture of the behavioural reciprocation required.

Figure 18: Model of Interactions

As the above theory has demonstrated, the multi-climate model has the potential to profoundly effect previous assumptions of safety climate research. Whereas previous research represented the relationship between safety climate and a chosen outcome as a direct thread, the multi-climate
model weaves this thread into a fabric of constantly interacting climates. At each point of interaction, climates can share factors and outcome measures, as demonstrated by the combination of safety and work ownership climate proposed.

Before concluding this section, there are a number of issues concerning the moderating findings and the subsequent multi-climate model proposed that require attention. The first concerns the nature of the safety climate survey used and its potential influence upon results. As detailed previously, Glendon and Litherland's (2001) survey was influenced by Performance Shaping Factors and so contained no management commitment or leadership scale. This absence, and resultant task orientation, may have had some bearing on the moderating effects produced. This issue has significance for study aims and objectives concerning the selection of a suitable safety climate measurement tool, however, it would be simplistic to conclude that the tool selected was not suitable for the task. Indeed, it may be that this selection provided the context through which the juxtaposed relationships between climate, LMX, compliance and participation could be expressed. This issue requires further research to produce an understanding of the replicability of the study findings, in particular, whether these findings can be reproduced using a more traditional measure of safety climate.

The second issue concerns the nature of the organization that participated in this study. Due to the nature of waste collections, work teams operate remotely. As a result, decision making concerning safety matters has to be passed onto drivers and loaders, even if this is removed and placed back with the supervisor when they arrive back at the depot. This subtle change in hierarchical structure presents a number of research issues and opportunities that will be discussed in more depth under the Sample heading in the Limitations and Improvements section of this chapter, however, in the context of the multi-climate model detailed above, it is the potential of mimicry that is of interest.

Mimicry refers to the possibility that individuals may report higher levels of work ownership or safety climate because of organizational conditions rather than managerial or supervisory decision making. For example, drivers may take ownership for safety during rounds in the absence of an alternative. There is an important distinction between these models as the individual and organizational motivation for adopting ownership has the potential to influence perceptions regarding its
effectiveness. For example, if it is forced upon drivers, they may perceive ownership as supervisors shirking responsibilities. Alternatively, if it is part of a well planned organizational initiative, it could be perceived as a recognition of competency. This mimicking effect may have contributed to the counter-intuitive results captured in this study. It is possible that such mimicking effects are a product of an immature and so poorly formed climate concept, however, only further research in differing working environments can shed light on either of these potential issues.

Consideration of the moderating relationships detected in this study has underlined the need for further research in two key areas. First, concepts concerning the role of economic theory and supervisor selection strategies are, at this time, little more than that. Research is required to improve understanding of how, if at all, factors such as economic theory influence worker and supervisor behavioural selection strategies. Second, Zohar and colleagues have put the idea of a multi-climate model on the map (Zohar 2008). The moderating relationships displayed in this study provide tentative support for this approach, however, they also provide evidence of the complexities, both theoretical and experiential, of the multi-level perspective. These complexities can only be unravelled through the ordered study of the multi-level model, focussing on the interaction of distinct climates and their outcome measures.

When considering practice and policy recommendations resulting from this theme, one of the key issues concerns the effective management of workers and supervisors. Organizations frequently send out complex and often contradictory messages to their workforce. It is not uncommon for companies to run a behavioural safety programme alongside an incentive scheme designed to improve productivity. Whilst these findings do not suggest anything fundamentally wrong with this arrangement, they do emphasise the need for organizational understanding of the complexities of a multi-climate environment. The results outlined in this study suggest that, whilst an organization may have a positive safety climate, and, as a result, better compliance and participation, other factors have the potential to influence this relationship and produce micro-variation.

In addition, these results provide further evidence of the importance of the supervisor-worker relationship in organizations using the traditional ‘hand on’ supervision model. Whilst studies have identified the significance of this relationship in the past (Clarke 2000; Zohar 2000; Hofmann et al
2003; Zohar and Luria 2004) this study does so with the additional suggestion that the supervisor, whether they be formally or informally identified, has a role in the selection of behaviours suitable for positive LMX relationship reciprocation. In terms of policy and practice, these results emphasise the need for senior management support to help supervisors identify and understand competing goals. Additionally, managers need to be aware that supervision can be provided in a number of forms and from a number of sources.

Theme 2: Mediating Hypotheses
Hypotheses 6-9 were concerned with the role of compliance and participation as partial mediators of the relationship between LMX and near miss/accident involvement. Before considering the results of these hypotheses, it is important to understand the structure and hence designation of the variables associated with this hypothesis. Neal et al (2000) and Neal and Griffin (2006) provided good evidence for their identification of the determinants (safety knowledge, motivation and skill), and the components (compliance and participation) of safety performance. This study borrowed elements from Neal and colleagues, including the identification of components of safety performance.

Although elements of Neal et al's model of safety performance were used, a number of changes were made to the arrangements and interactions therein. Safety climate, whilst still an antecedent, was identified as a moderating agent between LMX and compliance and participation. Additionally, the determinants of safety performance, knowledge and motivation, were not included. This left a requirement to explain the new relationship between LMX, compliance, participation and near miss/accident involvement, and, as a result, the mediating hypotheses. In their 2000 study, Neal et al suggested direct 'relationships' between their determinants and components of safety performance. In this respect, the introduction of a mediating hypotheses represents a relatively new strand of research concerning the components of safety performance.

Baron and Kenny (1986) assert that a variable may be designated a mediator ‘to the extent that it accounts for the relationship between the predictor and the criterion’ (Baron and Kenny 1986, pg 1176). A fuller explanation of mediation, including the statistical properties of relevant variables, is provided in the results section of this thesis. In the context of this study, the predictor was identified as LMX and the criterion as near miss/accident occurrence. Using the Sobel Aroian statistic, details
of which are also provided in the results section, the partial mediating hypotheses were supported for all relationships at all measurement points, with the exception of the LMX-Compliance-Near Miss relationship. The mediation findings detailed in this theme represent a contribution to knowledge in this area, not only for their confirmation of the mediating hypotheses but also for the discovery of fluctuation in mediation over time. This effect, demonstrated by the variation in the Sobel statistic, was particularly evident for those analyzes utilizing accident involvement outcome measures. Implications for theory and research, policy and practice will now be considered.

The discovery that compliance and participation mediate the relationship between LMX and near miss/accident involvement presents a number of implications for theory and research. As detailed earlier, the designation of compliance and participation as relationship mediators built upon the previous work of Neal and colleagues as well as Hofmann et al (2003). The confirmation of these relationships provides further support for those theorists, such as Neal and Griffin (2006) and Probst and Brubaker (2001), who have underlined the value in demarcating the components of safety performance.

In addition to recognizing a basic partial mediating effect, the Sobel statistic indicated a degree of variation in this mediating effect over the two time periods. This finding indicates that the extent to which compliance and participation mediate the relationship between LMX and near miss/accident data varies over time. In both examples, the mediation effect was seen to increase, indicated by an increase in the Sobel statistic, between measurement points 1 and 2. Potential explanations for this change centre upon the effect of the brainstorming sessions. In these sessions, groups were asked to suggest ideas to improve safety performance. Inevitably, many of these ideas were associated with participation and compliance. For example, ‘choose suitable PPE’ or ‘stop running’, were both ideas suggested in the brainstorming sessions and both can be linked with compliance and participation respectively. As a result, it is possible that the ideation process reinforced the role of compliance and participation and so strengthened the mediating effect over time.

