

**Faculty of Health Sciences  
School of Psychology and Speech Pathology**

**Managers, Mates and the Role of Social Exchange:  
A Multilevel Model of Safety Climate and Proactive Safety  
Behaviour.**

**Fiona Rae Geddes**

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## Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

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### Abstract

The issue of safety in the workplace may be described as an area of both chronic and acute significance to workers, organisations, families and communities. The aim of my research was to develop and test a work-level model of safety climate by incorporating coworker commitment to safety with existing safety climate measures of manager and supervisor commitment to safety. Climate for social exchange, involving management, supervisor and coworker social exchange dynamics, was further proposed as a foundation climate supporting the development of facet-specific safety climate. The application of a levels-of-analysis approach to scale development recognises the hierarchical nature of organisations. Using explicit organisation referents for both the social exchange and safety climate domains and was intended to clarify construct definition, distinction and interrelatedness issues. Self-report surveys completed by 342 front-line workers (excluding supervisors and managers) representing 120 functional work teams in 80 departments, across nine organisations (including contractor affiliates) formed the main cross-sectional sample. Organisations providing less than ten valid front-line worker responses were excluded when describing organisational safety climate profiles ( $N=6$ ) and work groups with less than two valid responses were excluded from group level analysis ( $N=77$ ). Factor structures and predictive models of climate variables were examined using individual and group-level data, allowing the direct comparison of results obtained using different aggregation methodologies. Results indicated that supportive climates for social exchange provide a foundation for the development of positive safety climates at aligned work-levels. The emergent factor structures of organisation and group-level safety climate, reflecting management and supervisor's commitment to safety, differed when analysed using individual and group-level analyses. A strong relationship was found between global safety climate and the safety behaviours of workers; however the hypothesised safety climate → safety behaviour → injuries/ incidents mediation model was supported when using group-level analyses. Larger predictive effects were observed for self-reported near miss incidents than for minor injuries, supporting the potential utility of this index in future research. The more proximal influences of coworker and supervisor safety climate subscales were found to mediate the more distal influence of management safety climate on workers' safety behaviours. The three work-level safety climate

dimensions (i.e. management, supervisor and coworker commitment to safety) fully mediated the effects of social exchange climate on individual safety performance, supporting a hierarchical psycho-social model of workplace safety. It was concluded that incorporating the normative influence of coworkers and climate for social exchange in models of workplace safety, enhances our understanding of how the social context impacts workers' safety perceptions and performance. The application of a level-of-analysis approach to construct operationalisation and data treatment generates practical, theoretical and methodological challenges for future safety research.

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## **1. Introduction and Overview**

### **1.1. Introduction**

The issue of safety in the workplace may be described as an area of both chronic concern to employers and governments and of acute significance to employees, families and communities. Australian safety statistics indicated that in the 2009-10 financial year, 640 700 people or 5.3% of the working population experienced at least one injury in work-related incidents in the past 12 months (Australian Bureau of Statistics, 2011). Of these workers 56 % required some time off work to recuperate. Even though the major consequences of workplace incidents are generally only minor injuries, workplace fatalities are still too frequent an occurrence. Excluding fatalities due to work-related traffic accidents on public roads, Safe Work Australia reported 111 deaths in 2009-2010, down from 151 in 2008-09 and 134 in 2007-08 (Safe Work Australia, 2010).

Even though work-related injury and fatality rates in Australia appear to be on the decline the total economic cost of work-related illness and injuries has been estimated at \$57.5 billion dollars or 5.9 % of GDP for the 2008-09 financial year (Safe Work Australia, 2010). Safe Work Australia reported 134 835 serious compensation claims being made in 2007-08 at an average claim payment of \$6 900. While estimates of the direct financial costs of workplace accidents to industry and the community can be extrapolated from lost work hours, medical costs and insurance claims, such figures may under estimate the real financial costs involved, as a significant proportion (36%) of workers who experience injuries choose not to pursue compensation claims (Australian Bureau of Statistics, 2011). Yet beyond the immediate economic costs, it is far more difficult to capture the full extent of personal suffering experienced by accident victims and their families, as the effects may well impact on individuals' short and long term physical, psychological, social and financial wellbeing.

It is often not until media attention is focused on specific cases of personal tragedy or major accidents that the significance of safety in the workplace is raised to a more global level and our communities begin to question "how could this have happened?" One such example was the Deepwater Horizon rig explosion and fire in April 2010

in which 11 people lost their lives and 17 others were injured. However beyond the personal injury toll experienced at Deepwater Horizon, the environmental, social and economic ramifications of this event continue to impact affected communities.

Despite the drama and tragedy of such large scale incidents briefly capturing local and worldwide media attention, the consequences of day-to-day workplace accidents are more often endured by the families of victims, workmates, corporations involved and local communities with little acknowledgement. Whether large or small scales, root causes of accidents are inevitably sought by industry investigators and the legal responsibility of accident causation examined by governing authorities, however just as the overarching personal, social and economic costs of accidents are hard to ascertain so too are the underlying causes of accidents.

Investigating why accidents occur and finding ways to improve workplace safety practices are areas that have long been of interest to organisational psychologists (e.g., Heinrich, 1931). Importantly, in recent years, research into the behavioural aspects of occupational safety has shifted emphasis away from describing *lagging* indicators, such as accidents and injuries rates, to focus on more complex models of *leading* indicators, including individual and organisational factors that support or prohibit safe behaviours by employees (Flin, 2003; Reason, Parker, & Lawton, 1998). Within this context, the *safety climate* of an organisation has been proposed as a key indicator of safety performance (Zohar, 1980). While safety climate instruments have continued to gain support from academics and practitioners, explanatory models examining the process through which safety climate influences the safety performance of individuals have been limited in number and scope (Flin, 2007). In addition the typical treatment of safety climate as an individual-level construct rather than a group-level construct has been criticised (Zohar, 2003, 2010).

The overall aim of this research is therefore to expand our understanding of the link between organisational climate and safety outcomes by developing and evaluating a psycho-social model of safety climate in an Australian sample using a levels-of-analysis approach as recently recommended by Zohar (2010). This approach recognises that in organisational settings any investigations should acknowledge and respect the extant hierarchies or functional work-levels operating in that specific

context. For example safety constructs should be operationalised at the relevant work-level and data collected from, aggregated to and evaluated at the corresponding levels. To address the need for stronger theoretical grounding in safety climate research my explanatory model will be developed within the context of social exchange theory. This approach fits well within the framework for organisational research recommended by Bennett, Cook and Pelletier (2003). A summary of how aspects of Bennett et al.'s conceptual framework have been used to guide the development of my research is discussed in the next section.

## 1.2. Conceptual framework

In an attempt to promote more theoretically and methodologically rigorous research in the field of Organisation Health, Bennett et al.'s (2003) framework highlights the importance of understanding organisations in terms of both the external and internal contexts in which they operate. Whereas Bennett et al.'s seven core themes originally focused on organisational health; when adapted to a safety context (see Table 1.1) they provided a meaningful framework for the development of this thesis.

Table 1.1 *Conceptual Framework of Research into Organisational Safety*

Theme	Postulates of Organisation Safety
<b>1 Multidimensional</b>	Recognition of multiple dimensions of safety.
<b>2 Multilevel</b>	Multiple levels of analysis and cross-level interrelationships should be taken into considered.
<b>3 Self-assessment adaptability</b>	Consideration given to ongoing monitoring of safety levels and adaptive responses associated with the multidimensional and multilevel components of safety.
<b>4 Effort in safety promotion</b>	Implementation of multilevel, proactive safety programs and policies
<b>5 Fitness/Congruence</b>	Consideration given to safety congruence both between organisation and external environment and within organisation components.

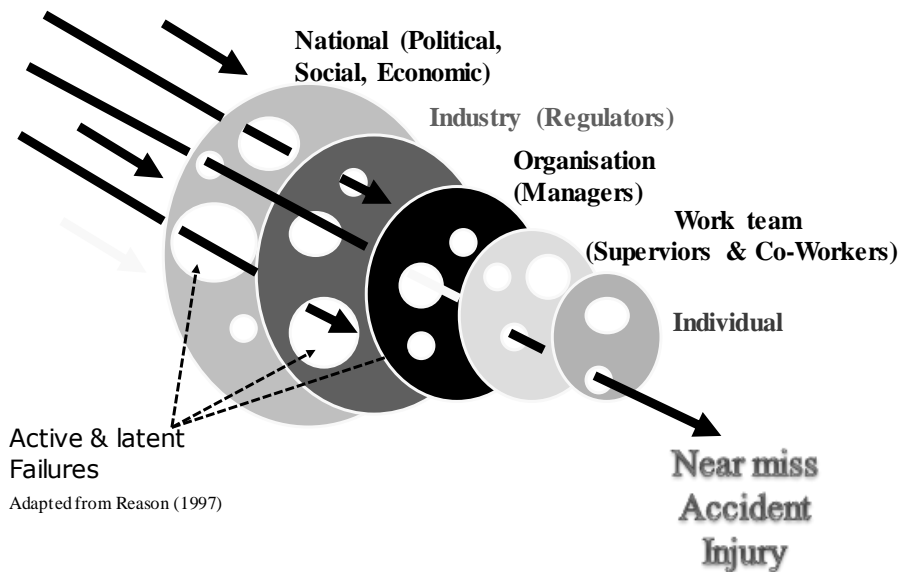
*(table continues)*

**Table 1.1** (*continued*)

Theme	Postulates of Organisation Safety
<b>6 Core tensions</b>	Awareness of core tensions involved in maintaining optimal safety
<b>7 Regression/ Development</b>	Awareness of the cycles of growth, regression and deterioration of organisation vitality which may affect safety efforts

Note. Adapted from (Bennett et al., 2003)

The first theme, multidimensionality, postulates that a safe organisation considers multiple dimensions of employees' safety including subjective and objective data. Implications of this theme in the development of my research include the need to critically appraise the utility and validity of current safety climate measures and the various indicators of safety outcomes including dimensions of individual and organisational safety performance, including accidents, injuries and near miss incidents. Figure 1.1 illustrates an overarching conceptualisation of a multilevel model of safety climate which has been based largely on Reason's (1997) Swiss cheese model of organisational safety and the seminal work of Zohar (2003, 2010). The graphic identifies near misses, accidents and injuries as separate but related outcomes of active and latent failures in safety systems and culture.



*Figure 1.1.* Ecological model of embedded cultures and multilevel organisational safety climate.

The second theme focuses on the nested or multilevel nature of organisations. In my study, a work-level approach is used in the development of all climate measures and analytical techniques employed. Particular attention is paid to the use of appropriate referent points (self, work group, supervisor and top management) in the generation of survey items. Model specification also delineates the level of aggregation applied for statistical analysis. Figure 1.2 illustrates the specific work-levels of interest in my thesis, being organisational level safety behaviours of managers and group level behaviours of front-line supervisors and workers. In accordance with Zohar's (2010) level-of-analysis approach this graphic illustrates how data collection can be conducted at the different levels supporting multi- and cross-level analysis. In the data collection phase of my research three versions of the survey were developed and coded to facilitate data matching across work-levels. Responses from managers, supervisors and front-line workers were obtained however only front-line worker responses are examined in this thesis.

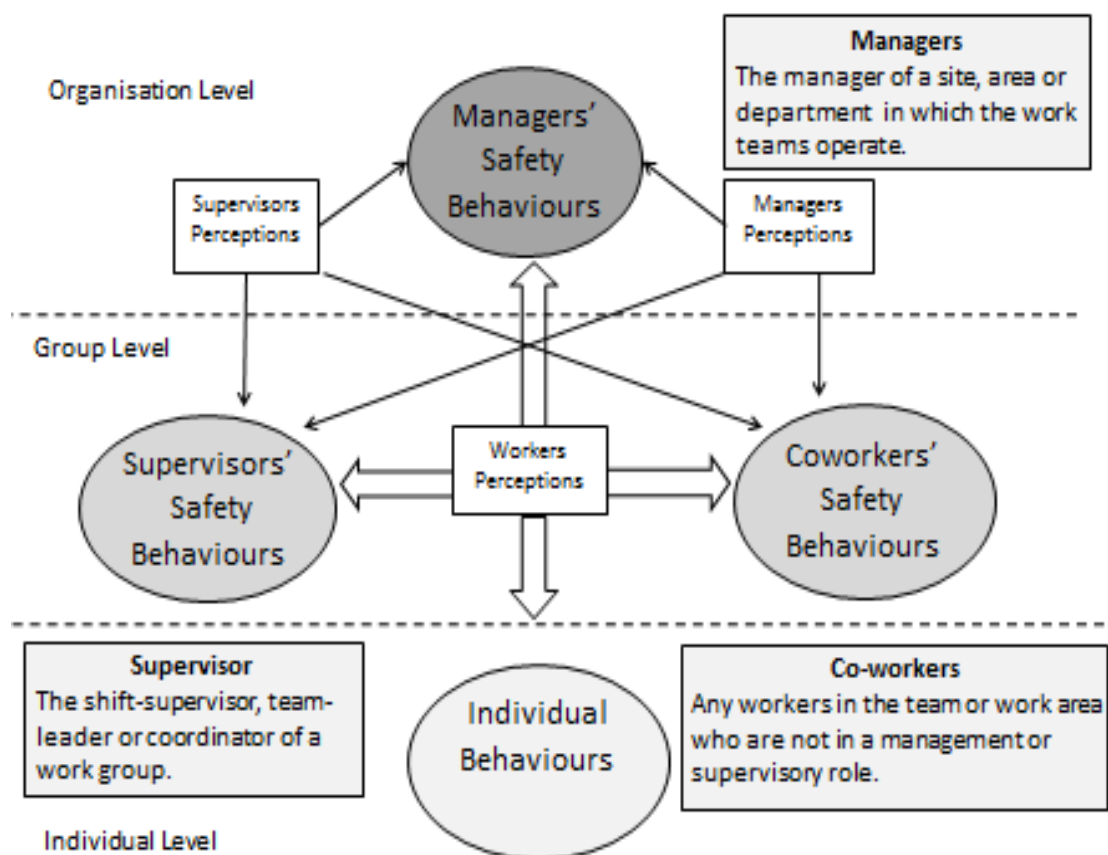


Figure 1.2. Work-level conceptualisation of organisational safety climate.

The third theme identified in Bennett et al.'s (2003) framework is concerned with self-assessment adaptability. In terms of my adaptation this focuses on both the researcher's and organisations' commitment to ongoing monitoring of safety levels and adaptive responses to safety feedback. A priority of my study is to provide participant organisations with baseline appraisals of their safety standing, while championing the need for and benefits of ongoing (longitudinal) assessments. Questionnaires incorporate coding systems and confidential identifiers to allow data matching across time in future evaluations.

Theme four, effort in safety promotion, highlights the importance of organisations acting on research feedback by implementing safety programs and improving policies. Even though provision of an intervention/training workshop was not a part of my research, all participant organisations were provided with comprehensive feedback identifying areas for potential policy change and training needs.

Theme five focuses on safety in terms of organisational fit - both external and internal. Conducting inter and intra organisational research offers opportunities to identify similarities and differences in safety-related antecedents and outcome variables across and within industries. To facilitate external fit analysis, I recruited organisations from different industry groups including the mining, resource (oil and gas), transport, construction and manufacturing sectors. Internal fit is linked to multilevel analysis as mentioned above and includes the assessment of diversity and consensus amongst individuals and work-groups on safety indicators, such as climate strength and variability.

Bennett et al.'s (2003) sixth theme relates to researchers having an awareness of the core tensions involved in maintaining optimal safety within an organisation. This theme considers the degree of organisational alignment of "adaptive tensions" in terms of three main dimensions: stability versus chaos; coherence versus diversity and a slack versus tight fit. Again the conceptual and statistical treatment of data in this study provides a measure of the coherence and fit of the group-level climate constructs operating within and between different organisations. While longitudinal data would provide an indication of the stability of the climate constructs over time

this important component was not assessed however provision was made for follow up data collection in the questionnaire design.

Bennett's et al.'s (2003) last theme recognises the process of both regression and development of an organisation's experience. Applied to a safety context this involves having an awareness of the cycles of growth and deterioration an organisation may go through and how these may affect safety efforts. From a top down perspective, this highlights the importance of understanding the broader political, social and economic context organisations operate within. This contextual component of the framework was critical in the initial sourcing and negotiations with participant organisations as data collection occurred within a period of economic volatility and labour market instability. References to contextual factors are briefly described in the methodology chapter and are also taken into consideration in the final interpretation and discussion of results.

This approach also allows us the opportunity to foster a greater appreciation of the impact safety incidents can have on organisational vitality and employees' perceptions of the pervading culture of the organisation. This specifically relates to the retrospective design characteristics of my study. Recently, the utilisation of both retrospective injury and accident statistics in safety research has been raised as a concern (Beus, Payne, Bergman, & Arthur, 2010). Beus, Payne, et al. argue that studies choosing this type of data source should theoretically frame explanatory models in terms of injuries predicting safety climate rather than safety climate influencing injury rates. Despite this concern, retrospective designs in which safety climate is framed as a *lead* indicator of incidents and accidents have been and continue to be the most common study design reported in the extant safety literature, largely due to the methodological issues, such as attrition, and logistical difficulties associated with obtaining prospective injury data (whether subjective or objective) from organisations using longitudinal research.

Bennett et al.'s (2003) framework provided a useful point of reference for the development of my research approach, however the main ideas and rationale for my thesis chiefly emerged from reviewing the seminal works of Zohar (Zohar, 1980,



2000, 2002a, 2003; Zohar & Luria, 2005) and Hofmann and colleagues (Hofmann & Morgeson, 1999, 2004; Hofmann, Morgeson, & Gerrass, 2003; Hofmann & Stetzer, 1996). Subsequent commentaries on safety climate by Zohar (Zohar, 2008, 2010; Zohar & Tenne-Gazit, 2008) and key meta-analyses in the domain (Beus, Payne, et al., 2010; Christian, Wallace, Bradley, & Burke, 2009; S. Clarke, 2006; Nahrgang, Morgeson, & Hofmann, 2011) provide added support for the approach taken and my research objectives as discussed in the review of safety literature outlined in the following section.

Three of the four meta-analyses referred to in my study (Beus, Payne, et al., 2010; S. Clarke & Ward, 2006; Nahrgang et al., 2011) utilised the meta-analytic approach recommended by Hunter and Schmidt (2004), indicating a relatively consistent approach across reviews. With regard to the choice of using fixed or random effects modelling only Christian, et al., (2009) specified the use of random effects in their meta-analysis. Both Clarke and Christian, et al., included only published articles in their meta-analysis, whereas Beus, Payne, et al. and Nahrgang also included unpublished studies and dissertations that complied with their inclusion criteria in their studies. Given the different publication time frames covered in each of the four meta-analyses it was noted that the majority of overlapping studies in the four meta-analysis represented all the key publications in the research domain over the past twenty years. The inclusion criteria and handling of multiple reported effects with in the same research were all comprehensively described and relatively consistent across the studies.

### **1.3. Thesis Overview**

The overarching aim of my study is to develop a model of safety climate and social exchange that examines climate indicators at multiple work-levels across the organisations. A further aim is to examine potential differences in construct structures and relationships for the proposed model when analysed at both the individual and group-level. Chapter 2 of my thesis focuses on the theoretical foundations and empirical findings relating to safety climate. This review begins with a brief overview of issues in general climate research before moving on to more specific aspects of safety climate operationalisation, measurement options and

application in explanatory models. My critique is intended to provide an understanding of relevant developments in the domain with a specific focus on current strengths and weakness in safety climate research. In particular I seek to justify the addition of coworkers (or mates in the Australian vernacular) as a focus of interest when operationalising safety climate measures.

In Chapter 3, I examine various indicators of safety outcomes beginning with a description of two key measures of individual safety performance: compliance and participative behaviours. Empirical evidence supporting the differential relationships between these behavioural outcomes and safety climate are presented. I then move on to evaluate the variety of accident and injury-related outcome measures that have been used in the safety literature. Often these have been linked to industry standards and have included statistics such as fatalities and lost-time injuries and more recently micro accidents and near miss incidents. This review is intended to provide justification of the selection of outcome measures in my research.

Chapter 4 provides a review of the leadership and group dynamics literature with a focus on the influences exerted by management and supervisor; and the more informal influences that coworkers have in establishing safety norms. Social-exchange theory is proposed as a theoretical basis for understanding the lateral and vertical workplace interactions operating within organisations. Evidence supporting the operationalisation of social exchange as a foundation climate construct supporting the development of safety climate is also examined. The cross-sectional design of my study precludes the definitive testing of causal relations between study constructs, however evidence from both the safety and leadership literature is provided to support the temporal ordering of climate for social exchange as an antecedent of safety climate and performance.

In Chapters 5 and 6, the rationale and methodology for my thesis are presented. Chapter 5 provides a summary of research objectives and rationale for the development of research hypotheses. Chapter 6 presents the methodology applied in my study, including a description of organisation characteristics. Chapter 6 also

includes an account of measurement development and a summary of injury and incident statistics.

The validation of the measures used in the study is the focus of Chapter 7. I begin this chapter with a summary of procedures pertaining to assumption testing and missing data treatment. The focus then shifts to the assessment of individual- level factor structures and psychometric properties of the individual safety behaviour, psychological safety climate and social exchange scales. Exploratory factor analytic procedures and both item and scale-level confirmatory factor analyses are undertaken. Examples of participant organisations' safety climate profiles are also provided. The chapter concludes with validation results for the group-level data and a brief discussion of results and their implications for the research domain.

In Chapter 8, the predictive validity of a global model of safety climate and safety outcomes is examined. Three methodological approaches for model testing are reported. To ground my results within existing empirical findings the first approach investigates the relationship between global safety climate, individual safety behaviours and safety outcomes using individual- level analysis. In the second approach, constructs are aggregated to the group-level based on individual- level factor structures (ILSA approach) as described by Peterson and Castro (2006). The final approach uses the Create Aggregate-level Scales (CSA) method of data aggregation in which the assessment of factor structures is conducted at the intended level of aggregation. Results for the three analytic approaches are interpreted and compared with past findings.

Chapter 9 provides results of the analyses testing a stratified work-level model of safety climate incorporating social exchange as an antecedent of safety climate to investigate how the quality of social exchanges influences perceived safety climate and workers' safety behaviours. The three modelling approaches used in Chapter 8 are repeated to support a direct comparison of individual and group-level results.

In Chapter 10, I present an overarching discussion of the key findings and contribution of my research to the field. I evaluate the methodological limitations

and strengths of my research, present the theoretical implications for researchers and the practical implications for safety practitioners and organisational leaders. Ideas for future research are also presented. My thesis concludes with comments on the benefits to be gained from applying a level-of-analysis approach to organisational safety, the significance of including coworkers in models of safety climate and the importance of understanding work-place social exchanges as foundations for the establishment of compliance and proactive safety norms.

## **2. Safety Climate**

### **2.1. Introduction**

In this chapter, I will review the theoretical foundations and empirical findings relating to safety climate with a specific focus on current strengths and weakness in the methodology of safety climate research. Topics covered include: the distinction between psychological and organisational climate, the link between foundation and facet-specific climates, and specific use of referents in climate research. Zohar's (2008, 2010) recommendations regarding the adoption of a level-of-analysis approach to safety climate research are examined and I consider the implications of ignoring the nested nature of data within organisations. Where possible, meta-analyses are used to identify important trends and differences in results for studies applying different construct treatments and statistical methodologies. In the later sections of this chapter, attention is paid to the specific measurement of existing components of safety climate including climate level, strength and variability.

### **2.2. Psychological and Organisational Climate**

Within any organisational setting, managers and employees are faced with a variety of goals and subsequently develop policies, procedures and practices to achieve these multiple objectives (Reichers & Schneider, 1990). An individual's perception or cognitive appraisal of the organisational environment results in the emergence of what has been termed a worker's *psychological climate* (R. J. James & Jones, 1974). Building on Locke's (1976) work on job-related values, James and colleagues developed a hierarchical model of psychological climate (PC) to explain how individuals ascribe meaning and assess their relative wellbeing within their work setting (L. A. James & James, 1989; Jones & James, 1979). Their PC model focused on workers' perceptions of four key workplace attributes: leader support and facilitation; role stress and harmony; job challenge and autonomy; and workgroup cooperation, warmth and friendliness.

In contrast, one of the key definitional aspects of climate research in organisations is the notion that the perceptions of relevant workplace conditions can be shared amongst employees. Instead of the focus on individual perceptions in the PC

construct, *organisational climate* (OC) is said to represent the shared perceptions of workplace environments. Organisational climate is measured by aggregating individual workers' perceptions (PC) to provide an index of the "typical or average way people in an organisation ascribe meaning to that organisation" (R. J. James et al., 2008, p. 15). Aggregation in multilevel research may be conducted at different work-levels to potentially derive a hierarchy of group or organisational climates. Payne has argued that for employee clusters to have "conceptual utility in helping to understand the functioning of organisations...[they] have to have some sensible socio-psychological identity...rooted in some formal or informal structured collectives such as work teams, work sites or departments" (R. Payne, 1990, p. 78). Furthermore, in multilevel research the questions researchers ask and utility of the climate indices they derive are linked to the compositional model they apply (Chan, 1998).

### 2.2.1. Composition Models

To assist researchers apply the appropriate forms of aggregation in climate research Chan (1998) has provided a typology of composition models. He identified protocols based on the focus of research questions, the use of criteria for aggregation, and referents applied in the survey items. The establishment of criteria to support data aggregation is considered important in research using consensus composition models (Bliese, 2000; Kozlowski & Klein, 2000; Zohar, 2003). In the various consensus models within-group agreement on climate scores has been proposed as grounds for the aggregation of individual-level constructs (e.g., PC) to form the higher level construct (e.g., OC). Consensus models are most commonly applied in organisational climate research as they generally align with the researchers' overall objectives to examine antecedents and outcomes of *climate level*. However, Chan has also described how indices of within group variance or *climate strength* may be used as a focal construct representing a group-level characteristic in multilevel dispersion models.

Chan (1998) also makes the distinction between composition climate models with a focus on individual perceptions (e.g., PC and OC) and climates with a referent shift to the collective, in which the focus of item content shifts to the perceptions of others (e.g., Collective PC and OC). The use of the term *collective climate* for Chan's

purposes refers to the application of a group rather than a self-referent and should not be confused with the statistical usage of the term in which collective climates are said to be formed through the statistical clustering of respondents on the basis of patterns of perceptual agreement on target scales (Jackofsky & Slocum, 1988; Joyce & Slocum, 1984).

The utilisation of multilevel analysis in which the aggregation of data is applied to the group, department or organisation-level acknowledges that in organisations the shared experiences of group members cause dependence of observations and should therefore not be considered statistically independent (Kreft & De Leeuw, 1998). Following on from his early climate research in the safety domain (Zohar, 2003, 2008; Zohar & Luria, 2005), Zohar (2010) has more recently proposed that a *level-of-analysis approach* to climate research in organisations should be adopted to help address the nonindependence issue. In this stratified approach to construct development, clearly defined referents are used to improve the alignment of item work-level specific content within organisations. That is, constructs examining coworker or supervisor practices are examined at the group-level using a collective group referent (e.g., our supervisor communicates effectively with team members), while top level management practices, affecting a broader range of workers, may be aggregated and analysed at a higher level such as the department or organisation-level.

As the application of appropriate levels of analysis in climate research has not always been optimal, clarification of the link between theoretical definitions used, referents applied and levels of analysis undertaken have been raised as methodological issues warranting greater attention (R. J. James et al., 2008; Zohar, 2010). More specifically in the safety domain, relatively few studies have used multilevel modelling with an application of composition models and collective referents to explore the shared nature of the construct as theoretically recommended (for exceptions see Hofmann et al., 2003; Simard & Marchand, 1995, 1997; Zohar, 2000, 2010; Zohar & Luria, 2005).

### **2.3. Foundation and Facet-specific Climates**

In seeking to understand how workers make sense of their complex working environments, climate researchers have also distinguished between foundation and facet-specific climates (Schneider & Bowen, 1993). According to Schneider and Bowen, foundation climates represent the general climate in which employees operate. An example of a foundation climate index used in safety research is Neal, Griffin and Hart's (2000) General Organisational Climate which outlined seven work environment factors (appraisal and recognition, goal congruence, role clarity, supportive leadership, participative decision making, professional growth, and professional interaction). Two further examples of foundation climates recently investigated in relation to occupational safety include the climates for organisational support and management-employee relations (Wallace, Popp, & Mondore, 2006). These two general constructs fit well within the leadership facilitation and support dimension originally identified in James and James's (1989) model of psychological climate.

In contrast, facet-specific climates pertain to a more restricted aspect of organisational operations such as safety, production or service orientation. Zohar defined safety climate as the "shared perceptions among members of an organisation... of the safety policies, procedures and practices... that reflect the true priority of safety" in the workplace (Zohar, 2003, p.125). Facet-specific climates may operate concurrently (e.g., work-ownership climate and safety climate; Zohar, 2008) and often compete for priority, such as in the case of climate for safety versus productivity (Zohar, 2000, 2003; Zohar & Luria, 2005). Importantly, when safety climate is considered as a social construct (Rochlin, 1999), attention is focused on the employees' consensual interpretation of the enforced policies and enacted practices, rather than on the espoused set of formal policies or procedures in and of themselves (Zohar, 2003).

Zohar (2008, 2010) recently proposed that understanding the pattern of relationships between general and facet-specific climates and workers' perceptions of relative priorities and competing demands across the organisational hierarchy should be a central focus for future safety research. This approach fits with the proposal "that the more general organisational climate provides a context in which specific evaluations



of the importance of [facet-specific priorities] are made” (Neal et al., 2000, p. 100). Neal et al. proposed that general organisational climate would not only predict facet-specific climates but that the facet-specific climate would mediate the influence of foundation climates on outcomes relevant to the domain of enquiry. However, research in the safety domain that has investigated the relationship between foundation climates, facet-specific climate and outcomes has been relatively sparse (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004; see Larsson, Pousette, & Törner, 2008; Neal et al., 2000; Silva, Lima, & Baptista, 2004; Wallace et al., 2006).

In their seminal work, Neal et al. (2000) found a strong, positive relationship ( $r=0.52$ ) between general organisational climate and safety climate in a hospital setting. They showed that the relationship between general organisational climate and individual safety behaviour was fully mediated by safety climate. However, in this instance, Neal et al.’s treatment of study variables as individual-level data more closely equates to general psychological climate as defined by James et al. (2008) than organisational climate per se, highlighting the problem and confusion that can occur due to the interchangeable and inconsistent use of terminology applied in climate research. That is, the term *organisation climate* can be used to reflect the theoretical focus of the item content of a scale on the broad aspects of organisational behaviour (as applied in Neal et al.’s study), to indicate the use of aggregated climate data rather than individual-level psychological climate perceptions as previously described in section 2.2, or as an indicator of the higher organisational, work-level focus of facet-specific climate scales (e.g., Zohar & Luria, 2005).

The strong, positive relationship found between general climate and safety climate in Neal et al.’s (2000) study has been supported by both Wallace et al. (2006) and Silva et al.’s (2004) results. In an investigation of the interrelationship between general foundation climate and facet-specific safety climate, Silva and colleagues (2004) operationalised both of their climate inventories using four work context dimensions: support, innovation, rules and goals. Their intention was to provide a restricted and consistent domain of reference for items across the two climate indexes. In their sample of 15 industrial organisations they found that general organisational climate explained 52% of the variance in safety climate, with both climate measures

independently predicting accident rates. However, Silva et al. did not test the mediation model of foundation climate → safety climate → safety outcome relationships.

In a further study, conducted at the group-level of analysis, Wallace et al. (2006) also found that safety climate mediated the relationship between two foundation climates and occupational accidents. When controlling for common method effects, Wallace et al. identified strong predictive relationships between safety climate and both the climate for Management-employee relations ( $r=.32$ ) and Organisational support ( $r=.41$ ). Finally, Larsson et al. (2008) found that general psychological climate has both direct and indirect effects on workers' safety behaviours, however their study did not look at the effects of safety climate in their predictive model.

Further research conducted in the retail industry examined whether safety climate mediated the relationship between general organisational climate and employees' perceived safety at work (DeJoy et al., 2004). DeJoy et al.'s analysis was again conducted on individual-level data. They found organisational support, coworker support, and communication to be significant predictors of safety climate ( $R^2 = .55$ ) after controlling for demographic, environmental conditions (hazards), and safety-specific policies and programs. DeJoy et al.'s results supported a partial mediation model with environment, policies and practices, and organisational support all retaining their significance (albeit with reduced values) after the inclusion of safety climate in the model. DeJoy et al. (2004) concluded that "a positive safety climate is more likely to exist in an environment that generally supports and values its employees and where there is open and effective communication" (2004, p.88). However, a potential issue to consider in DeJoy et al.'s study was the inclusion of environmental conditions and policies and programs as separate predictor variables when they are more often operationalised as dimensions of safety climate.

In sum it appears that current empirical findings support the proposal that general organisational climates provide the context in which more more facet-specific climates, such as safety climate emerge. While the foundation climates so far examined in the safety literature have represented a variety of contextual workplace dimensions, scope remains to further investigate the relationship between general and

facet-specific safety climate at the same hierarchical level of the organisation using a level-of-analysis approach (Zohar, 2010). However, as will be described in the following section, the operationalisation of safety climate has not been a clear-cut process.

#### **2.4. Issues in the Operationalisation of Safety Climate**

Since Zohar (1980) first introduced the term safety climate, problems associated with poor construct definition, indefinite factor structure and inappropriate methodological treatment of the construct have plagued research (see Cox & Flin, 1998; Guldenmund, 2000, 2007; Seo, Torabi, Blair, & Ellis, 2004; Zohar, 2003). To provide justification of the choices I have made when conceptualising safety climate in my study, in the following sections I will examine several of these problematic issues including: the distinction between climate and culture, the use of explicit referents, issues of dimensionality, and treatment of safety climate as a global or work-level construct.

##### **2.4.1. Climate, Culture and Referent Shifts**

One major issue in the safety literature has been the imprecise use of the terms *safety culture* and *climate*. While these terms have often been used interchangeably, some commentators have argued that they have different theoretical roots, definitional nuances and levels of abstraction (R. J. James et al., 2008; Reichers & Schneider, 1990). James et al. have argued that the typology of composition models provided by Chan (1998) offers a framework to distinguish between the individual referent focus of climate constructs (applying a direct consensus model) and the collective focus of culture-based constructs (requiring the application of a referent-shift consensus model). However, Chan did not make this climate/culture distinction, differentiating only between psychological climate (PC), as an individual-level construct using *self*-referents in his direct consensus model, and psychological collective climate (PCC), using *others* as the core referent in the referent-shift consensus model.

In their work on foundation and specific climates, Wallace et al. (2006) chose to apply two types of composition models (direct and referent-shift consensus models) when constructing their climate measures. They contended that the collective referent

(e.g., the work group) was a more appropriate focus for their safety climate construct as their intention was to measure perceptions at the group-level of abstraction rather than at the individual-level. As Chan (1998) has explained, in referent-shift consensus models:

Rather than an individual's own climate perceptions (i.e., psychological climate) or the aggregation of individuals' perceptions (i.e., organisational climate), the researcher now is interested in how an individual believes others in the organisation perceive the climate [requiring a shift in referent from self to others] and whether there is within groups consensus in such belief (p. 238).

To illustrate how the referent shift may be applied in safety climate research, I have adapted the efficacy example used by Chan (1998) to a safety context. For example, an item tapping safety efficacy would change from, *I am confident that I can perform tasks safely*, to *I am confident that my team can perform tasks safely*, when the group referent shift is applied. This item then becomes a more appropriate measure of group safety efficacy. However, to extend this example, it may be possible to further modify the item to read; *workers in my team are confident that they can perform this task safely*. This change facilitates the full shift of focus of the item to reflect the individual's perception of the collective belief or practice operating within the specified work unit (e.g., work group, department, site, and organisation). As safety climate is generally defined as the *shared perceptions* of respondents regarding the state and priority of safety in the organisation, the collective focus may provide a more appropriate referent for operationalising safety climate inventories as this offers a reflection of the group norm for the work unit. As no research has reported a comparison of results derived using referents shifts, my intention is to adopt a best practice approach based on Chan's recommendations rather than specifically comparing results derived using the various referent shifts.

While acknowledging that the nested nature of individuals within workplace settings in analyses more appropriately complies with the theoretical conceptualisation of safety climate as a collective construct, the majority of safety climate studies in the extant literature have measured psychological safety climate (PSC) using direct consensus referents. In support of this statement two recent safety climate meta-

analyses have organised their summaries according to the PC/OC orientation used in the original studies (Beus, Payne, et al., 2010; Christian et al., 2009). With some degree of overlap in the empirical studies included in the two meta-analyses, the ratio of PSC:OSC research appears to be at a rate of between 3:2 (Beus, Payne, et al., 2010) and 3:1 (Christian et al., 2009). In Christian et al.'s study, when looking at accident/injury data as the criterion, stronger relationships were observed with OSC ( $\rho = -.39, k = 13$ ) than with PSC ( $\rho = -.14, k = 27$ ). This trend was also observed in Beus, Payne et al.'s study (OSC;  $\rho = -.29, k = 10$  and PSC;  $\rho = -.16, k = 32$ ). Given the different effects sizes reported for PSC and OSC in both meta-analyses, the call for greater methodological rigour in distinguishing levels of analysis in safety research appears warranted on both theoretical and empirical grounds.