Although suggested links between brainstorming, compliance and participation provide a reasonable explanation for the fluctuation in mediating effects witnessed, it is clear that this theory requires research support. Indeed, further work is required across a range of topics to further understand the
relationships between the antecedents, components and outcomes of safety performance identified in this study. For example, why did the fluctuation in mediation effect the relationship with accident involvement but not near miss? In their meta-analytic review of the roles of person and situational factors in workplace safety, Christian, Bradley, Wallace and Burke (2009) point to potential inaccuracies in injury and accident reporting arguing that, whilst injuries must come about as a result of accidents, accidents may not necessarily result in injury. Indeed, an accident may be perceived as a potential injury avoided depending upon the nature of the response from those involved. Using a similar logic, it is possible that near miss involvement may be a measure of individual or group level safety awareness and hence accident avoidance rather than the assumed predisposition to unsafe behaviour.

Primary implications for policy and practice to be derived from this theme concerns the utility of compliance and participation as mediators of the LMX and near miss/accident involvement relationship. Just as Neal and Griffin concluded their longitudinal assessment of these factors regarding the importance of participation in safety performance (Neal and Griffin 2006), this theme has further identified compliance and LMX as significant factors. That mediation through compliance and participation may change over time suggests the importance of both individual relationships and the conduits through which these relationships travel. This variation suggests that organizations can meaningfully attempt to increase levels of compliance and participation in the knowledge that change is both possible and beneficial.

Theme 3: LMX and Outcome Measures
The first point of note is the basic correlation between LMX and accident/near miss involvement, measured using self report scales. This data agrees with those results captured by Hofmann and Morgeson (1999), who detected a correlation between LMX and accidents, and reinforces the growing consensus that the role of relationships in organizational safety performance is a topic that merits investigation. The results of the independent samples t-test provided support for the hypothesis that high LMX relationships would be associated with lower self reported accident involvement. Results also provided partial support for the prediction that high LMX relationships would be associated with lower levels of near miss involvement. Evidence that individuals who report high LMX relationships are less likely to self report involvement in accidents is relatively unusual,
indeed, this study represents one of the first to successfully demonstrate this link. Although the means by which this relationship is operated is considered later, the raw data points to a powerful and therefore valuable association between worker-supervisor relationships and subsequent accident and near miss involvement.

In their analysis of the moderating effects of transformation leadership, Zohar and Luria suggested positive relationship levels were associated with an increased proximity between the worker and supervisor. This, they argued, would allow the worker increased time to gather safety information about their supervisor and so model their behaviour accordingly (Zohar and Luria 2004). Exponents of LMX suggest a different model, dominated by favoured worker-supervisor relationships and subsequent reciprocal pressure (Graen and Uhl-Bien 1995). On paper, these results support the efficacy of the reciprocal route, and, in doing so, raise some interesting moral and ethical dilemmas.

Researchers have noted LMX to be predictive of a number of outcome measures with significance for the worker. Topics such as career progression (Scandura and Schriesheim 1994) and fairness (Sias and Jablin 1995) have served as conscious raisers, highlighting the impact that the leader can have on the working lives of their subordinates. The relationship between LMX and accident involvement demonstrated in this study takes this consciousness raising to a different level. Research has demonstrated the impact that supervisor level behavioural change can have upon worker micro-accident involvement (Zohar 2000), however, the LMX-accident relationship points to a scenario in which those with better working relationships with their supervisors, or those assuming supervisory responsibilities, are less likely to come to harm. Conversely, it is possible to hypothesize that poor working relationship can lead, inadvertently, to increased probability of worker accident involvement. Such are the implications of the LMX and safety performance relationship that each of the statements detailed above, and the implications therein, require careful qualification through research before further conclusions can be made.

Gerstner and Day (1997) suggested that LMX is more predictive of subjective as opposed to organizational outcomes. In the context of safety performance research, it is important to provide assurance that the LMX-accident/near miss involvement relationship has organizational implications. Safety climate studies have validated the use of self report accident/near miss data, however, the
introduction of LMX has the potential to adversely effect this relationship. Whilst safety climate scales normally require the rating of organizational factors, LMX requires the individual to subjectively rate their relationship with their supervisor, and relate that to accident/near miss involvement. If the relationship is positive, desirability effects may encourage the individual to under report accident involvement. Whilst Hofmann and Morgeson (1999) countered this potential problem through their use of organizational injury rates, this methodology introduced a number of other issues concerning incident reporting. In light of the advantages and disadvantages of self report and organizational accident data, it may be useful to design a behaviourally anchored scale that allows the observation and measurement of LMX. This technique could resemble that used by Glendon and Litherland (2001), who measured safety behaviours using site based observations. A study of this nature would allow researchers to validate LMX, perhaps alongside observations of compliance and participation, and so resolve any issues concerning common method variance and scale reliability and validity.

Providing recommendations for policy and practice change involving LMX is fraught with difficulties. LMX theory describes a process that occurs almost subconsciously. Workers and supervisors form opinions of each other based upon external and internal sense making processes. Ethically, the organization cannot and should not instruct or force individuals to form good individual relationships in the hope of improving performance. Yet, findings that detail a relationship between LMX and safety performance require attention at an organizational level. The key implication for policy and practice, therefore, must be the requirement for consciousness raising. When this occurs, and organizations understand the implications of effective and ineffective relationships, researchers will be able to provide the support needed to improve organizational performance.

The first obvious change would be the introduction of LMX as part of a larger assessment of safety performance. This process would allow the organization to gather a company wide picture of LMX levels and prioritize action accordingly. Although LMX measurement may be helpful, it does not provide an organization with a blueprint for action. In this respect, most paths lead back to training. At a fundamental level, personnel need to understand the impact and influence that seemingly intangible concepts, such as relationships, can have on meaningful outcomes, such as accident
involvement. If awareness of these issues can be raised, training programmes could subsequently target specific factors such as trust, loyalty and positive effect.

**Theme 4: Safety Climate and Outcome Measures**
The correlation between safety climate and near miss and accident involvement at measurement point 1 is of significance, although this relationship was not replicated at measurement point 2. This is an interesting, and, in some ways baffling result. It is possible that, in general terms, the relationship between predictor and outcome variables alter over time. It should be considered, however, that this hypothesis is not supported by a number of longitudinal studies that have detected a continuous relationship between climate predictors and safety performance outcomes over time (Neal and Griffin 2006; Tharaldsen and Rundmo 2007). This leaves the researcher to conclude this result could be an anomaly, caused in some way by the design of the study, perhaps an expression of frustration concerning repeated measures (e.g. having to complete the same questionnaire twice).

Alternatively, and perhaps, more likely, this fluctuation could have come about as a result of a change in perceptions due to the study itself. For example, if individuals perceive the organization to have taken steps to improve the safety climate, they may feel an expectation to reduce near miss or accident involvement data. Additionally, if the organization has taken steps to improve safety performance, it is likely that the number of accidents and near miss events has reduced and with it the opportunity for correlation. The issue of correlation is particularly pertinent in this study due to the reduced sample size and the influence this can have on statistical relationships.

When interpreting statistical relationships, it is important to consider the implications of sample size. Although this study recorded an excellent response rate, the total number of successfully completed questionnaires, 101 and 104 for measurement points 1 and 2 respectively, represents a relatively modest sample. Statisticians warn that, due to potential inflation effects, care must be taken when interpreting the strength of relationships generated from modest sample sizes (Field 2009). Although the sample size in this study can be considered sufficient for the level of statistical analyzes used, the replication of these results using a larger sample size can be considered desirable.
Although sporadic, the relationship between safety climate and near miss/accident involvement does represent a very specific contribution to knowledge. Glendon and Litherland (2001) were able to demonstrate a stable factor structure using their questionnaire, however, they were not able to demonstrate a link between the factor structure and subsequent safety performance outcome measure. This study has provided this link using an acceptable self report accident/near miss involvement scale and hence has made a small contribution to knowledge in this area. Studies of safety climate have often been frustrated by poor relationship between safety climate and suitable outcome measures. This pattern of frustration began with Zohar (1980) and has been repeated with a number of studies using a variety of outcome measures (Alexander, Cox and Cheyne 1994). The correlation between safety climate and accident/near miss involvement detailed in this study is therefore worth of further research.

There are a number of possible explanations for the significance detected in this study, the simplest being the design/nature of the questionnaire used. Glendon and Litherland (2001) attributed their questionnaire factor stability to the influence of Performance Shaping Factors, and it is possible that the ‘task oriented’ item set produced a more accurate measure of those elements most likely to influence accident or near miss involvement. By including task oriented items at the expense of leadership or management commitment questions, Glendon and Litherland effectively separated the measurement of safety climate from the measurement of leadership. The demarcation of safety climate and leadership is not something that has been researched before, mainly as theorists have perceived these concepts as inextricable. Indeed, management and leadership, in various arrangements, has formed a crucial element in every thematic analysis of safety climate factors performed (Flin et al 2000; Clarke 2000; Guldenmund 2000). Due to its performance shaping routes, the climate scale used in this study did not include a measure of leadership/management, instead focussing on issues such as support or relationships (Glendon and Litherland 2001).

To many, attempting to measure safety climate without measuring leadership is a contradiction in terms; Zohar argued that such approaches rendered the climate construct ‘irrelevant’ (Zohar 2000, pg 594). This argument was discussed in some detail in Chapter 1, indeed, it was the understanding that there must be more to safety climate than ‘just’ management commitment that prepared the ground for Glendon and colleagues and their task oriented questionnaire. Glendon and Litherland
were always clear that their survey was intended to act as a base, onto which more organizationally specific elements such as leadership could be transposed (Glendon and Litherland 2001). Although these results do not support the factor stability claimed by Glendon and colleagues, they do not discount the concept of safety climate measurement using core factors, supported by bespoke elements.

In simple terms, the relationship between safety climate and accident/near miss data demonstrated in this study provides support for Glendon and Litherland’s performance shaping approach, however, concerns regarding the unstable factor structure and the absence of a leadership/management scale complicate matters. The central argument in favour of using a questionnaire influenced by Performance Shaping Factors, that these elements have a role in climate measurements that has been under-researched, would seem vindicated. Debate concerning the nature of climate and its relationship with management commitment will clearly continue, however, this study adds to the growing number of publications that support a broad view and hence a multi-factor model.

The relationship between safety climate and near miss/accident involvement provides further evidence of the value of organizational safety climate measurement. Debate concerning the nature of safety culture/climate or the use of attitudinal/perceptual items can often distract researchers and organizations from the key purpose of safety climate measurement; to contribute to the reduction of incidents and accidents. Research that illustrates a clear relationship between these factors helps justify previous study and build the argument for further research.

In conclusion to this theme, it is possible that, due to the task oriented questionnaire used and the dynamic nature of participant roles undertaken, the safety climate tool in this study captured perceptions of task/role risk management, as opposed to an overall measure of climate. It is also clear that, regardless of the unique nature of the questionnaire itself, the tool showed a good predictive relationship with accident and near miss involvement and so has value in the measurement of safety performance. The bearing this theme could have upon policy and practice will now be considered.
Many companies use safety climate surveys as part of a performance improvement programme or as part of an annual assessment of safety performance. Research that illustrates a direct relationship between safety climate and accident involvement endorses this activity but also raises the prospect that organizations and regulators could do more with the data they have. A valid and reliable safety climate questionnaire with a good sample population could, with the introduction of regression analysis, produce an assessment of accident and incident rates for organizations. These rates could be combined with accident cost estimates to provide a reasonably accurate prediction of the likely cost of accidents to the organization. Such a process could encourage organizations to consider safety climate as a meaningful measure of safety performance and one which requires a substantive and company wide response.

**Theme 5: Factor Structure**

Hypothesis 1 predicted the replication of Glendon and Litherland’s (2001) factor structure for measurement points 1 and 2. This hypothesis was based on a number of factors outlined in detail during the safety climate literature review. First, the questionnaire used by Glendon and Litherland was based on a tool developed by Glendon et al (1994) that had produced an eight factor structure. Glendon and Litherland (2001) consequently replicated this structure, albeit with two factors removed due to organizational restrictions. These findings provided a good platform for the proposition that this climate tool possessed a core of six factors, identifiable by analysis. When commenting on the factorial stability demonstrated, Glendon and Litherland referred to the use of Performance Shaping Factors, suggesting the application of these elements influenced item content sufficiently as to produce an ‘operationally anchored [questionnaire]’ (Glendon and Litherland 2001).

Second, the questionnaire developed by Glendon and colleagues had been shown to display factorial stability across a range of industries. The 2001 study was conducted in partnership with an Australian Road Construction and Maintenance organization. As such, primary hazards concerning truck and public vehicle strikes were considered to be similar in nature to those faced by the participants in this study, UK waste collections workers. Due to the close working relationship between UK and Australian Health and Safety regulators, it was also assumed organizational obligations in this area would also be proximate.
Despite these indicators, results did not support the hypothesis. Principal component analysis indicated little inter-correlation between items and confirmatory factor analysis provided no support for the six core factors identified by Glendon and colleagues. These results were especially surprising as the repeated measures study design effectively removed some of the issues previously identified as potentially problematic when attempting to replicate factor structures (e.g. different organizations, different countries, different sectors).

Whilst the results concerning poor factor structure are surprising, there exists two relatively simple explanations, one methodological and one epistemological. The methodological explanation will be considered first. To produce a questionnaire that was manageable in size and content for the intended audience, a number of key decisions had to be made. Of the 40 items detailed in Glendon and Litherland’s (2001) initial questionnaire, eight items were removed. These items concerned training (5 items), trust (2 items) and management of change (1 item) and did not contribute to the six factor solution Glendon and Litherland were able to identify. Along with the deletions, a number of questions were rephrased to improve understanding (‘consulted’ to ‘asked’) and to bring the questionnaire in line with council personnel policies (‘workers’ to ‘staff’).

Due to time constraints, it was not possible to run a pilot study to gather an understanding of the impact that the item changes had made on the questionnaire factor structure. As such, it is possible that these changes degraded the questionnaire factor structure and so produced the single factor findings. This argument is mitigated slightly when it is considered that none of the eight items deleted featured in the six factor structure detailed by Glendon and Litherland (Communication and Support, Adequacy of Procedures, Work Pressures, Personal Protective Equipment, Relationships and Safety Rules). Additionally, many of the other changes were small, mainly concerning single words that were changed to improve understanding. Despite this, it is important to note that these changes could have impacted upon questionnaire factor structure findings and recognize that a pilot study may have allowed quantification and hence better understanding and management of any changes made.