Irrespective of the collective or individual referent used or level of data treatment applied, Cox and Flin (1998) concluded that safety climate measures provide a snapshot of the prevailing state of safety which may be used as an indication of the more enduring and underlying safety culture. They further argue that questionnaires measuring safety culture or safety climate are almost indistinguishable in terms of their component factors or dimensions and that across the domain, determining the content range and dimensionality of safety climate continues to prove problematic.

#### **2.4.2. Dimensions of Safety Climate**

Determining the generic structure of safety climate has been another central issue in the safety literature with commentators offering a variety of ideas about why the number and nature of factors vary so dramatically across studies (Guldenmund, 2000; Shannon & Norman, 2009). While these reasons range from theoretical (broad or specific content domain) to methodological (different statistical treatments across studies) consensus has yet to be found. Furthermore, Shannon and Norman recently proposed that in failing to acknowledge the nonindependence of data in workplace samples, existing derivations of safety climate factor structures are fundamentally flawed. They reason that as the focus of the majority of safety climate items is on the measurement of work-group or organisational characteristics (such as management or supervisor safety practices) rather than on the practices or attitudes of the individual respondent, the data generated is fundamentally multilevel in nature. As

such, identifying factor structures should be conducted using multilevel techniques rather than individual-level factor analyses. With respect granted to this critique of methodological flaws in the approach to factor identification, the reality remains that the vast majority of research to date has not adopted this strategy. The following review of literature and interpretations of results provide are therefore made with this limitation in mind.

In their review of safety climate inventories Seo et al. (2004) reported that the published factor structures of safety climate scales ranged from two to twenty-eight dimensions, consistent with findings in past reviews (see Cox & Flin, 1998; Guldenmund, 2000; Zohar, 2003). Seo et al. identified a core of five main constructs including management commitment to safety, supervisor safety support, coworker safety support, employee participation in safety decision making and employee competence. However, safety climate has most frequently been operationalised as management and supervisor commitment to safety (Brown, Willis, & Prussia, 2000; Zohar & Luria, 2005).

In his more recent evaluation of the use of questionnaires in safety research Guldenmund (2007) proposed that safety climate scales should recognise how management protocols manifest at different hierarchical levels of the organisation; that is at the organisation, group and individual-level. Guldenmund suggested that these management systems should include policies and practices associated with risk management, hardware design and layout, maintenance, procedures, manpower planning, competence, commitment, communication, monitoring and change. Indeed, several of Guldenmund's sub classifications are represented in the management and supervisor dimensions of Zohar and Luria's (2005) safety climate scales.

In conceptualising their organisation and group safety climate constructs, Zohar and Luria (2005) drew on behaviour expectation theory to describe active practices (e.g., monitoring, enforcing and controlling behaviours), proactive practices (e.g., promoting learning, development, instructing and guiding behaviours) and declarative practices (declaring and informing), as distinct but highly related aspects of management and supervisors' commitment to safety. Zohar and Luria's scale

items were based on benchmark safety management codes (British Standards Institute, 2000).

Johnson (2007) conducted one of the few studies to test the factor structure and predictive validity of the sixteen item version of Zohar and Luria's (2005) group-level safety climate scale assessing supervisor safety commitment. Using both exploratory and confirmatory factor analysis Johnson also identified a highly correlated three-factor structure ( $r = .94, .94$  and  $.93, p < .05$ ), which he labelled caring, compliance and coaching. Johnson argued that the supervisor safety climate scale could be further reduced to 11 items without a marked decrement in explanatory power. While Johnson's findings are largely commensurate with Zohar and Luria's, the trimming of 30% of Johnson's sample due to multivariate outliers warrants mention and may have impacted on his results.

#### **2.4.3. Higher and Lower Order Structures**

Importantly, while the number and nature of safety climate dimensions have been subject to ongoing discussion (Dedobbler & Beland, 1998), the treatment of safety climate as a single, higher-order construct (collapsing dimensions to form a global index of safety climate) has been the norm. For example, Seo (2005) examined the relationship between his five factor operationalisation of safety climate (Seo et al., 2004), with employees' perceptions of work pressure, risks, hazard level, barriers to safety and self-reported unsafe work behaviour. While he drew largely on earlier studies to support his theoretical model (i.e., Brown et al., 2000; Oliver, Cheyne, Tomás, & Cox, 2002; Rundmo, Hestad, & Ulleberg, 1998; Tomás, Melia, & Oliver, 1999), Seo did not follow Tomás and colleagues' (1999) lead in modelling the macro organisation factors (management actions supporting safety) and the micro factors (supervisory and coworker responses to safety and worker attitudes) as separate components, preferring to combine them as a global construct.

In Clarke's (2006) meta-analysis, examining the relationship between safety climate, safety performance and accidents/injuries, she reported effects for safety climate as a global construct. However more recently, the criteria applied by both Beus, Payne et al. (2010) and Christian et al. (2009) to classify and report safety climate effects in

their meta-analyses differentiated between the global and dimensional treatment of safety climate. Christian et al. categorised safety climate both as a global construct and separately as eight first-order factors based largely on Neal and Griffin's (2004) taxonomy. Christian et al.'s factors included management commitment, human resource management practices, safety systems practices, supervisor support, internal group processes, boundary management, risk and work pressure. Christian et al. identified 48 effects from studies adopting the *global psychological* safety climate approach (i.e., treatment of safety climate as a higher order construct using individual-level analysis,  $N=33\,739$ ); 14 effects from studies using the *global organisational* safety climate approach (i.e., treatment of safety climate as a higher order measure using group-level of analysis,  $N=794$  groups) and fewer studies examining the separate dimensions of safety climate using either individual or group-level analysis. According to Christian et al.'s review, when a dimensional-based approach was used the most frequent categories investigated have been supervisor support (16 individual-level studies and 8 group-level studies) and management commitment (9 and 1 studies respectively).

Beus, Payne, et al. (2010) also provided results for both global and dimensional specifications of safety climate in their meta-analysis of the safety climate-injury relationship. They included subscales for: management commitment to safety, management safety attitudes, management safety practices (supervisors), specific safety policies, coworker safety, safety communication, safety training, housekeeping, safety procedures and safety reporting. Beus, Payne, et al. identified 32 effect sizes from studies that adopted a global psychological safety climate approach ( $N=16\,011$ ) and 11 effects from studies using a global organisational safety climate approach ( $N=448$  groups). When looking at the effects for separate dimensions of safety climate, using individual or group-level analysis, management commitment to safety ( $k=26$ ) and management (supervisor) safety practices ( $k=12$ ) constituted the most common subscales used.

Beus, Payne, et al. (2010) also investigated the potential contamination and deficiency of the safety climate measures used in their review in terms of the identified factor structure in each study's correspondence to Zohar's definition of safety climate (Zohar, 2003; Zohar & Luria, 2005). Beus, Payne, et al.'s criteria for



construct validity focused on a scale's capacity to assess employees' perceptions of safety-related policies, practices and procedures, specifying that

*Safety policies* define strategic goals and the means for their achievement while *safety procedures* provide planned courses of action relating to those goals. Safety policies and procedures both exist at the organisational level and are maintained by upper management. *Safety practices* refers to implementation of policies and procedures at the work group-level [and relate to supervisory & coworker practices] (p.727).

Beus, Payne, et al. defined construct contamination as the inclusion of irrelevant content in a scale and deficiency as the failure to adequately represent the specified content domain. According to their criteria, safety climate dimensions such as personal safety attitudes, job safety/risk and supervisor competence were considered contaminants, while measures that excluded management commitment to safety or supervisor and coworker safety-related practices such as communicating safety information would be deemed deficient.

Contrary to their hypothesis, Beus, Payne, et al.'s (2010) determined that construct contamination artificially inflated safety climate → injury correlations in two of their three test conditions. However, this result makes sense when recognising that the association between the contaminant categories identified (e.g., risk perceptions and personal safety attitudes) and injury rates have been well established in the literature (Melia, Mearns, Silva, & Lima, 2008). That is to say, while such constructs may not be considered *true* safety climate dimensions according to Beus, Payne, et al.'s criteria, it is not surprising that safety-related constructs not fitting within their definition would still be correlated with injury rates. Therefore, such contamination would be expected to increase the variance explained in the outcome, being akin to adding another recognised predictor in a regression model. However, if the contaminants selected were more overt in showing limited predictive validity with injuries (e.g., job satisfaction or affective organisational commitment), the hypothesis for contamination may well have been supported.

Beus, Payne, et al. (2010) also found that scale deficiency generally resulted in weaker associations between safety climate and injuries. Again, in this instance the omission of key safety climate dimensions resulted in attenuated associations; a state akin to the expected reduction in the coefficient of determination when a recognised strong predictor is removed from a regression model. While Beus, Payne, et al. do not claim to have resolved the safety climate dimensionality issue, their use of Zohar's (2003) definition as a broad and sound basis for further construct development is well considered. However, Zohar (2010) himself, has recently shared further theoretical and methodological insights regarding the definition of safety climate to help clarify and guide future investigations in the field. Extending on his early work, Zohar's recommendations focus on elucidating how the hierarchical nature of organisations can and should be recognised in the dimensionality of safety climate and are discussed in the following section.

## **2.5. Work-level Approach to Safety Climate**

In his commentary on past and future directions for safety climate research Zohar (2010) identified a series of key conceptual issues including the recommendation that safety climate perceptions be viewed from the levels-of-analysis perspective. He argued that taking into consideration the importance of safety “procedures-as-a pattern” (p.1518) of associations and interactions within organisations would advance our understanding of the domain. More specifically Zohar asserted that

[as] the target of climate perceptions can relate to the organisation or group-level of analysis (i.e., senior management commitments and policies vs. supervisory or coworker practices) it follows that climate measurement should be based on level-adjusted subscales offering separate measures for climates associated with respective organisational levels...The practice of mixing items associated with divergent levels of analysis must be discontinued in order to avoid level discrepancy errors in safety climate measurement...[and the] development of level specific subscales should be encouraged as it is likely to enhance measurement sensitivity and conceptual rigor. (p.1521)

Adopting a levels-of-analysis approach in which safety climate is separated into more discrete work-level dimensions offers the opportunity to expand our

understanding of how safety climate differs across work-levels and to investigate how the shared perceptions amongst workers relevant to each dimension are formed. While attempts to gauge the different safety attitudes and behaviours of organisational agents (i.e., individuals, coworkers, supervisors and managers) has long been considered in the development of safety climate questionnaires (for an example see Safety Research Unit, 1993), to-date few studies have either specifically separated safety climate scales into work-level domains or attempted to tease out the relationships between the differing climate dimensions (for exceptions see Melia et al., 2008; Simard & Marchand, 1995, 1997; Tomás et al., 1999; Zohar & Luria, 2005). Tomás and colleagues encouraged the separation of the climate dimensions “in order to understand their complex relations with other criteria, and to obtain an analytic measure of them for diagnostic purposes” (1999, p.53). This multilevel approach was also observed in the empirical findings of Simard and Marchand (1997) who recognised that both macro and micro organisational factors differentially contribute to safety outcomes, and is finding renewed support in more recent theoretical discussions (Neal & Griffin, 2004; Zohar, 2003, 2010).

Zohar has been one of the strongest advocates of multilevel climate research in terms of both investigating work-level dimensionality and applying multilevel analysis (Zohar, 2000, 2003, 2008, 2010; Zohar & Luria, 2005). Zohar has described safety climate as “an emergent property, characterising groups of individuals [that can be] operationally assessed by aggregating individual perceptions to the required unit of analysis (organisation, department, work group) and using the mean to represent the climate for that entity” (Zohar, 2003, p.124). Zohar’s multilevel models of safety climate (see Zohar, 2003, 2010) provide the most comprehensive representations of the possible links between safety climate dimensions, antecedent factors and safety outcomes produced to date. Zohar and Luria (2005) empirically tested aspects of Zohar’s (2003) model by developing measures of safety climate at the organisational level (operationalised as top level management commitment to safety) and group-level (supervisors commitment to safety).

However, Kozlowski and Klein (2000) indicate that in organisations, emergent phenomena, such as safety climate are generally shaped by a combination of formal

structures and by informal social-interaction processes. Chiaburu and Harrison also concluded in their meta-analysis investigating peer influences in the workplace, that “coworker actions predict perceptual, attitudinal, and behavioural outcomes of their colleagues even when the influence of the direct leaders (on the same focal colleagues) is accounted for” (2008, p. 1094). As such, while Zohar has not previously included coworker safety practices as part of his group-level safety climate construct, it is my intention to argue that the informal normative influence of coworkers’ commitment to safety be considered as a relevant aspect of the content domain.

## **2.6. Coworker Commitment to Safety**

To add support for the inclusion of coworker commitment to safety in future studies and the operationalisation of safety climate in this thesis, evidence from studies that have included coworker practices and group processes in their explanatory safety models are provided in this section. As an indication of the limited scope of safety research that has included coworker safety practices, Beus, Payne, et al. (2010) identified only seven effect sizes for coworkers in their review. Interestingly, they found the association between coworker safety and retrospective injury rates ( $\rho = -.22$ ,  $k = 7$ ) to be stronger than that observed for either management /supervisor safety practices ( $\rho = -.16$ ,  $k = 6$ ) or management commitment to safety ( $\rho = -.12$ ,  $k = 10$ ) at the individual- level of analysis. As such they argued for the continued inclusion of coworker practices in safety climate measurement instruments.

In their meta-analysis, Christian et al. (2009) based their classifications on Neal and Griffin’s (2004) integrated model of workplace safety which included internal group processes as a first-order factor of safety climate. This factor incorporated workers “perceptions of communication and support for safety within work-groups or the extent to which employees perceive that their coworkers provide them with safety-related cooperation and encouragement” (Christian et al., p.1107). Exemplars of this factor from ten empirical studies that were included in their meta-analysis involved coworkers’ safety backup, workers’ safety communication, peer safety orientation and trust in peers. Christian et al. found support for the role of internal group processes predicting individual workers’ safety performance ( $\rho = .40$ ,  $k = 9$ ) and accidents/injuries ( $\rho = -.19$ ,  $k = 8$ ). In definitional and scale content terms, Christian et

al.'s internal group process category equates with the coworker social support dimension identified in Nahrgang et al. (2011) more recent meta-analysis.

The significance of coworker support and commitment to safety was also highlighted in a qualitative study of safety in Self Directed Work Teams (SDWT; Roy, 2003). Roy found that, while management commitment to safety and production-based incentive systems had an influence on safety behaviour, the influence of legitimate and illegitimate peer pressure appeared to be the main driver of safety outcomes in their study. Roy also found evidence to support the negative side effects of group norms on safety in situations in which the group standard leaned towards a tolerance for risk.

Roy's (2003) conclusions are supported by the earlier empirical studies of Simard and Marchand (1994, 1995, 1997) who found workgroup characteristics (i.e., coworker cooperative relations and group cohesion) to be important predictors of both workgroup compliance behaviour and propensity to engage in safety initiatives. These studies highlight the issue of whether any dimension of coworker safety climate should represent coworker commitment to safety in terms of specific safety practices, or more general coworker relations and internal group process as has been the case. This concern reflects back to the previously described distinctions drawn between foundation and facet-specific climates and will be explored further in Chapter 4 looking at leadership and group process as potential antecedents of safety climate.

In one of the few studies to adopt a stratified dimensional approach in safety research, Melia et al. (2008) proposed that safety climate would provide a more effective diagnostic tool if the conceptualisation and analysis of the construct focused on the distinct safety responses of all the key organisational agents involved in the psycho-social chain of safety influence (i.e., managers → supervisors → coworkers → workers). In their analysis of four construction industry samples from culturally distinct populations (English, Spanish (2) and Chinese), Melia et al. reported differential patterns of association between workers' risk perceptions and management, supervisor, coworker and worker dimensions of their safety climate

scale. When individual workers' risk perceptions were regressed on all safety climate subscales Melia et al.'s predictive model was significant in all but the Chinese sample.

Furthermore, when workers' safety behaviours were regressed on the management, supervisor and coworker subscales the influence of coworkers remained significant when controlling for supervisor and management influence, highlighting the important role coworkers play in establishing normative safety behaviours (Melia et al., 2008). This trend was most obvious in the Chinese sample, compared to the English and Spanish samples. While Melia et al.'s results support the utility of separating safety climate into hierarchically-based subscales their use of a series of individual-level regression analyses did not support the full testing of mediation effects leaving scope for future research to adopt the psycho-social chain of safety climate approach to explanatory models with alternate safety outcomes such as accidents and injuries using more rigorous statistical methods.

Two further studies have examined coworker safety practices as indicators of subjective safety norms and the key role these norms play in directing workers' safety performance (Fogarty & Shaw, 2010; Jiang, Yu, Li, & Li, 2010). Fogarty and Shaw used the Theory of Planned Behaviour (Ajzen, 1991) to explain the interplay between safety climate, group safety norms, individual safety attitudes, work pressure and workers intentions to violate safety procedures. The Theory of Planned Behaviour (TPB) explains behaviour as being a function of an individual's behavioural intentions and the perceived behavioural control they have over performing the task. In turn, an individual's intention to engage in a particular behaviour is said to be shaped by their attitude towards the behaviour and their perception of the normative practices of significant others. Fogarty and Shaw also included management attitudes (safety climate) as an antecedent of the TPB constructs in their model and determined that both management attitudes to safety and group safety norms play a vital role in shaping workers' intentions to violate and safety behaviour.

Fogarty and Shaw (2010) found that both management attitudes and group safety norms proved strong predictors of workers' intentions to violate safety procedures

and self-reported violation behaviours, contributing largely to the TPB model's accounting for nearly 50% of the variance in violations. Importantly Fogarty and Shaw showed that group safety norms mediated the influence of management attitudes on violations and showed stronger relationships with workers' reported intentions to violate than is generally found in TPB studies. This may possibly be due to the more explicit priority placed on safety in many organisations compared to other normative domains generally investigated in TPB research.

In a sample of Chinese petroleum and chemical workers, Jiang and colleagues (2010) also investigated the impact of workers' perceptions of management safety practices (aggregated to group-level safety climate) and coworkers' safety knowledge and behaviour (PCSK/B) on safety performance and self-reported injuries and near misses. The safety climate scale in Jiang et al.'s study used a generic *management* referent, resulting in a degree of ambiguity relating to whether supervisor or top level management safety practices and responsibilities were being targeted. The issue of ambiguity in management referents in organisational research has been raised by Flin (2003) and potentially poses problems for both scale validation and interpretation of results. However as Jiang et al. treat their management safety climate as a unidimensional scale and interpreted their results accordingly any limitations relate to a potential lack of fidelity rather than to a lack of construct validity.