The second factor for consideration concerns the direction of safety climate research and the emerging consensus regarding the role of dimensionality. Coyle et al (1995), supported by the
dimensionally diverse findings of Brown and Holmes (1986), Dedobbeleer and Beland (1991) and others, argued that safety climate dimensions could not be considered universal. Whilst challenged by more recent examples of climatic stability (Tharaldsen and Rundmo 2007), many researchers have agreed with the position adopted by Coyle and colleagues (Guldenmund 2000; 2007). These results may be viewed simply as an extension of this position, a reflection in the diversity of safety perceptions within organizations that ensure factorial stability remains desirable rather than deliverable.

Coupled to this, theorists such as Zohar (2000), Zohar and Luria (2004) Hofmann et al (2003) and Neal and Griffin (2006) have been operationalizing safety climate at a group, as opposed to an individual level, for some time. Inherent in the methodological assertions concerning group level models of safety climate is the shift from inter- to intra-climate dimensionality, a move that sees the dimensional content of the questionnaire take second place to levels of analysis (i.e. group or organizational level). Some theorists adopting a group level approach are happy to analyze climate using questionnaires that produce a single factor, a so called ‘global scale’ (Zohar and Luria 2004) or with tools that have as little as three items (Neal and Griffin 2006). In effect, their models have moved on from dimensionality to consider how safety climate, as a global construct, interacts with other climates (Zohar 2008).

These results provide limited support for the global model of safety climate as they indicate that individual participants did not differentiate between factors such as adequacy of support, communication or procedures (Glendon and Litherland 2001). High Cronbach’s Alpha levels for each scale (e.g. LMX, safety climate, compliance and participation) coupled with a poor collective alpha for all scales indicates that individuals answered safety climate, LMX, compliance and participation measures in distinct but reliable patterns. This demonstrates an awareness of content and so a willingness to demarcate between constructs where participants saw fit. Regarding safety climate, however, they seemingly elected to bundled items together to form a global measure of safety.

When looking for an antecedent or explanation for the global view of climate demonstrated in this study, a number of organizationally derived elements with potential significance can be identified,
most significantly, safety management. A poor safety management system may itself fail to separate safety related factors such as PPE or procedures. In this context, the global view might infact be an accurate depiction of an immature safety management process. Similarly, if individuals have not been trained to separate issues, or if the organizational has failed to communicate their own separation of issues, results could point to a global view. If safety climate is regarded, in part, as a reflection of something as organizationally specific as safety management systems, then factorial stability may well represent a futile goal (Coyle et al. 1995).

Concerning implications, these findings provide conditional support for a global view of safety climate. This support is described as conditional as, although results contribute to literature concerning global safety climate measurement, this backing does not extend to the linked concept of group models of safety climate. Indeed, issues identified in the design stages of this study point to potential concerns with the multi-level approach that will be discussed in the design weaknesses section of this discussion. Partial support of this nature presents an issue, however, as advocating a global view of safety climate without accepting the multi-level model may be interpreted as adopting a laissez faire position to safety climate questionnaire content. As the literature review demonstrated, such a position would be at odds with a series of findings supporting dimensional continuity (Flin et al. 2000; Clarke 2000; Guldenmund 2000) and hence the associated relationships between climate and outcome measures such as accident involvement (Clarke 2006b).

The solution to the complexities of dimensional versus global approaches may well lie in the melding of the theories; a combination of the functional elements of each to provide a more accurate tool. Such an approach might produce tightly specified conditions by which a safety climate tool can be defined, for example, a questionnaire that (a) analyzes climate at a perceptual level, and, (b) investigates only workplace safety related factors; but, additionally, operationalizes these factors at multiple levels with the aim of producing a restricted number of universal factors. Clearly, this approach requires further work, and, in this context, Zohar's attempts to move the debate on from dimensionality to multi-climate models (Zohar 2008) seem premature. A combinational climate tool would clearly add value to the products currently available and therefore would seem worth pursuing.
Theme 6: Brainstorming
Perhaps the most surprising result to be generated from this study was the absence of results, or, to be more accurate, the absence of a relationship between brainstorming, participation, and, consequently, near miss or accident involvement. The review of literature conducted prior to the design of this study supported the supposition that participation, more specifically, efforts to improve participation in safety, provided a suitable means to encourage improvement in safety performance (Neal and Griffin 2006). Participation and involvement had featured as part of safety climate dimensions (Dedobbeleer and Beland 1991), with perceived source of safety suggestions even identified as significantly related to accident involvement (Lee 1998).

The review of literature identified brainstorming as an ideal means by which participation could be introduced/improved (Dunnette et al. 1963). Coupled to this, the first study identified interactive brainstorming as a technique with the potential to improve perceptions of cohesion and satisfaction whilst producing ideas for safety improvement. With these elements combined, the predicted improvement in participation and the consequent reduction in near miss/accident rates seemed reasonable. Yet no significant difference was recorded for either outcome variable. This theme will consider potential explanations for these findings.

One of the most likely explanations concerns the timeframe of the study, more accurately, the seven month gap between the brainstorming sessions and the consequent re-measurement of variables. When designing this study, a review of literature revealed no ‘acceptable’ timeframe, no average gap between an intervention and consequent re-measurement that ensured actions taken had been given adequate time to bed in and take effect. As such, it is possible that the seven month gap in this study was insufficient to allow the effects of the brainstorming session to be felt through measures such as safety climate, participation or incident reporting. When attempting to gather a sense for the timings used in this study, literature review revealed two distinct camps; longitudinal studies and intervention studies.

2003, a two year gap. Torp and Moen (2006) conducted a one-year prospective cohort study of health and safety behaviour and musculoskeletal health of workers in small and medium sized companies. The questionnaire based methodology utilized a simple satisfaction with safety scale to assess perceptions of safety, however, results indicated a significant change in perceptions over the duration of the study.

Conversely, intervention studies tend to permit a shorter gap between action and measurement. Lingard, Cooke and Blismas (2009) studied the effect of first aid training on Australian organizations. The methodology involved the assessment of safety performance using a Global and Individual Safety Measure before and after the provision of first aid training. Lingard et al noticed a change in perceptions over a 24 week period, although it should be noted that the scales used require validation. Although not strictly an intervention study, Probst and Brubaker (2001) measured the impact of a company wide intervention and change programme to produce a model of the effects of job insecurity on employee safety. Their study was conducted over a six month period, sufficient to detect significant changes in safety compliance (Probst and Brubaker 2001).