Jiang et al. (2010) developed the PCSK/B scale as a measure of descriptive safety norms. Their 6-item scale focuses on coworkers' familiarity with safety equipment, safety skills, concern for safety in the workplace, compliance with safety procedures, safety-related habits and communication. Using Hierarchical Linear Modelling (HLM), Jiang et al. found a positive relationship between coworker behaviour, individual safety behaviours and reduced injury rates, with individual behaviours mediating the influence of PCSK/B on injuries. They also identified significant cross-level interactions indicating that for individuals operating in work-groups in which perceptions of management commitment to safety is high (stronger safety climate), the stronger the positive influences of coworker normative safety behaviour is on individual behaviour.

While the use of HLM is a key strength of Jiang et al.'s (2010) study, they recognised that the analysis of only 23 groups could impact on the generalisability of their results. Also, given the differential patterns of association found across cultural samples in Melia et al.'s (2008) study and the recognised importance placed on group cohesion and influence in collectivist cultures (Hofstede, 1997), the generalisability of Jiang et al.'s results to different cultural samples may be questioned. However, the correlations between coworker PCSK/B and both individual worker safety compliance ( $r=.23$ ) and participation ( $r=.25$ ) in Jiang et al.'s study did not mirror the inflated worker  $\rightarrow$  coworker associations found in Melia et al.'s Chinese organisational sample, indicating that Melia et al.'s results may be an artefact of the particular sample used rather than a cultural idiosyncrasy.

In sum, while Jiang et al. (2010) did not specifically conceptualise coworker safety knowledge and behaviour as a dimension of safety climate, the relationship observed with management safety climate, safety performance and injury rates add support for the inclusion of coworker practices in safety climate scales. In addition, the content of both Jiang et al.'s (2010) PSK/B scale and Melia et al.'s (2008) Coworker Safety Response (CSR) scale focus on safety-specific practices rather than on general group processes and cohesion which promotes greater face and construct validity in safety climate scales. Items from these coworker scales are also broadly aligned with the content covered in Zohar and Luria's (2005) management and supervisor safety climate scales in covering aspects of active, proactive and declarative safety practices such as communicating safety-related information; hazard awareness and response; and modelling and monitoring safety behaviours. While the issue of what content should be in safety climate scales remains problematic it is apparent that the inclusion of coworker safety practices has gained empirical support in more recent times.

In terms of the theoretical framework of this thesis and broader literature, the inclusion of safety-specific content in scales, organised around the safety practices of agents traversing the organisational hierarchy, acknowledges both the multidimensional and multilevel nature of safety climate. The utilisation of domain-aligned safety content (e.g., communication, rule compliance, monitoring and training), with more clearly defined referents, potentially offers opportunities for



researchers and safety practitioners to track areas of strength and weakness in the chain of safety activity, identify incongruent practices across work-levels, and identify core tensions in safety priorities between organisational agents. Finally, by adopting a work-level approach to climate research it is possible to describe safety climate not only in terms of the orientation (level) of safety climate, as has been done in the majority of safety studies, but also in terms of the within and between-group patterns of variability (Dragoni, 2005) which have attracted far less attention from researchers. The following section therefore describes the three currently applied indices of safety climate: level, strength and variability.

## **2.7. Safety Climate Indices**

Climate level refers to the direction or orientation of aggregate scores of a specified work unit, with a high score indicating positive perceptions. In contrast climate strength represents the homogeneity of individuals' climate perceptions within work units and climate variability indicates the pattern of between-group variance at some higher level of aggregation (Chan, 1998; Kozlowski & Klein, 2000; Zohar & Luria, 2005). Depending on the researcher's specific focus, units of interest may be work-groups, departments, work sites, organisations or even across an industry as a whole. However, across departments or divisions within an organisation the variability of work unit climate is not necessarily uniform, therefore when investigating any facet-specific climate, such as safety, identifying the within-group homogeneity (climate strength) of work units is complemented by assessing the degree of between-group variability to determine if an organisation has a uniformly strong or weak climate.

### **2.7.1. Climate Strength and Variability**

To date advancements in the measurement of safety climate to capture organisation and group cohesion by Zohar (2000) have included the operationalisation of within work-group homogeneity (safety climate strength) and between work-group differences (safety climate variability). Several statistical options to capture the concept of *sharedness* implicit in climate strength identified in the safety climate literature include: standard deviation scores (Beus, Bergman, & Payne, 2010; Zohar & Luria, 2005), within group correlation (L. R. James, Demaree, & Wolf, 1993;

Luria, 2008) and intraclass correlation coefficients (Glick, 1985; L. R. James, 1982; Pousette, Larsson, & Törner, 2008).

While a fairly limited proportion of safety climate research has applied multilevel techniques using the consensus approach to aggregation (Hofmann & Morgeson, 1999; Hofmann et al., 2003; Hofmann & Stetzer, 1996; Zohar, 2000; Zohar & Luria, 2004, 2005) even fewer studies have applied the dispersion model approach (or a combination of both approaches) to look at climate strength as an entity in its own right for descriptive or analytic purposes (see Beus, Bergman, et al., 2010; Luria, 2008; Oliver, Tomás, & Cheyne, 2006; Pousette et al., 2008; Zohar & Luria, 2004; Zohar & Tenne-Gazit, 2008). As my focus in this thesis is not on modelling predictors and outcomes of climate strength, a review of this literature is not provided. However by combining measures of climate level and strength for the different dimensions of safety climate, it is possible to provide a more meaningful picture of the overarching status of safety in an organisation; creating an organisation safety climate profile.

As shown in Table 2.1, having an understanding of both climate strength and level provides a more comprehensive descriptive metric for interpreting potential work unit climate profiles. For example, in work environments with weak safety climates, a higher level of situational role ambiguity is said to exist as employees differ in their interpretations of events and understanding of role expectations (Gonzalez-Roma, et al., 2002; Luria, 2008; Schneider et al. 2002). We would anticipate therefore that weaker climate strength and greater variability would be associated with more moderate climate levels. However, having a weak climate does not preclude the climate level from being relatively high overall; in this instance it would simply indicate a larger degree of polarisation, with the potential for pockets of workers holding extreme negative or positive views about the state of safety in the organisation.

In contrast, for organisations or work-groups with uniformly strong climates, individuals' perceptions are more consistent and normative behaviour aligned within and across work units. As such the potential for situational role ambiguity and need for clarification of facet-specific role expectations is reduced. The optimal safety

environment would therefore be described as a strong, positive safety climate in which employees uniformly perceived safety as a priority that guides workers' behaviours across the organisation. The least advantageous safety climate profile would conversely be a strong, negative safety climate in which employees universally perceive safety as a low priority and act accordingly.

Table 2.1 *Work Unit Profiles for Safety Climate Level and Strength Indices*

Climate Level	Climate Strength	
	Strong Homogeneous (Low within group variance)	Weak- Transitional Heterogeneous (High within group variance)
<b>Positive</b> (High Mean)	Extreme positive safety norms High level of consensus Minimal subcultures Low role ambiguity Optimal safety climate	Positive safety norms Low level of consensus Potential for polarisation Role ambiguity Resurgent safety climate
<b>Negative</b> (Low Mean)	Extreme negative safety norms High level of consensus Minimal subcultures Low role ambiguity Toxic safety climate	Negative safety norms Low level of consensus Potential for polarisation Role ambiguity Chronic safety climate

## 2.8. Summary

In summary, this chapter reviewed the theoretical foundations and empirical findings relating to safety climate with a specific focus on current strengths and weaknesses in the conceptualisation and methodology applied in safety climate research. My review examined the theoretical differences between general foundation climates and facet-specific safety climate. While the foundation climates so far examined in the safety climate literature have represented a variety of contextual workplace dimensions, a lack of empirical studies on this topic was identified. In particular, relatively few studies within the safety domain have used multilevel approaches to explore the nested nature of organisational data as theoretically recommended. My examination of the literature then moved on to explore more specific aspects of the operationalisation and measurement of safety climate. Topics covered included the

dimensionality of the construct, treatment as either a higher order global construct or set of lower order constructs, and level of analysis applied.

With regard to the operationalisation of safety climate, Zohar's (2010) recommendations regarding the adoption of a level-of-analysis approach to safety climate research were considered and the incorporation of coworkers as a key component of a stratified work-level model of safety climate proposed. As a key element of my thesis, measurement options associated with the analysis of safety climate at the individual or group-level were also described and the implications of ignoring the nested nature of data within organisations when testing explanatory models considered. Where possible, meta-analyses were used to identify important trends and differences in results for studies applying different construct treatments and statistical methodologies. Finally, different indices of safety climate including climate level, strength and variability were briefly described.

Having therefore examined the broad conceptualisation of safety climate as an emergent, multidimensional measure of overall organisational safety, in the following two chapters I move on to examine the link between safety climate and safety outcomes and the psycho-social antecedents of safety climate.

### **3. Safety Performance and Outcomes**

#### **3.1. Introduction**

A variety of approaches for measuring workers' safety performance and organisational safety outcomes have been described in the safety climate literature. Indeed, as an alternative to traditional indicators such as accident and injury rates, safety climate itself has been proposed as a lead indicator of organisation safety performance (Zohar, 2010). However, a recent issues raised in the safety domain concerns the potential reverse causality of this interplay (Beus, Payne, et al., 2010; S. C. Payne, Bergman, Beus, Rodríguez, & Henning, 2009). That is, should safety climate be treated as a lag or lead indicator of accident and injury outcomes? To begin teasing out the relationship between safety climate, individual safety performance, accidents, incidents and injuries my review begins by examining the links between safety climate and safety outcomes.

In the first section of this chapter I briefly evaluate the variety of accident-related outcome measures available including fatalities, lost time injuries (LTIs), micro accidents and near miss incidents. In particular I will consider the benefits and limitations of using objective and subjective sources of outcome data. I then move on to discuss two key measures of individual safety performance: compliance and participative behaviours. Empirical evidence supporting the differential relationships between these two individual-level safety performance measures and safety climate is then provided. To conclude the chapter I briefly touch on the issue of discriminant validity between dimensions of safety climate, as a group-level entity, and workers' safety behaviours as an individual-level construct (Glick, 1985; Kozlowski & Klein, 2000; Zohar, 2003).

#### **3.2. Safety Outcomes**

Accident-related outcome measures have been used in the safety literature with varying levels of success. Often these have been linked to industry standards and have included relatively low frequency statistics such as fatalities and LTIs (Zacharatos, Barling, & Iverson, 2005; Zohar, 2000). While fatalities and LTIs are two of the main Occupational Safety and Health Administration (OSHA) reporting criteria, for empirical purposes their relatively low incidence rates mean these gross

outcomes may be statistically insensitive to subtle changes in safety conditions within organisations. Further concerns regarding the use of low base rate fatalities and LTI data are potential power issues and restrictions to effect sizes in studies utilising these outcome measures (Neal & Griffin, 2006). In addition to LTIs, researchers have also used company infirmary records of basic first aid treatment for minor injuries or micro accidents including burns, cuts, bruises, sprains, and eye injuries (Hofmann & Morgeson, 1999; Hofmann & Stetzer, 1996; Zohar, 2000, 2002a).

While company injury records are considered one of the most valid and objective measures of safety performance, concerns regarding systematic organisational underreporting of injuries and accidents to regulatory bodies have been raised. Probst and colleagues (Probst, Brubaker, & Barsotti, 2008; Probst & Estada, 2009) found that the annual injury rates recorded in company OSHA logs were not an accurate representation of the actual injury occurrence; with the rate of unreported accidents to reported accidents being 5:2 (Probst & Estada, 2009). Furthermore, Probst et al. (2008) determined that the rate of underreporting injuries in organisations with poor safety climates (81% of injuries not reported) was higher than that found in organisations with positive safety climates compared (47%). Therefore, while organisational injury statistics provide a seemingly objective measure of organisational safety outcomes they are not unproblematic. Consequently, researchers have often turned to subjective measures of injury occurrence as more easily ascertainable indicators of individual safety outcomes.

One subjective approach to obtaining injury data is the use of self-report measures to assess the frequency, type and severity of injuries experienced by employees over a set period of time (Barling, Loughlin, & Kelloway, 2002; Kelloway, Mullen, & Francis, 2006; Zacharatos et al., 2005). While the time frame applied for retrospective recall of injuries has ranged from months to years, Veazie and colleagues have recommended six months as the maximum time period that accurate recall can be sustained (Veazie, Landen, Bender, & Amandus, 1994).

In addition to injuries, a less common, but potentially useful self-report measure of work-place safety is the frequency and type of near miss incidents (Mearns, Flin, Gordon, & Fleming, 2001; Oliver et al., 2002; Zacharatos et al., 2005). Near miss incidents provide a measure of how frequently workers experience an event in which they almost or could have sustained an injury. Near misses can be measured by likert-style frequency scales, as used by Zacharatos et al.(2005) or a recall count (Goldenhar, Williams, & Swanson, 2003; Jiang et al., 2010). If placed within Heinrich's (1959) classic safety triangle depicting the *ratio* of unsafe acts to minor and major injuries, the inclusion of near miss incidents would fit underneath minor injuries, and therefore represents a broader probability base for measurement purposes. As Christian et al. (2009) contended, the inclusion of near miss incidents as an outcome measure in safety research provides greater flexibility for profiling incident occurrence and greater statistical sensitivity, opening new doors for future research in to the relationship between safety climate, incidents and injuries.

Three recent meta-analyses (Beus, Payne, et al., 2010; Christian et al., 2009; S. Clarke, 2006) have investigated the association between safety climate and injury/accident rates. Clarke examined the relationship between safety climate, safety behaviours and accidents/injuries. In particular she compared results of studies obtained using retrospective and prospective injury data. Clarke identified the use of individual or group data for safety climate and source of accident indicators in her summary of each study; however she did not include this information as mediating factors in her analysis. In contrast, Christian et al. classified their studies according to data sources and further distinguished between studies applying individual- and group-level analysis. Beus, Payne, et al. distinguished between studies adopting individual- and group-level data treatments while also looking at differences found when using retrospective and prospective accident data. However, no study has examined the interplay of data source (subjective-objective), temporal ordering (retrospective-prospective) and data treatment (individual-group) concurrently.

In her meta-analysis of 28 safety climate studies, Clarke (2006) reported that an increase in safety climate scores corresponds to a decrease in accident/injury rates ( $\rho = -.22$ ). (Note. The signage of Clarke's reported correlations have been reversed to

be consistent with conventions applied in the other meta-analyses and this thesis). Clarke concluded that the strength of this relationship is even stronger for studies using prospective injury data in which safety climate is treated as a leading indicator of safety outcomes ( $k = 6$ ;  $\rho = -.35$ ) compared to retrospective studies ( $k = 25$ ;  $\rho = -.22$ ). However, it is difficult to determine if these stronger effects are actually attributable to the source of data or level of analysis applied rather than their prospective nature, as the effects reported are largely obtained from studies using company medical records at the group-level of analysis (Mearns, Whitaker, & Flin, 2003; Neal & Griffin, 2006; Zohar, 2000, 2002a; Zohar & Luria, 2004).

Beus, Payne, et al.'s (2010) results were generally consistent with Clarke's (2006) findings however, when classifying studies according to level of analysis, the inclusion of more studies under the group-level, prospective injury design classification resulted in Beus, Payne et al.'s estimate being slightly weaker ( $k = 6$ ;  $\rho = .24$ ). In addition Beus, Payne et al. did not identify any studies that used individual-level data for the measurement of safety climate and prospective injury data. For retrospective injury data Beus, Payne, et al. found stronger association in studies using group-level data (OSC  $k = 10$ ;  $\rho = -.29$ ), than individual data (PSC  $k = 32$ ;  $\rho = -.16$ ). While it appears from this result that regardless of the use of retrospective or prospective data, stronger associations are found using group-level analysis, the source of data may still be a potential confound in the relationship.

As objective medical and OSHA data has been used in both prospective (Zohar, 2000, 2002a; Zohar & Luria, 2004) and retrospective designs (Hofmann & Stetzer, 1996), when considered in combination with level of analysis issues, the source of data may have implications for the different correlations found for the relationships between safety climate and injury statistics in both Clarke (2006) and Beus, Payne, et al.'s (2010) studies. As stated in section 2.4.1, Christian and colleagues (2009) identified stronger relationships between safety climate and outcomes when using group-level data. Despite the smaller number of studies included in the OSC  $\rightarrow$  self-report injuries ( $k = 2$ ;  $\rho = -.21$ ) category of the meta-analysis compared to those using objective data (OSC  $\rightarrow$  injury records,  $k = 11$ ;  $\rho = -.42$ ), a trend toward weaker effects is observable. Whereas this trend was found to be consistent in studies using



individual- level data the overall magnitude of correlations between safety climate and outcomes was weaker (PSC→ Injury records,  $k = 4$ ;  $\rho = -.20$ ; PSC→self-report injuries,  $k = 24$ ;  $\rho = -.13$ ).

In summary therefore, it appears that stronger relationships are observed for the relationship between safety climate and injuries when the nonindependence of data is addressed using group-level analysis. Furthermore, safety climate and injury correlations are also enhanced when objective data such as OSHA and infirmary records are used compared to self-reported injury experiences. While it also appears that studies using retrospective injury data produce weaker associations than studies using prospective data, the overlap between data source, level of analysis and design confound the issue.

As such, despite the apparent drawbacks in reduced effects sizes that can realistically be expected when using retrospective, self-report accident and injury data, the utility of this information source should not be dismissed but rather considered as an underestimate of the real state of affairs. If longitudinal, objective injury statistics are not accessible (which is often the case in organisational research) and cross-sectional, self-report data is the only data source available as is the case in my thesis) consideration should be given to conducting the analysis at the group-level to optimise potential construct relations. However, beyond accident and injury data, an alternate safety outcome often used in safety climate research is the safety performance of individual workers or work-groups. In the following section I examine this alternative outcome in greater depth.

### **3.3. Safety Performance**

As safety climate instruments have continued to gain support from academics and practitioners, several frameworks conceptualising the link between safety climate and safety behaviours have been developed (Brown et al., 2000; Christian et al., 2009; DeJoy et al., 2004; Fogarty & Shaw, 2010; Griffin & Neal, 2000; Neal & Griffin, 2004; Seo, 2005; Silva et al., 2004; Tomás et al., 1999; Zohar, 2003). The measurement of safety behaviours has been undertaken using both objective and subjective data sources such as self-reports, supervisor ratings (Simard & Marchand,

1997), safety audits (Zohar & Luria, 2005) and behavioural observations (Cooper & Phillips, 2004; Glendon & Litherland, 2001; Neal et al., 2000). While safety audits and behavioural observations are considered superior methods of safety assessment, they are both cost and labour intensive; requiring the collaboration of independent, trained assessors to observe workers over extended periods of time. In contrast, self-report and supervisor ratings that assess individual employees' behaviours on specific tasks or group-level safety behaviours (Simard & Marchand, 1995, 1997), are more easily attained and cost effective data collection methods. As such the majority of safety performance research has been conducted using subjective self-report measures.