When it is considered that this study was designed primarily as an intervention, the period between interactive sessions and subsequent re-measurement would seem sufficient. A second potential factor, linked to the issue of timeframes, concerns the feedback mechanism used by the organization. Participation and PDM literature demands excellent channels of communication to ensure participants have a full understanding of the impact their input is having on the organization. The methodology detailed the best practice used in this study including feedback meetings, notice boards and communication bulletins. It is still possible, however, that individuals felt their contribution was lost or that real change would not be realized. One example of this issue concerned side waste collections. Side waste refers to the bags of excess waste householders have placed next to their wheelie bins for collection. These bags present a number of risks to waste collections personnel, including the potential for sharps injuries from glass/needles, musculoskeletal pulls and exposure to hazardous materials. Consequently, the removal of side waste collections was repeatedly identified in the brainstorming sessions.
This issue was taken to the council, who recognized the need for action but were unable to change the side waste collections policy without breaking an election pledge. Councillors understood the seriousness of the side waste issue, it was raised at the highest level in the council, and, as a result, recommended for review. In total, this process took six months, and, although feedback was provided to personnel, the issue of side waste was repeatedly raised during the second questionnaire sessions. At the point of writing, the researcher understands that action has been taken on side waste raising the prospect that this high level change may have had some impact on perceptions of participation and near miss/accident rates since the final questionnaire session was conducted.

The final potential explanation concerns the suitability of brainstorming as a medium for the improvement of participation in safety. Although literature supported the utility of brainstorming as a tool to improve participation and engagement, this study represented the first attempt to use it as a mechanism to improve safety participation. The review of safety participation literature revealed a tendency towards ‘felt’ participation, such as behavioural safety (Kogi 1993), participatory ergonomics (Kuorinka and Patry 1995) or distinct organizational changes (Shearn 2005). These techniques delivered immediate changes that were in clear view of the workforce and so provided a strong link between their participation and their impact. Brainstorming, as the example concerning side waste collections illustrates, struggled to provide the immediacy that individuals may desire to assign value to their participation.

The implications for policy and practice can be considered to be extremely limited, due to the negligible impact brainstorming had upon participation and self report near miss/accident data. Although these results did not support the expected relationship between brainstorming and participation, these findings do not negate the importance of participation in the overall picture of organizational safety performance. Rather, they suggest that any attempt to improve participation in safety must be done with a clear understanding of the route through which participation will be improved and the capacity of the organization to respond to the requirements of this route. For example, for brainstorming to be fully effective as a tool to encourage participation, the organization must be willing to respond to ideas suggested and enact change where practicable. Providing
feedback does not complete the participative process as the workforce will remain disenfranchised concerning decision making.

Looking at the broader issue of participation and safety performance, this study suggests organizations may benefit from a ‘hands on’ approach, similar in nature to that detailed by Shearn (2005). Moving the participative process out of the classroom and into the working environment allows organizations to keep the link between ideas/decisions and actions as short as possible. In addition, it ensures individuals perceive the process as workforce as opposed to management owned.

**Other Findings of Note**

### Group Level Analysis

Throughout the literature review, methodology and results chapter of this thesis the issue of individual, group and organizational level analysis of safety climate has been referenced and discussed a number of times. The review of literature detailed problems with the group level analysis methodology, focusing on a number of issues. Organizational demands for efficiency savings have been identified as central to a change in supervisory function from a traditional ‘hands on’ role to a more distant managerial position. In addition, it was noted that workers in self managed teams may take informal supervision from colleagues and peers as opposed to designated line managers. During the design of the study questionnaire, issues concerning identify of supervisors became apparent with the health and safety manager and loaders confirming an informal and formal structure for supervision. This feedback prompted questionnaire design changes, including the introduction of the ‘who do you consider to be your supervisor?’ item, plus the term ‘driver’ in the response. This change produced data that illustrated over a third of the total sample for measurement points 1 and 2 perceived drivers to be their supervisors.

The correct identification of work groups is essential to the group level approach. Central to Zohar’s designation of group and organizational climates is the concept that workers take their cues concerning safety climate from the actions of supervisors. These actions, Zohar argues, are representative of the supervisors interpretation of management vision.
In the context of group level analysis, the introduction of the ‘perceptions of supervision’ item represents a contribution to knowledge with the potential to improve methodological accuracy. Despite this, however, there remains problems with group level analysis. Whilst the perceptions of supervision item allowed a degree of group level analysis in this study, this process was aided by the participating organization who arranged their workforce in small, stable and defined groups. As detailed previously, this arrangement is not one that necessarily dominates UK working environments.

The changes to the role of supervisors coupled with the practice of informal supervision demonstrated in this study calls into question the operability of group level analysis in the modern workplace. Zohar (2000) and Zohar and Luria (2004) have demonstrated the potential of the process, however, just as this study had to produce a bespoke approach to reliably collect data, Zohar and colleagues had to develop a unique questionnaire in each study. It can be argued that it was the perceived simplicity and universality of the initial safety climate concept that encouraged researchers and organizations to experiment and so benefit from it. Although Zohar (2008) may see a multi-climate multi-level future for safety climate, the reality may be that this future is too far removed from the initial appeal of this concept to come into fruition.

**Limitations and Suggested Improvements**

All research is subject to criticism in one form or another, ontologically, epistemologically and methodologically. This section will focus on methodological issues having justified the ontological and epistemological decisions made as part of the Methodology.

**Lack of Longitudinal Data**

One frustration during the analysis and discussion of the data collected was the inability to track individuals over the two measurement points used. During the design stages of this study, it was initially proposed that individuals would be identifiable over the measurement points allowing researchers to analyze lagged relationships as per Neal and Griffin (2006). This technique allows researchers to fully exploit the longitudinal methodology and so understand how individual (and group) level perceptions vary over time. As a result, researchers can respond to issues concerning reverse causation (Clarke 2006b) and contribute to the literature concerning the strength of
longitudinal safety climate-outcome relationships (Neal and Griffin 2006; Tharaldsen and Rundmo 2007).

Unfortunately, whilst piloting the survey with participants, union involvement produced a clear requirement for anonymity. This anonymity extended to the researcher, who was not able to assign random numbers to individuals and so allow tracking. Although this position was understandable, it has limited the range of the study findings. This is especially frustrating as the relationship between safety climate and accident outcome points to a potential opportunity to contribute to longitudinal literature in this area.

Control
One of the most obvious issues concerning the methodology used in this study concerns the absence of a viable control group. A number of options were considered in this area, including the separation of participants into control and intervention groups and the use of an external organization to act as a control. The idea of splitting the participants into control and intervention groups was dismissed for a number of reasons. First, it was felt that participants numbers were already limited and that further reduction would render certain types of statistical analysis (e.g. regression) impossible. Second, the participating organization were happy for the researcher to have access to their site and personnel on the basis of 100% workforce participation to maximize impact.

In light of these requirements, the researcher identified a similar organization engaged in the same activities located within an acceptable proximity from the participating organization. They agreed to act as a control group, however, questionnaire response rates were so poor that it was decided to abandon the arrangements. When it is considered that the control organization may have perceived little benefit from their participation, it is not surprising that their questionnaire response rate was so poor.

Sample
The sample size in this study can be recognized to be modest with 101 and 104 completed questionnaires produced at measurement points 1 and 2 respectively. Issues concerning the suitability of statistical techniques such as multiple regression were considered in the methodology
section as were concerns regarding the strength of relationships detected relative to sample size. As a result of these issues, it is concluded that a further study using a larger sample size would provide added assurance. The organization of collections teams, with drivers assuming informal supervisory responsibility, also provided problems and triggered the introduction of the ‘who do you consider to be your supervisor?’ perception item in the questionnaire. Responses to this item, detailed in the methodology section, provided a confused picture with around a third of respondents at each measurement point identifying their driver as their supervisor.