Historically, researchers examining individual workers' safety performance using self-report measures have conceptualised safety behaviour as a unidimensional construct focused on rule compliance or its opposite – violations and unsafe practices. However, in the late seventies Andriessen (1978) recognised the value to be gained from distinguishing between dimensions of safety behaviours associated with workers following rules or carefulness (i.e., active practices) and using their initiative (proactive practices).

### **3.3.1. Active and Proactive Safety Behaviours.**

Simard and Marchand (1994, 1995) provide several important insights into the nature of safety in workplaces; being some of the first authors to develop a noncompliance-based safety scale. However, their initial 3-item measure of workgroup safety initiative provides limited coverage of the construct domain (see Little, Lindenberg, & Nesselrode, 1999 for a commentary on multivariate indicators). In a later validation study, Simard and colleagues concluded that workers' safety behaviours should be conceptualised as a bidimensional construct, including both compliance and proactive safety practices. They argued that safety behaviours such as reporting hazards, engaging in safety meetings, communicating safety information, and offering ideas about safety issues constituted a more participative type of safety practice which they termed safety initiative (Marchand, Simard, Carpentier-Roy, & Ouellet, 1998).

In their investigations of the macro and micro organisational factors that affect safety outcomes, Simard and Marchand (1994) also initiated the use of multilevel analytical techniques in the safety arena. While safety researchers have conventionally stressed the importance of employees' compliance behaviours, Simard and Marchand's (1994) results indicated that the propensity for work-groups to take safety initiatives is a stronger predictor of effectiveness in occupational safety than the level of care taken by workers. Simard and Marchand also highlighted the significant role that leadership styles and the nature of social relationships between workers, coworkers and supervisors have in influencing safety outcomes (Simard & Marchand, 1994, 1995, 1997), a domain of interest further pursued by other key researchers in the safety field (Hofmann & Morgeson, 1999, 2004; Hofmann et al., 2003; Hofmann & Stetzer, 1996; Zohar, 2002a; Zohar & Tenne-Gazit, 2008). As such Simard and Marchand (1994, 1997) heralded the four key trends in current organisational safety literature. They are; utilising methodological techniques to analyse group-level data; separating the safety climate construct into key macro and micro dimensions (Zohar & Luria, 2005); exploring the role that formal and informal social exchanges (Hofmann & Morgeson, 1999; Hofmann et al., 2003) and leadership styles have on safety outcomes (Hofmann & Morgeson, 2004; Neal et al., 2000; Zohar, 2002a); and investigating proactive safety behaviours in addition to compliance behaviours (Hofmann et al., 2003; O'Toole, 2002).

Griffin and Neal (2000) also operationalised safety compliance and participation using short 3-item scales. They identified a degree of independence between the two safety performance scales in two samples (Study 1,  $r = .38$ ; Study 2,  $r = .30$ ). This was also reflected in the stronger associations found between safety climate and participative safety behaviours observed when safety climate was modelled as a predictor of both constructs. In a more recent study, Pousette et al. (2008) distinguished between personal safety behaviours (i.e., compliance activities) and two further scales established by Cheyne et al. (1998) representing structural safety behaviours (i.e., participation in organised safety activities) and interactional safety behaviour (i.e., safety activities associated with communicating safety information and ideas with coworkers and managers), however these later two scales have been combined under the participation or safety citizenship banner.

In a study examining the important role leadership style plays in organisational safety, Hofmann et al. (2003) expanded the conceptualisation of participative safety to develop a measure of safety citizenship behaviours. Hofmann et al.'s scale included six key types of proactive safety behaviour: helping, voice, stewardship, whistle blowing, civic virtue (keeping informed) and initiating safety-related change. These dimensions were derived from existing organisational citizenship measures (see Morrison & Phelps, 1999; Podsakoff, MacKenzie, Moorman, & Fetter, 1990; Van Dyne, Graham, & Dienesch, 1994), with the resultant 27-item scale providing a more comprehensive measure of proactive or safety citizenship behaviour.

The rationale behind using organisational citizenship behaviours is that such actions may be considered more discretionary than procedural-based behaviours, thereby requiring employees to go beyond what is expected in formal work role definitions (Hofmann et al., 2003). In support of this argument, Hofmann and his colleagues found that employees could discriminate between safety citizenship role definitions and core safety role definitions (i.e., mandated job requirements such as following procedures). Of additional interest in Hoffman et al.'s study was the importance of the quality of social exchanges between leaders and subordinates in promoting safety citizenship behaviours. Hofmann integrated role theory, social exchange and safety climate research to propose "that employees will reciprocate implied obligations of leadership-based social exchange (e.g., Leader-member exchange [LMX]) by expanding their role and behaving in ways consistent with contextual behavioural expectations (e.g., work-group climate)" (Hofmann et al., 2003, p.170). That is, in work-groups where safety is valued, employees who have high quality LMX relationships *pay back* their leaders by being more proactive in their safety activities. However, as yet, relatively few studies have utilised the bidimensional model of safety performance to examine the interplay between the two performance dimensions their distal and more proximal antecedents (e.g., leadership and safety climate respectively), and their outcomes (accidents and injuries).

### **3.3.2. Safety Performance in Predictive Models.**

In their recent meta-analysis, Nahrgang et al. (2011) reported construct associations between both workers' compliance practices and engagement in safety and a variety

of safety-related constructs. They used the term *engagement* to describe workers' participative safety behaviours however I have relabelled it here as proactive safety behaviours for greater interpretive consistency. Nahrgang et al. found slightly weaker correlations between proactive behaviours and accidents/injuries ( $r_c=.08$ ) and adverse events ( $r_c=.32$ ) than for compliance (.20 and .49 respectively). In contrast they found slightly higher correlations between safety climate (i.e., management commitment to safety) and workers' proactive behaviours ( $r_c=.80$ .) than compliance behaviours ( $r_c=.71$ ). Nahrgang et al. concluded that the different patterns of associations between proactive safety and compliance, safety climate and safety outcomes added support to the construct distinction between these two aspects of workers' safety performance.

In relation to the explanatory models used to describe the relationship between safety climate, workers' safety performance and outcomes, Griffin and Neal (2000) identified knowledge and motivational drivers as mediating factors between safety climate and safety behaviours. In contrast, Zohar (2000, 2003) has drawn on behaviour-expectation theory to explain workers' safety-related actions. Zohar and Luria (2005) further established that the relationship between manager commitment to safety and workers' performance is mediated by group-level supervisor commitment. Flin (2007) synthesised elements of both these models to expand her conceptualisation of the safety climate–injury relationship to include the impact of human error. Like Zohar before, while Flin acknowledged the key role supervisors, managers and (to a lesser degree peers), play in establishing performance expectations, she refrained from including coworker influences in her model.

In their recent study Jiang et al. (2010) investigated the role coworker safety knowledge and behaviours plays in mediating safety climate's impact on both compliance and participative safety behaviour. Jiang et al. found a strong association between safety compliance and participation ( $r=.63$ ); a weak but significant relationship between safety climate and participation ( $r=.13$ ) and no significant association between safety climate and compliance ( $r=.03$ ). They also identified different associations between performance and safety outcomes, with significant zero order correlations being observed between participation and injuries ( $r=-.11$ );

and safety compliance and near miss incidents ( $r=.13$ ). While the direction of this latter relationship is counter to that anticipated, the positive association may reflect a greater awareness of potential incidents or willingness of report near miss occurrences in those workers who see themselves as highly compliant.

In one of the few studies to use longitudinal analysis to examine the lagged and leading relationship between safety climate, worker safety performance and safety outcomes, Neal and Griffin (2006) examined both employee safety behaviours and group accidents rates over a five-year period. Using multilevel analysis they found that for hospital work-groups in which individuals engaged in compliance and participative safety behaviours, accident rates for lost time injuries were significantly reduced over time. Pousette et al. (2008) also found safety climate predicted self-reported safety behaviours obtained 7 and 14 months after the initial data collection. The temporal ordering of the safety climate-safety behaviour relationship was further supported in Pousette et al.'s study, as the relationship remained significant when prior (Time 1) safety behaviours were controlled.

Two further meta-analyses have examined the relationship between safety climate and performance (Christian et al., 2009; S. Clarke, 2006). While both identified that a growing number of studies are incorporating safety participation in their predictive models, the body of empirical evidence is still relatively sparse. Clarke's (2006) meta-analysis demonstrated the importance of differentiating between workers' compliance and participative safety behaviours. Clarke identified strong association between compliance and participation ( $k=5$ ;  $p=.47$ ) in the small number of studies that included both measures. Clarke found that while safety climate predicted both compliance and participation practices the strength of the relationship between safety climate and individual workers' participative safety behaviours was slightly stronger ( $k = 8$ ;  $\rho = .50$ ) than with compliance behaviours ( $k = 12$ ;  $\rho = .43$ ).

Clarke (2006) also reported a relatively weak relationships between accident/injury outcomes and both safety compliance ( $k=9$ ;  $p=.09$ ) and participation ( $k=3$ ;  $p=.14$ ), however the latter effect was observed in a very small sample ( $N=411$ ) in meta-analytic terms. In this instance, due to recoding of accident data used in her study,

the positive correlation indicates that greater compliance and levels of participation are associated with a decrease in accident/injury rates. Despite being based on only a small number of studies, Clarke's findings add support to the value of including both explicit, role-determined compliance practices and more implicit, proactive safety citizenship behaviours (Hofmann, et al, 2003). Clarke's review also identified the general lack of research linking safety behaviours to safety outcomes such as injury rates.

In a subsequent study, Christian et al. (2009) also used safety performance and accidents /injuries as criterion measures in their meta-analysis of the personal and situational factors influencing safety outcomes. With some overlap in the studies included in their reviews, it was not surprising that Christian's results were consistent with Clarke's (2006); however the separation of effects for safety climate according to dimensionality and level of analysis provides an opportunity to examine associations more closely in Christian et al.'s work. For the five effects observed between participation safety and compliance behaviours Christian calculated a mean corrected correlation of .46, consistent with Clarke's result. Of significance to note were the relatively stronger overall effects observed for both performance and accidents when group-level analysis were applied compared to results obtained using individual- level analysis. Also of interest were the stronger relationships found between climate, performance and outcomes when objective data, such as archival records, safety audits and OHS medical data, are used in predictive models rather than highly subjective self-report data. However as mentioned previously, obtaining such information is invariably more difficult.

One issue in regarding the construct relationships between safety behaviours and both antecedents and outcomes concerns the practice of embedding items targeting employee participation in safety activities and rule compliance within safety climate scales (e.g., Seo et al., 2004). The inclusion of individual-level data in safety climate scales has been criticised on the basis that such information is not an emergent property of the group or organisation as the definition of climate implies (Glick, 1985; Kozlowski & Klein, 2000; Zohar, 2003). In line with the approach taken by Beus, Payne, et al. (2009), the inclusion of items assessing workers' safety

behaviours using an individual worker referent, constitutes construct contamination. Depending on the actual measure of individual performance or attitude used and the explanatory model conceived, the inclusion of individual-level constructs in safety climate scales may artificially inflate or attenuate the relationship between antecedent, predictor and criterion. However, if the referent is shifted to assess coworker safety performance within the workgroup or organisation the emergent property of climate constructs is respected and the potential for confounding with individual-level antecedent or outcome measures reduced.

### **3.4. Summary**

In the above review I have described how current and past research has tended to focus on one safety outcome measure alone in predictive models which restricts the opportunity for direct comparisons to be made between and within studies.

Furthermore, I have discussed how alternate safety outcome measures such as micro accidents or minor injuries and near miss incident data, which potentially offer scope for greater response variability amongst workers, have been underutilised in the literature. I have also described how research has largely examined the relationship between the global operationalisation of psychological safety climate, as an antecedent of compliance and to a far lesser extent participative safety behaviours, and touched on the issue of construct contamination between safety climate and safety performance in the literature. My review also showed that the link between safety climate and safety outcomes has typically been investigated using retrospective self-report accident/injury data analysed at the individual-level.

Whereas results of the meta-analysis described above go some way towards determining if the magnitude of effects found in the literature are linked to methodological and design issues (i.e., the use of retrospective and prospective injury data), data sources (i.e., the use of objective or subjective performance and injury data) or level of analysis issues (i.e., conducting individual or group-level analysis), scope remains to investigate these issues further.

My review of the extant literature was intended to provide a justification for the selection of outcome measures used in my thesis and the approach taken to data modelling. Again, meta-analyses were referred to as overarching indications of the



strength of construct relationships in the literature. With regard to my research framework my review recognised the multilevel, multidimensional nature of safety performance and safety outcomes in organisations by examining the diverse range of measurement options available and in particular the dependence of empirical studies on subjective rather than objective outcome data. I also took into consideration measurement issues relating to the collection and analysis of data at the individual, group and organisational levels. Furthermore, the temporal ordering of safety climate-behaviour-outcome issue ties in with the regression/development postulate of my framework in recognising the dynamic nature of organisations and the profound impact safety incidents can have on workers' perceptions and broader organisational function. Having briefly reviewed the literature relating to the outcomes of having a positive safety climate, in the next chapter I focus on potential antecedents of safety climate and performance.

## 4. Leadership, Support and Social Exchange

### 4.1. Introduction

In this chapter I present a review of the leadership, social support and social exchange research conducted within the safety domain. In particular I focus on investigating the influences exerted by management and supervisors and expand the examination to include the informal influences that coworkers have in establishing safety norms.

### 4.2. Leadership in Safety Research

When recently describing his integrated model of safety climate and outcomes, Zohar (2010) included the process of *sense-making* as an underlying foundation for a modified version of the safety pyramid. In this multilevel model the social and cognitive exchanges between leaders and workers plays a crucial role in the formation of climate perceptions. In a review of the role of leadership in safety, Hofmann and Morgenson (2004) highlighted the importance of leaders' commitment to safety in the workplace as a key dimension of safety climate, however they noted a relative paucity of studies that directly examine how different leadership styles influence workers' perceptions of climate or safety behaviours. Hofmann and Morgenson identified 12 studies that either focused directly on safety-specific leader behaviours (e.g., Barling et al., 2002; Tomás et al., 1999; Zohar, 2000, 2002b) or examined the relationship between general leadership styles and safety outcomes (e.g., Hofmann & Morgeson, 1999; Hofmann et al., 2003; Simard & Marchand, 1997; Zohar, 2002a; Zohar & Luria, 2004).

My review of more recent publications indicates that the modelling of relationships between leadership, safety climate level and outcomes has continued as the main enterprise in the research field (e.g., S. Clarke & Ward, 2006; Crichton, 2005; Kath, Marks, & Ranney, 2010; Kelloway et al., 2006; Martinez-Córcoles, Gracia, Tomás, & Peiró, 2011; Wu, Chen, & Li, 2008; Zohar & Tenne-Gazit, 2008). However, understanding the role leadership plays in the formation of group consensus (climate strength) has also attracted some limited research attention (Luria, 2008; Zohar & Tenne-Gazit, 2008). Christian et al. (2009) included leadership style as a situational predictor in their meta-analysis of safety performance and outcomes. Their results indicated that leadership had a moderate positive relationship with safety

performance ( $k=9$ ;  $\rho=.31$ ) and weak negative association with accidents and injuries ( $k=7$ ;  $\rho=-.16$ ). When the leadership effects were separated into compliance and participation dimensions slightly stronger associations were found between leadership and safety participation ( $k=3$ ;  $\rho=.35$ ) than for compliance behaviours ( $k=3$ ;  $\rho=.24$ ). This result is consistent with the proposal that leadership style is associated with worker engagement in participative or organisational citizenship behaviours (Podsakoff et al., 1990). However as indicated by the limited sample sizes for these categories and the lack of specification of which level of leadership is driving the safety performance outcomes, there is a need for further research in this area.

While Christian et al. (2009) did not distinguish between studies using safety-specific leadership scales or traditional leadership inventories, Zohar and Luria (2005) have highlighted the need to establish the discriminant validity of safety leadership and generic leadership measures given the integrated nature of the constructs. In the following section I briefly look at empirical findings obtained using both safety-specific and generic leadership approaches before focusing on the most commonly applied leadership approach: leader-member exchange.

#### **4.2.1. Safety-Specific Leadership**

Kelloway, Mullen and Francis (2006) extended their earlier collaborative work with Barling (Barling et al., 2002) to operationalise two safety-specific leadership styles. By modifying the wording of items tapping active/transformational and passive leadership in the Multifactor Leadership Questionnaire (Bass & Avolio, 1997) they created new facet-specific leadership scales for use in a safety context. In testing their leadership-safety model, Kelloway et al. identified that both of these safety leadership styles differentially related to safety consciousness and safety climate which subsequently predicted safety events and injuries. However, a major limitation of this study was the use of working, undergraduate students as the sample population, as the use of this predominantly white collar/service industry sample places in question the generalisability of their results to higher risk settings, typically targeted in safety research.

Wu, Chen and Li (2008) also investigated the relationship between safety leadership, safety climate and safety performance in university laboratories. Their operationalisation of safety leadership tapped aspects of caring, coaching and controlling which mirrors Johnson's (2007) renaming of supervisor safety climate factors in his validation of Zohar and Luria's (2005) scale. A closer inspection of the items for both safety leadership and safety climate measures in Wu et al.'s study indicated little construct differentiation. Evidence of poor discriminant validity was also seen in Wu et al.'s path analysis that showed a very strong association between safety leadership and safety climate.

More recently Martínez-Córcoles et al. (2011) examined the relationship between safety culture, safety climate, safety leadership and compliance behaviours. They operationalised safety climate as top level management commitment to safety (Zohar & Luria, 2005) and adapted the Empowerment Leadership Questionnaire (Arnold, Sharon, Rhoades, & Drasgow, 2000) to reflect the safety focus of supervisors in the nuclear industry. They subsequently identified five supervisory safety leadership factors which they labelled: leading by example, participative decision making, coaching, informing and showing concern, which again align quite closely with Zohar and Luria's (2005) supervisor safety climate scale.