Although this confusion was used to justify the one dyad LMX approach used, it is equally prescient for the growing trend of group level safety climate assessment (Zohar 2000; Zohar and Luria 2004; Neal and Griffin 2006) that requires the collection of workforce opinion of supervisor and/or manager performance. Results in this study point to the complexities in identifying those groups with supervisory or managerial influence. As such, group level analysis that claims to be collecting worker perceptions of supervisor performance might actually be collecting worker perceptions of colleague’s performance. This issue may be sample dependent, a work-around that has been developed as a response to the issues of supervising small teams who work remotely, however, the results detailed in this study do suggest the requirement for further research into the group level climate hypothesis and the methodologies used to study it.

**Unique Working Practices**
A number of waste collections operatives are collected after trucks had left the depot and are dropped off before they return. For these individuals, safety climate and LMX questionnaires can only be answered from the perspective of the team in which they work as opposed to the organization. Work arrangements of this nature raise the prospect of safety ‘micro-climates’; a term originally used by Zohar to describe the demarkation of supervisor and management influence on safety perception (Zohar 2000; Zohar 2002).

It is possible to identify a distinction between Zohar’s conceptualization of micro-climates and that being proposed in the context of this study. For Zohar, the micro-climate exists as a result of differences in supervisory and managerial roles. Supervisors, it is said, have to turn management strategy into day to day reality. In this study, the proposed micro-climate is created by the
requirement to work in small, established teams independent from significant managerial or supervisory control. This distinction has implications for the nature and influence of the proposed micro-climate. For example, the absence of an identifiable supervisor could lead to individuals bartering for influence using valued attributes such as skill, experience or knowledge. Such a process could produce informal supervisors with a high degree of perceived legitimacy and hence a disproportionally large influence on perceptions of safety climate. Whatever the process, the end product, a harmonisation in group safety climate perceptions, would be similar to that identified by Zohar. Harmonisation has the potential to influence safety climate perceptions and hence the relationships between predictor and outcome variables (e.g. safety climate and accident/near miss involvement).

The anatomy of LMX in small, established work teams with poorly identified supervision has not featured in prior research, however, it would be sensible to assume these conditions exerted a limited influence on the results produced in this study. LMX theory suggests leaders do not treat all followers in the same way, rather, they develop positive relationships with certain individuals who then become the recipient of more support, opportunities for development and so on. This study presented a number of challenging aspects for LMX theory. First, the identify of the supervisor was not clear and hence the nature of the LMX relationship was complicated - could all high LMX relationships be treated as significant, regardless of the identity of the leader (i.e. supervisor, driver, loader)? In this study they were, however, it is important to note the potential for error that this approach introduced.

Second, the work groups used in this study consisted of between 3-4 individuals. Whilst it is possible to visualise how a leader may employ a selection strategy when managing upwards of 7-8 individuals, it is difficult to understand how this process would be undertaken in such small teams working in conditions that demand frequent leader-member interactions. Cogliser and Schriesheim (2000) further complicate matters suggesting ‘work unit cohesiveness may be conceived as being both a between- and within-groups phenomenon, having different effects on subordinate outcomes when there is either group consensus on LMX or high variation within the work group’ (Cogliser and Schriesheim 2000, pg 492). It is possible to conceive, therefore, of small work groups with a consensus view of LMX that influences group performance. Such a scenario would echo that
detailed for safety climate above; an exaggerated link between the ‘individual’ level scale and the outcome measure (e.g. self report accident/near miss levels).

**Study Tools**
The selection of safety climate questionnaire was one of the most important aspects of this study. Safety climate research is comprehensive and the selection of one questionnaire over another now has significance for the assumptions the research makes prior to the study and the conclusions they can make after it. The researcher recognized Glendon and Litherland’s questionnaire as a risky choice, however, it was felt that this risk was worth taking in light of the potential benefits. Key among these was the central thesis that the non-traditional roots of the questionnaire, the Performance Shaping Factors, had produced a more task oriented and therefore stable tool. Results did not support this hypothesis, however, it is possible that the choice of questionnaire did have other, non intended benefits.

The most significant of these is the separation of leadership and safety climate that allowed for the discovery of the juxtaposed moderating patterns discussed earlier. In light of this beneficial but unexpected side effect, it may seem strange to focus on the climate survey when looking at potential study improvements. Despite this, it is essential to understand if the moderating effects witnessed in this study were as a result of the studies used or whether they are common features of the climate, LMX, compliance and participation relationships. This can only be understood through the application of a traditional safety climate survey alongside the measures used in this study (e.g. LMX, compliance and participation).

**Accident Reporting Timeframe**
Due to a clerical error, the organization used a version of the questionnaire that requested information about accident and near miss involvement over a three year period. Once the error had been identified, it was not possible to redistribute the questionnaire and so the decision was made to continue with the study as planned. To ensure comparability, the second questionnaire also requested three year accident and near miss history. The researcher recognizes this mistake compromised the efficacy of the data, diluting any potential relationships between predictor and outcome variables. If the researcher had been able to match the timeframe for accident and near miss reporting at the first measurement point with the delay between the first and second
measurement point, it would have been possible to more accurately analyze the impact of the brainstorming sessions on accident and near miss involvement.

For example, if the questionnaire used at measurement points 1 and 2 had requested accident and near miss data for the last six months, and the gap between the interventions had remained six-seven months, it would have produced a more precise snapshot of before and after the intervention and hence a better measure of its impact. As a methodology, it would also have more accurately reflected other intervention based studies (Probst and Brubaker 2001; Lingard et al 2002; Zohar 2002; Zohar and Luria 2004). Using the three year period for both questionnaires reduced the potential to detect change between each measurement point as the change over the six month period was diluted by the three year measurement.

This oversight was particularly frustrating when it is considered that, despite the two and a half year overlap, accident and near miss involvement reduced from the first measurement point to the second. This finding suggests that, had the researcher been able to match the duration of the outcome measures for the two measurement points, it may have been possible to detect a change in accident and near miss involvement and hence provide support for one of the central study hypotheses - namely that brainstorming could be used to improve participation in safety and hence reduce accident involvement. Clearly the three year accident and near reporting timeframe was a methodological oversight, however, it may have positively contributed to the findings in one respect, namely the size of the accident and near miss involved groups.

Using accident and near miss involvement as an outcome measure in research is often fraught with difficulty as the involved groups tend to be small. Researchers have responded to this issue using a number of more frequently occurring measures such as micro-accidents (Zohar and Luria 2004) and behavioural observations (Glendon and Litherland 2001). Analysis of data produced in this study identified approximately one-third of the sample reporting accident and near miss involvement at measurement points 1 and 2, a significant number that permitted statistically robust between group comparison. When contrasted with similar studies, the accident and near miss involved population identified in this research seemed large, however, one potential explanation for this finding relates to the extended timeframe used in the questionnaires. By asking for accident and near miss
involvement over a three year period, researchers greatly increased the likelihood of positive response, especially in a high hazard sector such as waste collections (BOMEL 2004). As such, the extended accident reporting timeframe can be regarded as a large hindrance but also as a small aid to the significance of the findings identified in this study.
Chapter 7 - Conclusions

Introduction

The purpose of this chapter is to summarize the findings of the thesis in line with the aims and hypotheses detailed in the introduction and results section respectively. Guidance for future research will also be discussed.

Conclusions

Study two was broadly responsible for the delivery of three of the four study aims. Aim one was to ascertain whether brainstorming could be used to improve levels of perceived participation in safety, and, as a result, effect a change in near miss/accident rates. Results indicated brainstorming was not suitable for this application, however, it is proposed that the study design and execution allowed the successful investigation of this aim. The potential explanations for the failure to improve either perceived levels of participation or near miss/accident involvement have been detailed in the discussion section of this thesis, however, indications concerning change in workforce perceptions of the role of participation and compliance post-brainstorming suggest a potential argument in favour of further research. The second and third study aims concerned the delivery of improved understanding of the relationships between LMX, safety climate, compliance, participation and near miss/accident involvement. The working model proposed represented a combination of variables that had yet to be studied in safety research. The results of analysis supported the model structure, including the moderating and mediating assumptions. This represents a contribution to knowledge with significance for research concerning safety performance, safety climate and LMX (Hofmann et al 2003) as well as safety performance, safety climate, participation and compliance (Neal and Griffin 2006).

Analysis of the moderating and mediating effects proposed revealed some unexpected relationships. Multiple regression indicated that the moderating effects of safety climate on the LMX-compliance/participation relationship did not follow the pattern identified by Hofmann et al (2003). Again, this finding represented a contribution to knowledge and its proposed explanation, utilizing a mix of economic and multi-climate theory, represented a novel combination of ideas. The Sobel statistic, generated to investigate the hypothesized mediating roles of compliance and participation, highlighted a degree of fluctuation that underlined the potential for change in workforce perception of the roles of compliance and participation.
Future Research
A number of potential avenues for future research have already been detailed in the discussion section of this thesis. As a result, this chapter section will summarize the future research opportunities already identified using a theme based technique to provide continuity between this, and the discussion section. Any additional avenues of research, not previously identified, will also be included in this section.

Theme 1: Multi-Climate Framework
One of the most significant study findings concerned the nature of the safety climate moderating effects recorded. The counterintuitive relationship between LMX, safety climate, compliance and participation produced a complex explanatory proposition that combined elements of economic theory with Zohar’s multi-climate concept (Zohar 2008). This proposition requires further research to discern whether support for an alternative climate can be found, and, if it can, whether the interaction between competing climates can be demonstrated. Although it may be possible to analyze proposed climates using a questionnaire based methodology, it may be beneficial to expand this process to include tripartite techniques. For example, a questionnaire based approach could be combined with audit and observation. This technique would avoid issues concerning common method variance, a particular concern as the number of variables dependent upon a single measurement technique increases, and may help in the identification of points at which the competing climates interact. For example, both safety and work ownership climates have the potential to influence productivity vs. safety decision making. Using observation may help in the identification of cues or triggers that influence decision making and so further understanding of which climates are effective and when.

In addition to multi-climate theory, it was also suggested that supervisors may directly highlight their behaviour expectations based upon economic selection techniques. In this context, economic theory was borrowed from group level research that has demonstrated that individuals moderate their efforts depending upon the impact they believe they will have upon group outcome. Clearly this theory requires further research to ascertain whether it can be extended from the study of brainstorming through to safety. This research would require the creation of a new scale to measure
supervisor perceptions of influence on a variety of group outcomes, however, it may also be useful to combine this questionnaire with the physical measurement of agreed outcomes. This technique would again avoid common method variance but also help to establish the efficacy of the new questionnaire.

**Theme 2 - Safety Climate Analysis**

Study findings concerning safety climate produced two main conclusions. Conclusion one concerned the poor factor structure ascertained and pointed towards the efficacy of a global measure of safety climate. Conclusion two concerned the direct relationship between safety climate and near miss/accident involvement and underlined the value of safety climate as a pro-active measure of organizational safety performance. Whilst Zohar (2008) has endorsed a global measure of safety climate in an effort to move the debate on from iterative factor proving analyzes, this study falls short of this recommendation for a number of reasons. First, the potential for a universally applicable means of climate measurement is too great for it to be dismissed after only 30 years of research. Second, because the issues concerning Zohar’s proposed alternative, namely group level analysis, seem equally if not more problematic than those associated with a universal measure of climate.

In retrospect, there may not be a need for a 30 or 40 item analysis of safety climate. Theorists have experimented with smaller questionnaires (Zohar and Luria 2004; Neal and Griffin 2006) and produced positive results. Perhaps, therefore, the answer lies in the study of safety climate dimensions using a reduced number of items. This could produce a core factor structure, similar to that proposed by Glendon and Litherland (2001), and leave open the opportunity for organizations to tailor their questionnaires along whichever avenues they deemed significant. Whilst this approach is not fully endorsed by the findings produced in this study, it does represent the weaving of study findings with the larger safety climate literature.

**Theme 3 - LMX**

LMX was instrumental to several of the more significant contributions to knowledge made in this study. The role of supervisor/workforce relationships was seen to demonstrate a direct relationship with near miss/accident involvement but also shown to be mediated through compliance and
participation. Further research is required to reinforce the findings produced in this study but also investigate the LMX construct in more depth. Although this study only analyzed one half of the dyad (e.g. the workforce perspective) it would be significant to note how fully operated dyad relationships correlated with near miss/accident involvement. In addition, although knowledge, motivation and skills were not included in this study, it is possible to predict that worker-supervisor relationships may have the potential to influence one if not all three of these determinants of safety performance.

One aspect of LMX research worthy of further study concerns the criticism already detailed for the group level analysis of safety climate. The group level approach adopted by Graen and Uhl-Bien in the LMX-7 scale seems, at surface level, very similar to that used by Zohar and colleagues. Both rely upon worker perceptions of supervisors to produce a group level measure, however, closer inspection of the theoretical support for LMX-7 reveals this scale makes no assumptions concerning the relationship between these perceptions and the nature of ‘organizational’ and ‘group’ leadership. Despite this, the focus on the significance of the worker-supervisor relationship can be seen to be a potentially limiting aspect of LMX/safety performance research.

As previously stated, this study benefited from an organization with a stable group structure and defined teams. Complications concerning supervisory influence were relatively easy to manage through the introduction of the supervisory identification item. Regulatory research has demonstrated that pressures from de-manning and drives for further efficiency are changing traditional working arrangements and removing the role of the traditional ‘hands on’ supervisor. Often, this is leaving workers to rely on informal or peer based supervision. This change may have an effect on the future utility of LMX in high risk or safety critical environments and it is important that future research attempts to counter this possibility.

Research that demonstrates the continuation of the LMX-neat miss/accident relationship in organizations with more diffuse or less authoritarian management structures would provide vital assurance that LMX has the flexibility to become a significant variable in the measure of safety performance. The idea that behavioural reciprocation may be able to extend beyond to immediacy of supervisor-worker relationships to more distant leader-worker relationships has support in both LMX research but also in the wider field of social psychology (e.g. reciprocity).
Appendix I - Study 1 Relevant Rules
The Rules of Brainstorming

Interactive Brainstorming

1. As many ideas as possible
2. No criticism
3. Crazy ideas welcome
4. Freewheeling to be encouraged

Nominal Brainstorming

1. As many ideas as possible
2. Crazy ideas welcome
Appendix II - Study 1 Questionnaire
THESE QUESTIONS RELATE TO THE BRAINSTORMING SESSION ONLY. PLEASE COMPLETE THIS QUESTIONNAIRE AS HONESTLY AS POSSIBLE. ALL INFORMATION COLLECTED WILL BE TREATED ANONOMOUSLY. IF YOU HAVE ANY SPECIFIC QUESTIONS REGARDING THIS QUESTIONNAIRE, PLEASE ASK YOUR TRAINER.