While Martínez-Córcoles et al. (2011) identified a strong bivariate correlation and standardised pathway between leadership and safety climate ( $r=.55$ ;  $\beta=.61$ ) the ordering of these constructs in their model is somewhat puzzling in that they proposed top level management commitment to safety as a mediating factor between workers' perceptions of supervisory safety leadership style and compliance behaviours. However in terms of the distal (organisation-level management practices) and proximal (group-level supervisory practices) influences represented down the organisational hierarchy, it would seem more logical to model supervisory safety practices/style as a mediating influence between top management practices and performance, or for organisation-level safety climate to moderate the group climate  $\rightarrow$  performance relationship. This apparent management-level incongruence in Martínez-Córcoles et al.'s study may be linked to the use of ambiguous referents in the particular nuclear context (i.e., supervisors may actually equate to top level managers rather than first line supervisors as inferred).

When commenting on the lack of empirical evidence relating to how managers influence organisational safety, Flin (2003) highlighted the ambiguous application of the term *management* in safety climate research as a problematic issue. She argued that clarifying the differential influence of management commitment to safety across the organisational hierarchy (from front-line supervisors to managing directors) would enhance our understanding of workplace safety. This stance has since been supported by Zohar (2010) in his call for the application of a level-of-analysis approach and greater content specification in safety climate research. While both Flin and Zohar were referring to clarification of management safety practices and roles listed within safety climate inventories, the same issue and potential solution applies when considering the influence of leadership style.

On the basis of such findings it becomes apparent that the distinction between leaders' commitment to safety (as a dimension of safety climate) and leadership style may be more easily confounded when safety-specific leadership scales are used. Zohar and Luria (2005) contend, that while "leader interactions provide the medium in which policies are implemented,... the medium, although influencing the message (e.g., greater emphasis on safety under high quality leader-member interactions), [should] not be confused with it" (2005, p.626). In support of this statement they argued that the limited findings to date indicate that individuals discriminate between the two constructs, by basing leadership perceptions on relationship referents and climate perceptions on commitment referents. This distinction is however confounded when safety-specific leadership scales are used.

In contrast therefore, by focusing on more general leadership behaviours in safety research the opportunity exists to tease out the influences of both a leader's style and safety orientation, as independent constructs. For example, in climate-based research, leadership style may be conceptualised as a component of a broader organisational foundation climate within which the facet-specific safety climate emerges. Indeed intuitively, the independence of leadership style and safety orientation makes sense, in that one cannot automatically assume (only hope) that an effective leader must have a strong commitment to safety, especially if organisational goals prioritise production over safety outcomes.

#### **4.2.2. General Approaches to Leadership**

While the range of approaches to leadership in the organisational literature is extensive (for a review see Yammarino, Dionne, Chun, & Dansereau, 2005) the leadership models applied most frequently in the safety domain have focused on Transformational and Transactional leadership (Bass & Avolio, 1997), leader-member exchange (Graen & Uhl-Bien, 1995), and leader influence tactics (Yukl & Falbe, 1990). Zohar (2002a) initially found evidence to support the interaction between leaders' safety priority and two dimensions of transactional and transformational leadership in the prediction of safety climate and micro accidents. Zohar and Luria (2004) later identified that the transformational leadership style of supervisors (platoon leaders) in the military were positively correlated to group-level safety climate and moderated the relationship between supervisor practices and safety climate perceptions. Clarke and Ward (2006) also found that leaders' influence tactics had significant positive direct and indirect effects when modelled on safety climate and safety participation. In one of the few studies to use longitudinal data, Parker, Axtell and Turner (2001) also found evidence that supportive supervision predicted safe working 18 months after initial data collection.

Additionally, establishing how the quality of leader-member exchanges (LMX) influences safety climate and performance has attracted a considerable degree of research interest. In their 1999 study, Hofmann and Morgeson described how social exchange theory provides a conceptual foundation to explore key aspects of organisational behaviour, and included two forms of social exchange; perceived organisational support (POS) and LMX in their safety model. Similarly, Oliver et al. (2002) drew upon social exchange theory when discussing the importance of both supervisor support and coworker support in their study of the individual and organisational factors that affect occupational accidents. More recently Kath et al. (2010) also examined the relationship between safety climate, LMX, POS and upward safety communication.

While Hofmann and Morgeson (2004) rightly identified the relative lack of research into leadership and supervisory social exchanges within the safety domain, it is possible to extend this concern to argue that even less research has focused on investigating how the broader range of social relations and group processes operating

within and across the workplace hierarchy can affect safety outcomes. In the following sections I therefore review empirical studies that have examined the relationship between organisation support, leadership, group process, safety climate and safety outcomes with a specific focus on the application of social exchange theory.

### **4.3. Social Exchange Theory**

Social Exchange Theory (Blau, 1964) describes the nature of exchanges in social resources that occur within relationships. When considered in combination with the norm of reciprocity (Gouldner, 1960), the underlying premise of social exchange theory is that an expectation exists between individuals that support provided, services rendered or rapport established within relationships will be reciprocated in a commensurate form. In an organisational safety context, social exchange theory suggests that in the normal progress of daily interactions workers and leaders establish exchange-based relationships (leader-member exchanges). In situations in which high quality leader-member exchange relations are formed and safety is valued by the leader, a worker would be expected to feel a sense of obligation to respond in a manner beneficial to and consistent with the safety goals and objectives of their leader. In low quality exchange situations any obligation to reciprocate in a positive manner is weakened.

However, social exchange dynamics are not restricted to supervisor LMX relationships, but rather span the organisation to include management- worker and worker- coworker interactions, potentially forming a broader climate for social exchange. While few studies in the safety literature have attempted to look at the complexity of social exchange variables operating down the organisational chain of influence (DeJoy et al., 2004; Hofmann & Morgeson, 1999), these exceptions are included in the following review. To reflect the hierarchical nature of social exchange relations I begin with the most distal exchange relationship, that between higher level managers and workers.

#### 4.3.1. Organisation-level Social Exchange (POS)

In general, social exchange research conducted at the upper management or organisational level has been investigated under the banner of perceived organisational support. In developing their POS scale, Eisenberger et al. (1986) followed Levinson's (1965) approach in arguing that employees "view actions of agents of the organisation as actions of the organisation itself... [resulting in] the personification of the organisation" (Eisenberger, Huntington, Hutchinson, & Sowa, 1986, p. 500). However, from the perspective of workers, agents of the organisation operate at all hierarchical levels. As such, when completing a POS scale, using the *organisation* referent, as generally administered, it may be difficult to ascertain whether respondents are actually rating perceived support in terms of the agency provided by their immediate supervisor, lower level managers or executive levels of management as the content of items is often applicable at different management levels.

In this instance the generic use of *organisation* may exacerbate the potential for ambiguity as previously discussed in the nonspecific usage of the term *management* in safety climate research mentioned by Flin (2003). In line with the level-of-analysis approach to safety climate recommended by Zohar (2010), I would argue that to improve construct validity in variables tapping social exchange interactions at various levels of the organisation, the distinction between focal referents should be made explicit.

Mearns and Reader (2008) also drew on social exchange theory when developing their organisation wide support for health and safety model. They described how "essentially building a climate of care, concern and support for health within the work group... [based on] appropriate social exchanges within an organisation, may lead to unanticipated benefits in terms of employee safety behaviours that go beyond normal compliance..." (p. 388 & 392). This stance is consistent with general leadership theory which links high quality, transformational leadership with expanded employee engagement in organisational citizenship behaviours (Podsakoff et al., 1990). In developing their facet-specific health support scales for supervisors and workmates, Mearns and Reader found that the strongest relationships with safety citizenship behaviours were observed when supervisors supported employee health ( $r$



= .33;  $\beta$  = .23). Perceived organisational support also showed significant correlations with safety citizenship ( $r$  = .29;  $\beta$  = .14) and to a lesser degree workmate support of health ( $r$  = .21;  $\beta$  = .08).

As previously described in Chapter 2, Wallace et al. (2006) found that safety climate mediated the relationship between two foundation climates (the climate for organisational support and management-employee relations), and occupational accidents. Safety climate was also found to mediate the relationship between general organisational climate and employees' perceived safety at work (DeJoy et al., 2004). DeJoy et al. included organisational support, coworker support, involvement with others, involvement with supervisors and communication in their conceptualisation of organisational climate. They found support for the relationship between organisational support, coworker support and safety climate and also concluded that organisational support has both direct and indirect effects on safety outcomes. In these two studies POS was conceptualised as one dimension of the broader organisational or foundation climate however only Wallace et al. treated POS as a group-level construct. Indeed, as in the general leadership literature where levels-of-analysis issues have been raised as a concern (Yammarino et al., 2005), safety-related social exchange studies have generally analysed individual-level data derived from the dyadic relationship between supervisors and individual workers, with few studies correctly aligning theory, data and measurement techniques.

For example, Hofmann and Morgeson (1999) regressed both POS and LMX on group leader's safety communication, safety commitment and injuries. In a sample of 49 supervisor and group leader dyads in the manufacturing industry, Hofmann and Morgeson distinguished between nonunion supervisors and unionised group leaders. However the unionised group leaders may be considered first line supervisors in their own right depending on the sample population. Of importance here is the issue of clarifying not only the level of analysis applied (Yammarino et al., 2005) but also the status of the focal leader and relationship to the respondent. Hofmann and Morgeson's results indicated that both social exchange variables had significant associations with safety communication (POS: SC  $r$  = .54) but that only LMX showed significant associations with all three criterion variables (LMX: SC  $r$  = .47,

Commitment  $r = .29$ , Accidents  $r = -.32$ ). These results indicate that the more proximal exchange relationships between workers and their direct supervisors is more critical in fostering better safety communication, commitment to safety and fewer injuries in group leaders than more distal organisational support. However in their review of the application of multilevel analysis in leadership research, Yammarino indicated that while the appropriate levels of analysis were implied in Hofmann and Morgeson's theory and hypothesis development, they believed that the theory, concepts, data and measurement levels were misaligned and required more explicit clarification as was subsequently undertaken in Hofmann et al.'s (2003) later research on LMX.

In sum the results of these studies add support to the proposal that a network of social exchanges at different levels of the organisation may be influencing employee behaviours and safety outcomes. Importantly the literature indicates that employees are influenced not only by their relationships with their supervisor, but also by their perceptions of the degree to which upper management values and is committed to them as individuals; and the nature of social interactions within work teams.

#### **4.3.2. Group-level Social Exchange (LMX)**

As a key link in the psycho-social chain of influence, research has to date largely focused on the social exchanges between first line supervisors and their team members. In her discussion of the emergence of state goal orientations in work-groups Dragoni (2005) argued that through a process of social learning (Bandura, 1986), consistent patterns of leader behaviours are observed and interpreted by workers as the leader's achievement priority. Through ongoing interactions, this priority forms the basis for the specific goal orientation or normative behavioural expectations for the individual and group; that is psychological or group climate. Dragoni further described how some group leaders with a "particularly compelling presence" (p. 1091) have the capacity to galvanise climate perceptions within their work-groups.

Hofmann et al. also proposed that "employees will reciprocate implied obligations of leadership-based social exchanges (e.g., leader-member exchange) by expanding their role and behaving in ways consistent with contextual behavioural expectations

(e.g., work-group climate)” (2003, p. 170). Consolidating these two lines of thinking, it appears that leaders play an important role in both helping to form group-level safety climate perceptions and encouraging workers to operate within or even surpass the normative behavioural expectations. In support of these statements, Hofmann et al. (2003) found that perceived safety climate moderated the relationship between leader-member exchanges and workers’ safety-related role definitions and safety citizenship behaviours. That is, in work-groups in which safety was valued and the quality of leader-member exchanges was high, workers were more likely to engage in beyond-role safety citizenship behaviours.

Michael and colleagues (Michael, Guo, Wiedenbeck, & Ray, 2006), also examined the relative importance of supervisor LMX and safety communication in predicting subjective and objective safety outcomes for blue collar workers in the wood manufacturing industry. Michael et al.’s results indicated that when viewed from a subordinate’s perspective, the quality of LMX is a stronger predictor of their subjective recall of safety events over a 12 month period than safety communication. Using hierarchical regression to control for age, gender and job satisfaction, they found that LMX accounted for a small but significant amount of variance in safety events (2.3%) but only .3% of safety communication. Even though self-reported accident data and company OSHA records in Michael et al.’s study were significantly correlated, neither LMX nor safety communication emerged as significant predictors of the objective safety records. While the overall size of the effects observed were considered small, Michael et al. concluded that the importance of front-line supervisors’ actions and relations with workers should not be overlooked when promoting safety in the workplace.

Furthermore, just as supervisors have been identified as an important cog in the wheel driving organisational safety, so too are a worker’s fellow team members, as they represent the most proximal point of contact within the organisational social system (Hofmann & Stetzer, 1996; Turner & Parker, 2004). As described previously, while the need to clearly distinguish between leadership style and leaders’ commitment to safety has garnered support (Zohar, 2010; Zohar & Luria, 2005), even less attention has been paid to the apparent lack of construct distinction found

in the labelling and measurement of coworker social support and cohesion as aspects of internal group processes in the safety literature, compared to coworker commitment to safety as a dimension of safety climate.

#### **4.3.3. Group Member Social Exchange**

In the safety literature to date there has been a lack of distinction made between the general quality of group interaction occurring (workgroup context) and safety-specific group practices (safety climate related norms). For example in Christian et al.'s (2009) meta-analysis, they adopt Neal and Griffin's (2004) taxonomy to label *internal group processes* as a category within psychological safety climate. As their definition focused on the "perceptions of communication and support for safety within work-groups or the extent to which employees perceive that their coworkers provide them with safety-related cooperation and encouragement" (p.1107), the content domain appears to reflect emergent group safety practices and therefore its inclusion as a dimension of safety climate is appropriate. However when I examined the item content in a number of the studies included under this category in Christian et al.'s (2009) meta-analysis, their focus was on generic group characteristics rather than safety-specific interactions. For example, DeJoy et al. (2004) investigated coworker support, Hofmann and Stetzer (1996) work-group processes, and Hse, Lee, Wu and Takano (2008) teamwork. In each of these scales there was no mention of safety in any of the items.

In contrast, Watson and colleagues examined the safety norms of coworkers, with items focusing on coworkers wearing protective clothing and taking corrective safety actions (Watson, Scott, Bishop, & Turnbeaugh, 2005). In this instance the scale is correctly included under the safety climate subcategory but does not really reflect internal group process as the label implies. With the intention of promoting the value to be gained by establishing greater construct distinction, in the following review I focus on studies that have investigated the relationship between generic group process and safety outcomes rather than those that have adopted the hybrid group process/safety climate approach.

While no studies in the safety domain have investigated group member social exchange specifically, the important role that coworker support and group cohesion

plays in reducing role ambiguity, organisational citizenship behaviours and task performance is well established in the organisational literature (Chiaburu & Harrison, 2008; Kidwell & Mossholder, 1997). For example, when examining the relationship between group cohesion and organisational citizenship behaviours, Kidwell and Mossholder (1997) used social exchange theory to explain one of the mechanisms through which cohesiveness encourages worker participation. They argued that “cohesive groups would display more positive and frequent social exchanges than noncohesive groups...[thereby] encouraging trust in the long run that social exchanges will be reciprocated [in the form of organisational citizenship behaviours]” (1997, p.778). While Kidwell and Mossholder did not attempt to measure the quality of social exchanges as a separate construct from group cohesion, a later study by Love and Forret (2008) found strong correlations between team-member exchange and supervisors’ ratings of workers on four of the five dimensions of organisational citizenship behaviours.

Within the safety literature, Simard and Marchand (1995) included supervisors’ perceptions of work-group cohesiveness in their multilevel analysis and found that cohesion was related to workers’ propensity to engage in safety initiatives at the individual ( $r=.21, p<.01$ ) and group-level of analysis ( $r=.41, p<.01$ ). When modelled with other macro and micro organisational factors (including supervisor participative management of safety), group cohesion remained a significant predictor of safety initiatives. Furthermore, Luria (2008) found that group cohesion in military units was a positive predictor of safety climate strength. When modelled with the leadership style of their platoon leader, significant interaction effects indicated that the strongest levels of group consensus regarding safety climate perceptions were found in groups that were more cohesive and also rated their platoon leader highly on the transformational leadership scale. Conversely in groups that had a leader who engaged in a passive leadership style, high cohesiveness in the platoon was found to mitigate the lack of direction from the leader in establishing a relatively stronger safety climate than found in groups with lower social cohesion.

In a further study, Hofmann and Stetzer (1996) investigated the impact of group-level safety climate, group members’ willingness to approach workers engaging in

unsafe acts (approach intentions), and group processes on unsafe behaviours and group-level accidents. They operationalised coworker support as a separate, generic construct using a 7-item scale from the Survey of Organisations (Taylor & Bowers, 1972). Using group-level analysis to investigate the construct relationship for 222 workers nested in 21 teams, Hofmann and Stetzer (1996) reported moderate to strong correlations between group process and safety climate at both the individual and group-level (individual  $r=.34$ ; group  $r=.49$ ). Correlations observed between group process and unsafe behaviours (individual  $r=-.17$ ; group  $r=-.49$ ) were also significant and stronger at the group-level, but for the group process  $\rightarrow$  accident relationship the effect was not significant (group  $r=-.31$ ,  $p<.10$ ). Considering the small sample size at the group-level, insufficient power may have contributed to this finding. Subsequently Hofmann and Stetzer claimed marginal support for their group process  $\rightarrow$  accident hypothesis.

In a further study examining employee perceptions of job demands and safety climate in a sample of injured construction workers, Gillen and colleagues (Gillen, Baltz, Gassel, Kirsch, & Vaccaro, 2002) found that workers who perceived that their working environment was safer, as indexed by more positive safety climate ratings, also rated supervisor ( $r=.55$ ) and coworker support ( $r=.31$ ) higher on the Job Content Questionnaire (JCQ).

Of importance to note in these studies is the consistent magnitude of the relationships observed between the variety of group process indices (whether they measure coworker support or group cohesion) and both safety climate and safety outcomes. In addition, the trend for associations observed at the group-level of analysis to exceed those found using individual-level data warrants comment. When scale items focus on the individual workers' or supervisors' perceptions of the general social interactions between coworkers in their team, this referent shift is consistent with the criteria for climate constructs in that the focus is directed on the emergent qualities of the group. If aggregation of this data is subsequently conducted, the shared nature of climate perceptions is reflected at the target level of analysis. Subsequently if group process variables, leadership and measures of organisational support are examined in combination it may be possible to operationalise a modified version of the overarching *environment for support* recently described by Nahrgang et al. (2011).

In their comprehensive meta-analysis of the extant safety literature, Nahrgang et al. (2011) used the Job Demands-Resource Model (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001) as a framework to investigate how job demands and job resources impact on employee burnout, engagement and safety outcomes. Within the job resources domain, they included social support, leadership and safety climate as dimensions of a supportive environment. One of Nahrgang et al.'s key findings was that a supportive environment was a major factor in promoting workers' compliance and engagement in safety practices and safety outcomes across industry settings. Nahrgang et al. (2011) concluded that the consistently strong correlations found between the three supportive environment variables, safety engagement and compliance, add weight to the hypothesis that support environments may act as antecedents to both safety climate and safety performance.