Are you  Male  ✔  Female  ☒
Aged   18-24  ☒  25-35  ✔  36-45  ✔  46-55  ✔  56-65  ✔  65+  ✔

Please indicate your level of satisfaction with the following. Please circle the corresponding number:

- Number of ideas generated
  - Not satisfied: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Very satisfied: 10

- Quality of ideas generated
  - Not satisfied: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Very satisfied: 10

- The brainstorming process itself
  - Not satisfied: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Very satisfied: 10

Please indicate the level to which you agree, or disagree with the above statements. Please circle the corresponding number:

- I feel a sense of belonging to this team
  - Strongly disagree: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Strongly agree: 10

- I feel that I am a member of this team
  - Strongly disagree: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Strongly agree: 10

- I see myself as a part of this team
  - Strongly disagree: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Strongly agree: 10

- I am enthusiastic about this team
  - Strongly disagree: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Strongly agree: 10

- I am happy to be with this team
  - Strongly disagree: 0, 1, 2, 3, 4
  - Neutral: 5, 6, 7, 8, 9
  - Strongly agree: 10
Appendix III - Study 2 Questionnaire
Participant,

Thank you for taking the time to complete this questionnaire. You probably have some questions, we have tried to answer some of the most common questions below:

**Why have I been asked to complete a questionnaire?**

Your company is looking to improve or continue improvements made in their health and safety performance. Research tells us understanding workforce opinions are an excellent way of beginning or continuing safety improvement programmes. This questionnaire gives you an opportunity to tell us what you think about health and safety at your organization.

**How long will this take?**

Everyone completes questionnaires at different speeds; however, we estimate this should take between 15-25 minutes to complete.

**What will happen to my data?**

This questionnaire is **COMPLETELY ANONOMOUS**. The answers you provide **CAN NOT AND WILL NOT** be traced back to you. Please be as honest as possible when completing this questionnaire.

**Further information and feedback**

If you have any queries regarding this questionnaire, please contact:

David Birkbeck
Principal Consultant
Entec Risk and Safety
Tel: 01606 354935
e-mail – david.birkbeck@entecuk.co.uk

Thank you for your participation.
**Instructions**

To complete this questionnaire, please read the question and circle the response that matches your thoughts. For example, question 1 asks:

<table>
<thead>
<tr>
<th>Safety rules are followed even when the job is rushed</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] Never</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

If you think safety rules are always followed, even when the job is rushed, you might circle 9 as indicated below:

<table>
<thead>
<tr>
<th>Safety rules are followed even when the job is rushed</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] Never</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

If you think they are sometimes followed, but often not, you might circle 3, as indicated below:

<table>
<thead>
<tr>
<th>Safety rules are followed even when the job is rushed</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ] Never</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

There are no right answers, just your answers. Please answer all questions indicated. Your responses are important and will help your organization
1. Are you (please circle) 
   - Male  
   - Female 

2. Age range (please circle) 
   - 15-24  
   - 25-34  
   - 35-44  
   - 45-54  
   - 55-64  
   - 65+ 

3. Please indicate your job role (please circle) 
   - Management  
   - Supervisors  
   - Driver  
   - Loader 

4. Who do you consider to be your supervisor? (please circle) 
   - Management  
   - Supervisor  
   - Driver  
   - Loader 

5. Have you been involved in an incident or accident in the last 3 years? 
   - Yes (please answer question 6)  
   - No 

6. How serious was this incident or accident (please circle) 
   - No action was taken  
   - First aid administered (personally)  
   - First aid administered (by first aider)  
   - Further medical treatment required  
   - Immediate medical assistance required (ambulance) 

7. Have you been involved in or seen a near accident? 
   - Yes (please answer question 8)  
   - No 

8. How serious would the incident have been? (please circle) 
   - No action would have been needed  
   - First aid would have been needed (personally)  
   - First aid would have been needed (by first aider)  
   - Further medical treatment would have been required  
   - Immediate medical assistance would have been required (ambulance)
<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Sometimes</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Safety rules are followed even when the job is rushed</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>10. Safety rules can be followed without conflicting with work practices</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>11. Safety rules are always practical</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>12. Workers are confident about their future within the organisation</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>13. Good working relationships exist in this organisation</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>14. Morale is good</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>15. PPE use is monitored to identify problem areas</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>16. PPE users are consulted for suggested design improvements</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>17. Findings from PPE monitoring are acted upon</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>18. PPE use is enforced</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>19. There is sufficient ‘thinking time’ to enable workers to plan and carry out their work to an adequate standard</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>20. There are enough workers to carry out the required work</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>21. Workers have enough time to carry out their tasks</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>22. Time schedules for completing work projects are realistic</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>23. Workload is reasonably balanced</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td>24. Problems arising from factors outside workers control can be accommodated without negatively affecting safety i.e. route changes</td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>25. Work procedures are complete and comprehensive</td>
<td>Never</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>26. Work procedures are technically accurate i.e. reflect the job</td>
<td>Sometimes</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>27. Work procedures are clearly written</td>
<td>Always</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>28. Written work procedures match the way tasks are done in practice</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>29. Workers can easily identify the relevant procedures for each job</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>30. An effective documentation management system ensures the availability of procedures</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>31. Work problems are openly discussed between workers and supervisors</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>32. Workers are spoken to when changes in work practices are suggested</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>33. Workers can express their views about work policy</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>34. Workers can discuss important policy issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>35. Changes in working procedures and their effects on safety are effectively communicated to workers</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>36. Workers are told when changes are made to the working environment on a job site</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>37. Company policy is effectively communicated to workers</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>38. Arrangements are made so workers are not working by themselves</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>39. Workers are encouraged to support and look out for each other</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>40. Potential risks and consequences are identified in training</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Neither</td>
</tr>
<tr>
<td>----------------------------------------------------------------</td>
<td>-------------------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>41. I use all the necessary safety equipment to do my job</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>42. I use the correct safety procedures for carrying out my job</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>43. I ensure the highest levels of safety when I carry out my job</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>44. I promote the safety programme within the organization</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>45. I put in extra effort to improve the safety of the workplace</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>46. I voluntarily carry out tasks or activities that help improve the workplace safety</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
These questions refer to you and your supervisor. Please use the individual you selected in question 4 as your supervisor

47. Do you know where you stand with your supervisor…do you usually know how satisfied your supervisor is with what you do?
Rarely Occasionally Sometimes Fairly often Very often

48. How well does your supervisor understand your job problems and needs?
Not a bit A little A fair amount Quite a bit A great deal

49. How well does your supervisor recognize your potential?
Not at all A little Moderately Mostly Fully

50. Regardless of how much formal authority he/she has built into his/her position, what are the chances that your supervisor would use their power to help you solve problems at work?
None Small Moderate High Very high

51. Again, regardless of the amount of formal authority your supervisor has, what are the chances that he/she would ‘bail you out’ at his/her expense?
None Small Moderate High Very high

52. I have enough confidence in my leader that I would defend and justify his/her decision if they were not present to do so?
Strongly agree Disagree Neutral Agree Strongly agree

53. How would you characterise your working relationship with your supervisor?
Extremely ineffective Worse than average Average Better than average Extremely effective
Bibliography