Nahrgang et al.'s (2011) review also highlights that, while there are fewer studies examining the role coworker social support plays in safety models, both population estimates and the relative importance statistics derived add credence to the importance of coworker activities in predicting workers' safety performance and safety outcomes. In all but one relationship with criterion variables (i.e., unsafe behaviours) correlations for coworker social support exceeded the values of the more intensely researched leadership variables. Coworker social support was also found to account for more variance in both accidents and adverse events than safety climate (accidents 65.5% of .32; adverse events 31.6% of .22). That being said, the criteria used when formulating the job resource -supportive environment variables show a degree of construct confusion both within and between categories. To quote directly from Nahrgang et al.'s methodology:

Social support includes involvement and support from coworkers, team-work, and coworker support for safety. Leadership includes styles of leadership (i.e., transformational), relationships between leaders and workers (i.e., leader-member exchange), trust, and supervisor support for safety... Safety climate includes the overall perceptions of the safety climate, the perceptions of management's involvement in safety, and proactive management of safety (2011, p. 76).

While the use of such broad brush strokes across construct domains allowed greater flexibility in the meta-analysis it may have been at the cost of construct validity. As I have previously discussed in my review of the literature, the failure to distinguish between general and facet-specific concepts in the social support and leadership categories is problematic in a manner akin to not distinguishing between the message and the medium through which it is delivered (Zohar & Luria, 2005). Furthermore, items measuring coworker and supervisor support for, or commitment to safety are often included in global safety climate measures along with management commitment to safety. This potential mixing of domain content again may lead to construct validity issues, potential problems with multicollinearity and artificially inflated estimates with safety performance and outcomes.

Despite these concerns Nahrgang et al.'s (2011) organisation of the job resources variables distinguishes between individual (knowledge and autonomy), group (coworker support and leadership) and organisational level (safety climate) information, reflecting Zohar's (2010) recommendations to approach safety climate research from a levels-of-analysis perspective. If further construct refinement was undertaken in empirical studies to clearly distinguish between safety climate and social support dimension, such as focusing on workers' perceptions of the lateral and horizontal social exchange interactions engaged in by organisational agents, the operationalisation of a foundation climate for social exchange could be formulated to hierarchically align with levels of group (coworker and supervisor) and organisational (management) safety climate. Such an undertaking would potentially advance our knowledge of the psycho-social chain of influence in safety research, as is the intent of my research.

#### **4.4. Summary**

I began this chapter with a brief description of leadership styles investigated in the safety literature. My review highlighted the need for researchers to make two clear points of differentiation in their studies. The first involved the use of generic or safety-specific leadership and the need to improve construct discriminant validity between the two. The second, focused on the need to clearly distinguish between levels of management to minimise focal target ambiguity in safety research.



Drawing upon the general leadership literature, I then provided evidence to support the utility of social-exchange theory as a common theoretical basis for understanding lateral and horizontal workplace interactions operating within organisations. In line with arguments previously presented regarding the importance of including coworker influences in safety models, empirical findings examining the role of coworker support and group dynamics were also described.

## 5. Rationale

### 5.1. Research Aims and Objectives

As I have described in the preceding chapters, research indicates that an important link exists between the safety climate of an organisation, employee compliance and participative safety behaviours, and safety outcomes such as accidents and injuries (Christian et al., 2009; S. Clarke, 2006; Nahrgang et al., 2011). Furthermore, the quality of leadership and informal relationships in workplace settings has been found to influence employee safety behaviours (Hofmann et al., 2003; Nahrgang et al., 2011). However, few studies to date have investigated these factors concurrently or examined the direct impact of applying different levels of analysis and aggregation methodologies on construct associations. My overall aim in this research is therefore to examine the relationships between key organisational predictors of employee safety outcomes by developing and testing a work-level model of safety climate and social exchange using group-level analysis to directly compare the results derived. More specifically a series of objectives are proposed, namely:

1. To develop a measure of safety climate, using a level-of-analysis approach that incorporates the active and proactive safety practices of organisational agents.
2. To show how climate level, strength and variability can be used to examine organisational differences in safety climate profiles.
3. To investigate how the relationship between employee perceptions of management, supervisor and work-group commitment to safety (i.e., levels of safety climate) influence individual employees' safety performance and safety outcomes (e.g., injuries, near miss incidents).
4. To investigate the relationship between the climate for social exchange, including the quality of more formal (management and supervisory) and informal (coworker) social exchanges, perceived safety climate level and workers' safety performance.
5. To examine potential differences in the hypothesised construct structures and relationships for the work-level model of safety climate when different aggregation techniques are used to conduct group-level analysis.

The following rationale is separated into two sections. In the first section I focus on hypotheses relating to the development and validation of the constructs to be used in the work-level safety climate model. In the second section I present the rationale for testing two explanatory models. The first of these models examines the relationship between global safety climate, safety behaviours and safety outcomes. The second proposes a stratified work-level model of climate for social exchange, safety climate and safety behaviour. Within each of these sections a justification of the methodological and theoretical choices made in my research is offered and specific hypotheses presented.

## **5.2. Operationalising Study Constructs**

In response to the call for safety research to shift its focus to investigating functional processes and explanatory models (Flin, 2007; Zohar, 2010; Zohar & Luria, 2005; Zohar & Tenne-Gazit, 2008), my research explores the mechanisms of how climate for social exchange and safety climate combine to influence safety behaviours and outcomes. To achieve this goal, a critical first step is the operationalisation of a work-level safety climate construct that expands upon Zohar's Organisational Safety Climate Scale (Zohar, 2003) to include coworker commitment to safety at the group-level and also the operationalisation of climate for social exchange indicators. A preliminary objective of my thesis is therefore the validation of both existing and new safety behaviour, safety climate and social exchange scales.

### **5.2.1. Work-level Organisational Safety Climate Scale.**

#### **5.2.1.1. *Coworker Dimension***

Reviews examining the dimensionality of safety climate have identified a range of possible components (see Cox & Flin, 1998; Guldenmund, 2000; Seo et al., 2004; Zohar, 2003) with leader actions having emerged as the principal component and key focus of research in recent years (Flin, 2007, Zohar, 2003). However, in accepting the definition of safety climate as the shared perceptions of safety conditions (including the policies, procedures and practices) within an organisation, should our operationalisation not reflect the practices of employees at all work-levels, not just those of managers and supervisors? In line with social interaction perspectives (Schneider, 1975) and the Theory of Planned Behaviour (Ajzen, 1991), including

coworker actions in group-level safety climate acknowledges the influences work mates have on the formation of subjective safety norms.

As discussed in section 2.6, in using the TPB as a framework to examine the relationship between safety climate (operationalised as management attitudes to safety), group safety norms and unsafe behaviours (violations) Fogarty and Shaw (2010) highlighted the key role coworkers play as models for normative behaviour. Chiaburu and Harrison (2008, p.1097) have also argued that “coworkers matter [by] *making the place* for a broad range of employee outcomes.” While the influence of coworkers is not a new addition to the safety domain, previous research has typically focused on coworker support (Roy, 2003) or influence (Findley et al., 2007) rather than specifically on coworkers’ commitment to safety. As indicated in Nahrgang et al.’s (2011) recent meta-analysis, coworker social support and support for safety have been found to be highly correlated with safety climate measures and strong predictors of safety performance and outcomes.

While the reasons for including management and supervisor safety practices in generic safety climate scales seems self-evident, the inclusion of workers’ self-ratings of their safety practices (such as participation, compliance, knowledge or competence) is problematic, as it confuses perceptions of safety climate with individual safety performance. Depending on the explanatory model developed, self-reported worker safety performance is often used as a criterion measure. If workers’ safety practices also form a part of a global safety climate index inflated correlations between predictor and criterion would be expected. Furthermore, such information is not considered an emergent property of the group or organisation as the definition of climate implies (Glick, 1985; Kozlowski & Klein, 2000; Zohar, 2003). To reduce the potential for confounding between predictor and outcome, including workers’ perceptions of coworker safety practices as an index of group safety norms addresses the theoretical issue of emergence properties required in climate constructs. Furthermore using a rating of coworker safety practices in safety climate scales frees workers’ ratings of their individual safety behaviour for use as individual-level or aggregated group-level outcome measures.

However, in seeking to develop a comprehensive measure of coworker safety climate a logical and pragmatic solution is apparent; to adapt an existing worker safety

performance measure to a coworker referent. Furthermore, in developing such an instrument I wished to tap complementary content domains to Zohar and Luria's (2005) active and proactive management and supervisor safety climate scales. In reviewing the safety performance literature, Hofmann et al.'s (2003) operationalisation of front-line worker compliance and proactive behaviours emerged as the prime contender from which to create a group-level coworker climate scale. When examined at the item level a strong theoretical overlap was observed between the three content themes used by Zohar and Luria (2005) and the two dimensions of safety practices identified by Hofmann and colleagues. To maintain greater continuity in the thesis, the terms active and proactive safety practices will be used for both individual safety behaviour subscales and group-level coworker safety climate subscales to represent compliance and participative practices respectively. (See section 6.4 for a description of the derived scales)

Therefore, having conceptualised coworker commitment to safety as a derivative of worker safety behaviour, three important issues need to be assessed. First, that the proposed two-factor structure for both the individual and group climate scales is consistent across referents; second, that participants can clearly differentiate between the coworker and individual behaviour scales; and finally that the shared nature of perceptions implicit in the definition of climate scales is observed in the coworker scale.

When investigating the level of agreement amongst workers, Zohar (2005) used standard deviation scores as a measure of Climate Strength. Pousette et al. (2008) found that the level of agreement (sharedness) observed for safety climate factors was stronger than that observed for measures of individual attitudes towards safety. However, consideration of the premises of controllability, stability and locus of causality described in attribution theory (see DeJoy, 1994) would arguably direct observers to expect less variability in aggregated self-response variables than in measures using other organisational agents as the referent (whether it be the coworkers, supervisors or managers).

To expand, self-directed biases may result in workers attributing their own *good* safety performance to controllable, stable, internal causal factors (e.g., their own effort, knowledge and ability) and any negative performance elements to less stable, uncontrollable, external factors (e.g., tiredness due to shifts, changing work pressure or poor procedures). In contrast, the fundamental attribution error would predict that workers would be more likely to attribute observations of both positive and negative safety performance of their coworkers or managers to dispositional characteristics of those individuals than to situational factors (Ross, 1977). Acknowledging the reality that in functional groups, workers and coworkers come with a diverse range of skills and knowledge, yet are arguably exposed to the same or very similar workplace environmental factors, a process of biased attributions would in theory result in two outcomes. First, it would contribute to workers operating within generally positive safety climates maintaining high self-ratings across the response domain as safety deviance or violations are more likely to be dismissed as aberrant events rather than normal patterns of behaviour. Second, it would support greater response variability in workers' ratings of coworkers than when an individual referent is applied.

To support the utility of both the individual safety behaviour scale and the coworker safety climate scale, I would expect that mean scores for self-ratings will be higher than ratings of coworkers and that the level of agreement between workers when assessing their own safety behaviours would exceed the level of agreement observed between workers when assessing coworkers' commitment to safety. Therefore, a three-stage strategy will be used to assess the continuity of factor structure, differences across response referents and differential level of agreement between safety climate and individual behaviour measure as outlined in the following hypotheses:

Hypothesis 1: The factor structure of individual safety behaviours will be best represented by a correlated two-factor structure representing active and proactive safety behaviours when tested against single and uncorrelated two factor models.

Hypothesis 2: The factor structure of the coworker safety climate scale will be best represented by a correlated two-factor structure representing active and proactive safety behaviours when tested against single and uncorrelated two factor models.

Hypothesis 3: Front-line workers will differentiate between measures of coworker safety climate and individual safety behaviours such that ratings of coworker commitment to safety will be lower than workers' self-ratings and level of agreement will be weaker for the coworker scale.

#### **5.2.1.2. Management and Supervisor Dimensions**

Having expanded the work-level conceptualization of safety climate to include coworker activities, my next aim is to confirm the overall factor structure of the safety climate scale and test the model's predictive validity. This first involves validating the factor structure of Zohar and Luria's (2005) management and supervisor safety climate scales in the sample of front-line workers to be used in my study.

Zohar and Luria (2005) proposed that each dimension of their safety climate construct (i.e., both management and supervisor commitment) would conform to a correlated three-factor structure. Their results indicated a high level of item-cross loadings and strong factor correlations, leading them to conclude that each dimension would be better represented as a single, higher order structure reflecting the general commitment to safety of both supervisors and management. To date only one study by Johnson (2007) has attempted to replicate the factor structure of the supervisor dimension of safety climate obtained by Zohar and Luria. As discussed in section 2.4.2 Johnson identified three highly correlated factors labelled: caring, compliance and coaching which he argued closely aligned with Zohar and Luria's (2005) original dimensions. However, he recognised that both the single and two-factor models also provided a good fit to the data.

Therefore in seeking to further validate Zohar and Luria's (2005) safety climate scales, exploratory analysis of the factor structure of both the organisational (management) and group-level (supervisor) safety climate dimensions will be conducted in the front-line worker sample in this study. Due to the high level of factor correlations previously identified in the literature, and in recognition of the potential impact of attribution biases when rating distal organisational agents, it is proposed that a one-factor structure will emerge as the best fit for the data in each safety climate subscale as hypothesised below.

Hypothesis 4: The factor structure of the organisation- level management safety climate scale will be best represented by a one factor structure when tested against imposed two & three factor models.

Hypothesis 5: The factor structure of the group-level supervisor safety climate scale will be best represented by a one factor structure when tested against imposed two & three factor models.

### **5.2.2. Climate for Social Exchange**

As discussed in Chapter 4, the importance of different leadership styles in predicting safety climate and promoting employees' safety performance has been well documented in the safety literature (e.g. Barling et al., 2002; Hofmann et al., 2003; Kelloway et al., 2006; Nahrgang et al., 2011; Zohar, 2002b). However, the role of group dynamics in the development and maintenance of safety norms has attracted less research attention. An important aim of my study is therefore to investigate how the quality of management, supervisor and coworker social exchanges in the workplace relates to employees' perceptions of safety climate and their safety behaviours. In line with the approach taken by Wallace, et al., (2006), in their investigation of the relationship between organisational support, management-employee relations and occupational safety, my intention is to operationalise the three social exchange measures as foundation climates. Accordingly, the focus of each scale will be directed at interdependent, group-level social exchanges rather than direct, dyadic exchanges (Molm, 1994).



As my overall aim is to test an explanatory model of safety climate and outcomes that includes the influence of social exchange, an important initial step is the validation of the climate for social exchange scales. My intention is to align the three social exchange indicators with the stratified dimensions of safety climate in a manner consistent with the level-of -analysis approach recommended by Zohar (2010).

#### **5.2.2.1. *Leader-Member Exchange***

In seeking to find measures of social exchange appropriate for my research, I initially focused my attention on one of the most well recognised and documented exchange variable: leader-member exchange. My literature review showed that the leader-member exchange scale, originally developed by Graen and colleagues (Graen & Scandura, 1987; Graen & Uhl-Bien, 1995), provided a statistically valid measure of leadership style in safety contexts (Hofmann & Morgeson, 1999; Hofmann et al., 2003). More pragmatically, compared to alternative leadership instruments such as the Multifactor Leadership Questionnaire (Bass & Avolio, 1997) used by Zohar (2002a), the 7-item LMX scale has fewer items and allows a scaling of higher to lower quality of social exchange, rather than a categorisation of leadership style. The LMX also lends itself to both self-report and climate rating formats. That is, by changing the referent, it is possible to compare how employees' and supervisors' perceptions of the social exchanges that occur between them differ (Liden, Wayne, & Stilwell, 1993). The LMX scale was therefore selected to examine social exchanges between workers and their direct supervisor.

#### **5.2.2.2. *Manager-Member Exchange***

The operationalisation of social exchange constructs at a management/ organisational level has previously been undertaken using measures of Perceived Organisational Support (Eisenberger et al., 1986). However, LMX measures have also been used to assess social exchanges between managers at different levels of the organisation (Hofmann & Morgeson, 1999). The POS scale used by Hofmann and Morgeson (1999) was a modified 9-item version of the original POS scale (Eisenberger et al., 1986). Hofmann and Morgeson's scale statements showed considerable item overlap

with the LMX, but with the more ambiguous referent of “the organisation.” Mearns and Reader (2008) used a “support from the operator” scale when investigating the relationship between organisational support and safety citizenship behaviours in offshore oil and gas facilities. Mearns and Reader’s operator support scale comprised 13-items selected from both Eisenberg et al.’s (1986) POS scale and Ribisl and Reishl’s (1993) worksite health climate scales.

As existing scales did not appear to capture the specific nature of Management-Member social exchange as I had envisaged, I propose to use a modified version of the LMX scale, retaining four common items of the POS, and shifting the “organisation” referent to the more specific top level management referent to form a Manager-Member Exchange (MMX) scale (Further scale information is provided in Section 6.4). Given the unidimensional structure previously found for the POS and LMX scales, I propose that the MMX will retain a one-factor structure.

### **5.2.2.3. *Group-Member Exchange***

When reviewing the literature on group member social exchange, the coworker interactions scale used by Simard and Marchard (1995) focused on work-group characteristics of group cohesion and cooperation with their supervisor. However, this scale was based on supervisor ratings of group behaviour, rather than the quality of social exchanges amongst workers from an individual worker perspective. While alternative measures of group cohesion are available (see Mudrack, 1989 for a review) many of the scales focus on friendships, and group member attraction to and identification with the group, rather than targeting work-related social exchanges specifically.

One exception is the work by Seers, Petty and Cashman (1995) who developed the Team-Member exchange quality scale. This 10-item scale focuses on both the contribution focal individuals make to the team environment as well as the support and recognition they receive back from coworkers. Three of the items are therefore replicated in terms of the reciprocity of offering and receiving praise and assistance. The remaining items in the TMX overlap with several LMX scale items. While Seers et al.’s original scale applied a frequency of behaviour rating format, other researchers have since used modified versions of the scale that apply agree/disagree

response formats (Love & Forret, 2008; Tse, Dasborough, & Ashkanasy, 2008).

When assessing the utility of this instrument for inclusion in my study, I considered the within-scale item shift in referent from self to others as potentially problematic.

Hofmann and Stetzer (1996) also measured group process and effective teamwork using a 7- item scale from the Survey of Organisations (Taylor & Bowers, 1972). Again this measure showed considerable item overlap with the LMX scale, in terms of worker confidence in others' decision making capabilities, knowledge about job roles, and willingness to help solve work-related problems. However, several of the common items were combined as double barrelled questions in Taylor and Bower's scale. To provide a valid means to assess the quality of social exchanges between coworkers, distinct from existing group cohesion and social exchange scales, I therefore propose to develop a Group-Member Exchange scale (GMX), based on items in the LMX instrument, with modifications to the group referent. That is the exchange relationship focuses on the respondents' perceptions of the general quality of social exchanges within the group rather than their personal social exchanges with other team members.

To validate the climate for social exchange scales, exploratory analysis of the factor structure of the organisational (MMX) and group-level (LMX and GMX) safety climate dimensions will be conducted in the front-line worker sample. Given the small number of items in each scale and previous unidimensional structures found for the LMX it is proposed that a one-factor structure will emerge as the best fit for each of the climate for social exchange subscale as hypothesised below.

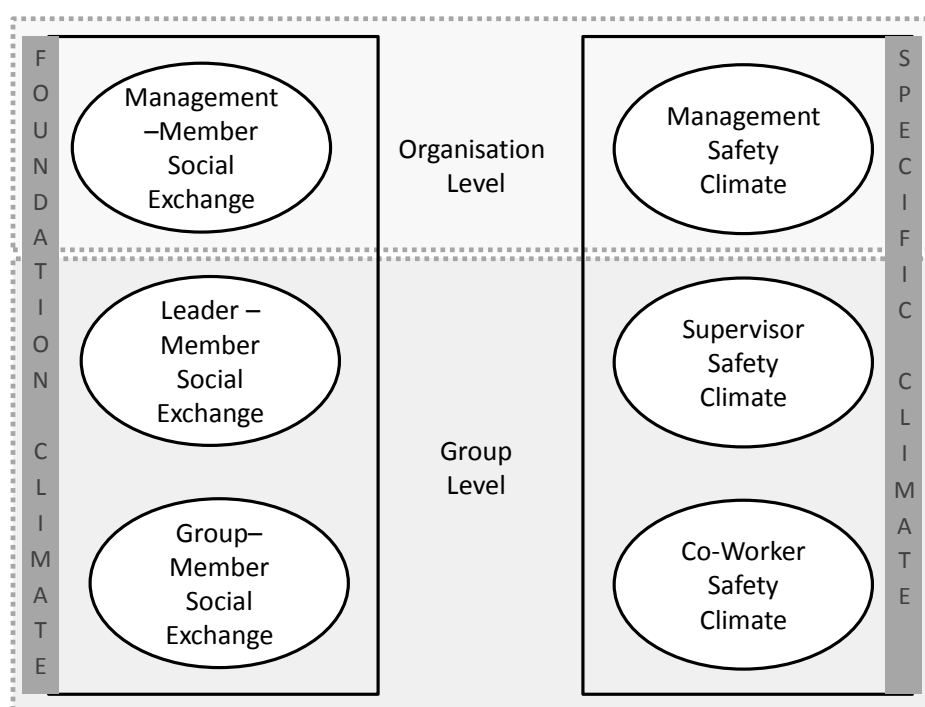
Hypothesis 6: For each of the three climates for social exchanges variables representing the management, supervisor and co-workers social exchanges, a one-factor structure will provide the best fitting factor solution when compared against imposed two factor emergent structures.

### **5.2.3. Construct Distinction**

Zohar and Luria (2005) highlighted the need to establish the discriminant validity of safety climate and leadership style inventories given the integrated nature of both

constructs. They contended that while “leader interactions provide the medium in which policies are implemented... the medium, although influencing the message (e.g., greater emphasis on safety under high quality leader-member interactions), [should] not be confused with it” (Zohar & Luria, 2005, p.626). In support of this statement Zohar and Luria argued that individuals discriminate between the two constructs, by basing leadership perceptions on relationship referents and climate perceptions on commitment referents.

To test this proposal, item and scale-level confirmatory factor analyses will be conducted to examine if front-line workers can adequately distinguish between the hierarchically aligned dimensions of safety climate and social exchange constructs as indicated in Figure 5.1.



*Figure 5.1.* Organizational and group-level climate and social exchange dimensions.

Furthermore, if Zohar and Luria’s (2005) ideas of separate organisation and group-level climates are correct, we should find stronger correlations between the two group-level climate constructs, measuring supervisor and coworker commitment than

between the group and organisation-level factors. In support of this proposal research within the general organisational literature has identified a degree of correspondence between hierarchical work-levels and *collective* climates (Gonzalez-Roma, Peiro, Lloret, & Zornoza, 1999). Gonzalez-Roma and colleagues identified that top level and sectional management typically form one level of collective climate and middle and low level employees a distinct second collective climate (Gonzalez-Roma et al., 1999); with management generally responding more positively to climate perceptions of support, innovation, goal and rules than lower level workers.

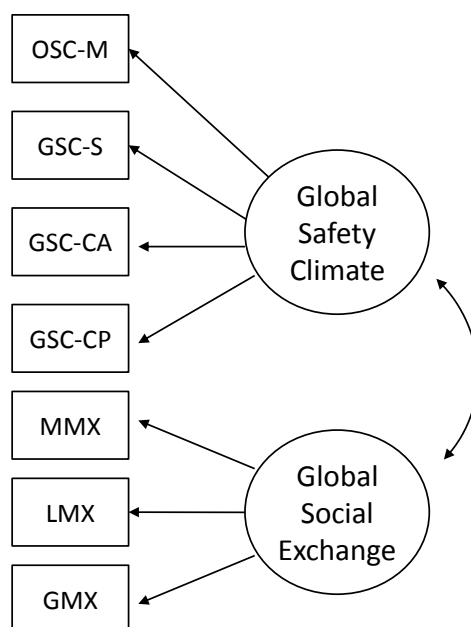
Hypothesis 7: Front-line workers will discriminate between safety climate and social exchange constructs when tested as both first-order and higher order structures such that:

- (a) The factor structure of organisation level management behaviours and will be best represented by a correlated two factor structure representing management safety climate and management–member social exchange when tested against single factor, uncorrelated two & three factor models.
- (b) The factor structure of group level supervisor behaviours and will be best represented by a correlated two factor structure representing supervisor safety climate and leader–member social exchange when tested against single factor, uncorrelated two and three factor models.
- (c) The factor structure of group level coworker behaviours and will be best represented by a correlated three factor structure representing coworker safety climate and group–member social exchange when tested against single factor, two factor & uncorrelated three factor models.
- (d) Correlations between the active and proactive co-worker safety climate subscales will be stronger than correlations found between either active and proactive co-workers safety climate and group member social exchange.

- (e) Correlations between safety climate and social exchange constructs within hierarchical levels (i.e. organisation and group levels) will be stronger than those observed within construct domains (i.e. safety climate and climate for social exchange).

To test Hypothesis 7, a series of theoretical models were developed. As a precursor to structural modelling to be undertaken in Chapters 8 and 9, scale-level model testing was conducted on the combined workers' sample. Social exchange and safety climate scales were based on structures identified in the exploratory and confirmatory factor analysis.

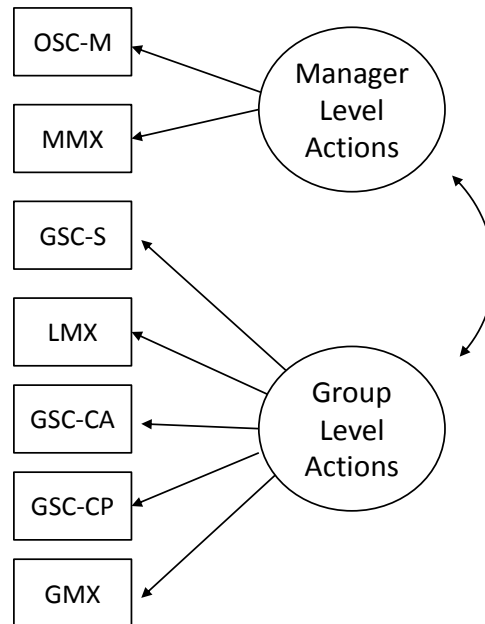
The first hypothesised model, illustrated in Figure 5.2, examines the alignment of workers' perceptions within construct domains by proposing a two-factor model of global safety climate and social exchange. This model offers support for the use of global safety climate and social exchange measures across organisational levels in predictive models. In contrast, the alternative models (see Figures 5.3 & 5.4) depict a stronger alignment of workers' perceptions within organisational levels than within construct domains.



*Figure 5.2.* Two-factor model of global safety climate and social exchange.

OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

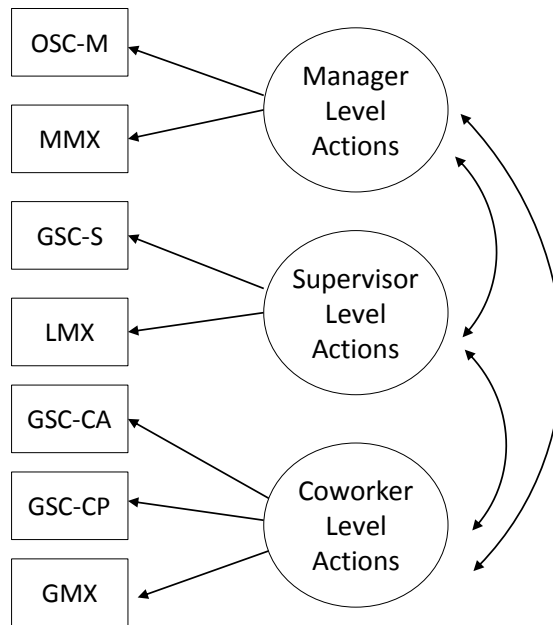
In line with Zohar and Luria's (2005) recognition of the importance of supervisor behaviours in the development of group-level climate, the alternative model represents a two-factor model of organisation and group-level actions in which supervisor and coworker safety commitment and social exchange are closely aligned.



*Figure 5.3.* Two-factor model of organisational-level safety climate and social exchange.

OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

The third model further stratifies the hierarchy of workers' perceptions to clearly distinguish between workers' perceptions of management, supervisor and coworker actions. A stronger correspondence of workers' perceptions within hierarchical levels of the organisation than within construct domains would provide support for the use of first-order work-level models of safety climate and social exchange variables in predictive models.



*Figure 5.4.* Three-factor model of organisation-level safety climate and social exchange.

OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactice; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

#### 5.2.4. Organisation Safety Climate Profiles

A further objective of my research is to present a format for reporting organisational safety climate profiles based on climate level, strength and variability. As indicated in Nahrgang et al.'s (2011) meta-analysis, patterns of associations between safety-related constructs can vary considerably across industry settings. With the aim of providing a diversified sample which would provide greater scope to investigate the capacity of the safety climate measures to discern both organisational and work-level differences, the participant organisations in my study were recruited from diverse industries.

When evaluating the overall climate levels based on front-line worker responses and the separate organisational safety climate profiles, it is proposed that self-other biases will manifest more obviously in front-line workers' ratings of managers' and supervisors' commitment to safety compared to ratings of coworker commitment. In this instance the fundamental attribution error would indicate that workers would be



more likely to attribute negative safety performance of their managers and supervisors to more stable, dispositional characteristics of those individuals rather than to situational factors. This process of biased attributions would contribute to workers providing relatively higher ratings of coworker climate measures than for more distal supervisors and managers. It is also proposed that less response variability will be found when workers complete rating scales within their own work-level than when they rate the safety behaviours of more distal organisational agents.

Hypothesis 8: Front-line workers will differentiate between measures of management, supervisor and coworker safety climate such that:

- (a) Average scores (climate level) will be highest for ratings at the respondents' work-level and diminish with increased organisational distance.
- (b) Level of agreement will be strongest for scales targeting the respondents' own work-level (climate strength).

Having investigated how the perceptions of front-line employees can be used to form valid measures of organisational level safety climate, my next aim is to examine group-based perceptions of safety climate.

#### **5.2.5. Group-level Factor Structures**

Shannon and Norman (2009) have indicated that the vast majority of studies undertaken to determine the factor structure of global safety climate are fundamentally flawed because they fail to acknowledge the nonindependence of data. However individual-level exploratory and confirmatory factor analyses remain the most widely used and accepted data reduction techniques in organisational research. To investigate potential differences in emergent factor structures when using multilevel techniques, factor analyses will be conducted on both individual- and group-level data, and the results compared.

While multilevel methodologies are becoming more evident in the organisational literature, there is still a relative lack of research that applies group-level analysis in applied safety settings. As such the use of both individual and group-level modelling in the same study contributes to our understanding of how potential differences in

results may occur when applying different methodological techniques in safety climate research.

#### **5.2.5.1. *Approaches to data aggregation in factor evaluation***

While Shannon and Norman (2009) have highlighted the inadequacy of safety climate research to account for the nonindependence of data when deriving factor structures, the issue of using correct measurement metrics for scale development at aggregate levels of analysis is far from simple. In their discussion of approaches to aggregate measure construction, Peterson and Castro (2006) put forward three procedural options: the ILSA approach (create individual-level scales and aggregate), the CSA approach (aggregate items and create aggregate-level scales), and the combined ILSA/CSA approach (create individual-level scales, aggregate and then create aggregate-level configural scales).

In the ILSA approach scale items are evaluated for factor structure and scales created at the individual-level of analysis. The level of within-group agreement is then assessed for each scale at the target level (e.g., group or organisation) and aggregation of the scales conducted. The ILSA methodology has to date been the general approach adopted by organisational researchers and is considered appropriate for the aggregation of individual-level constructs such as personality, attitudes and personal relationships (Peterson & Castro, 2006). With regard to Chan's typology (1998), variables suitable for ILSA aggregation would use direct referents in item development. The ILSA approach is therefore considered the appropriate type of aggregation method for individual workers' safety behaviours when seeking to form group-level safety behaviours. However, whereas the ILSA method of factor evaluation has been used in all safety climate studies to date, according to Peterson and Castro's recommendations, it is not considered the appropriate methodology to apply when dealing with safety climate scales.

In the CSA approach, aggregation of items to the target level of analysis occurs first, followed by the evaluation of factor structure and creation of scales at the higher level of analysis. Peterson and Castro (2006) indicate that the CSA strategy is suitable when dealing with constructs that reflect normative behaviour and aligns with the multilevel EFA and CFA procedures discussed by Shannon and Norman

(2009). Accordingly, if we again consider Chan's typology (1998), variables suitable for such aggregation would apply referent shifts to the group rather than the individual in item development. As group-based referents are used in all the social exchange and safety climate scales used in this research, the CSA approach would be considered the appropriate aggregation protocol for these scales. However, in practical terms, as the group becomes the unit of analysis for EFA and CFA in the CSA approach, larger samples sizes are required to ensure sufficient item to case ratios and statistical power.

Finally the combined ILAS/CSA method uses a combination of both approaches. The ILAS/CSA approach is practically the most difficult to manage as it "requires an unusually large number of items and aggregate units" to support evaluation of scales at both individual and aggregate levels (Peterson & Castro, 2006, p.515). As such the use of this protocol is restricted to extremely large samples typically used in cross-cultural research. Given the anticipated sample size in my research this approach was not considered a viable option and therefore not be used.

To comply with Shannon and Norman's (2009) recommendations regarding the use of multilevel factor analysis in safety climate research, all climate scales will be analysed at the work-group level using the CSA approach. Conducting both individual-level factor analysis (i.e., the bases for ILSA protocols) and CSA group-level factor analysis allows the examination of potential differences in emergent factor structures when using the two approaches.

As an exploratory examination it is hypothesised that the factor structures identified using the CSA approach for the more distal climate constructs (i.e., management and supervisor behaviours) will differ from those determined using individual-level data, potentially corresponding to the three-factor structure described in their initial validation (Zohar & Luria, 2005). For the coworker scale, I propose that a two-factor structure representing active and proactive safety practices will be consistent across methodological treatments in line with the theoretical development of the scale. Given the relatively small content domain covered in the social exchange scales and the stability of the one-factor structures of the LMX, POS and TMX scales on which

they are based I propose that the structures of these scales will not differ across treatments. As the CSA approach is recommended for the assessment of normative behaviour, such as inferred in climate scales, (Peterson & Castro, 2006) it is proposed that the CSA methodology should be sensitive to group-level nuances and therefore provide the most accurate dimensional representation of the constructs.

Hypothesis 9: When analysed using the CSA approach to group-level aggregation the factor structures for the more distal safety climate scales representing Management and Supervisor commitment to safety will differ from the one factor structures hypothesised at the individual-level of analysis.

By applying the protocols for evaluation of factor structures described above it will be possible to compare results for explanatory safety using the following approach:

- Comparing directly between predictive models assessed at the individual and group-level using the ILSA approach to aggregation (i.e., both based on individual-level factor structures) and;
- Comparing directly between predictive models derived using the ILSA and CSA approaches to aggregation.

As the main focus of my thesis is on using group level methodologies, the explanatory models based on the ILSA and CSA aggregation approaches are reported in Chapters Seven and Eight. Results for individual level models are included for reference purposes as an Appendix.

### **5.3. Explanatory Models**

My next objective is to develop and test explanatory models of social exchange, safety climate and safety outcomes. To achieve this goal, two explanatory models will be tested at group-level of analysis using scales derived using both the ILSA and CSA approaches.

As the work-group safety outcome measures are formed through direct aggregation of reported injuries and incidents these indicators are consistent across both the ILSA and CSA replications. Furthermore, the ILSA approach is considered the appropriate technique for deriving the work-group safety behaviour scale, therefore this measure

will also be consistent across model replications. In contrast, (as discussed in section 5.2.5.1 above) the structure of safety climate and social exchange scales may potentially vary across replications based on their CSA factor evaluations.

### **5.3.1. Global Psychological Safety Climate Model**

Within the safety domain, Clarke's (2006) meta-analysis examining the relationship between safety climate, safety performance and workplace accidents, incorporated studies treating organisational safety climate as a global construct. While many of the safety climate scales included in Clarke's study differed in their constituent parts, overall results supported the validity of composite safety climate measures in predicting safety participation and to a lesser degree safety compliance. More recently, the meta-analysis conducted by Christian et al. (2009) reported mean corrected correlations for studies using safety climate as both a global construct and as separate safety climate dimensions as specified in their conceptual framework.

Results of meta-analyses conducted by Clarke (2006), Christian et al. (2009) and Nahrgang et al. (2011) have identified that the relationships between safety climate and safety outcomes such as accidents and injuries operate indirectly through workers' safety behaviours. As indicated in Figure 5.5, initial modelling will therefore examine the relationship between safety climate (operationalised as a global construct), individual safety performance and self-report safety outcomes, including LTI, minor injuries and near miss statistics. To test a mediation hypothesis Structural Equation Modelling (SEM) will be used to compare the fit of the mediation, full and direct models. Assessment of fit statistics and a series of Chi-square difference tests between nested models will allow the comparison of theoretically derived models depicting direct and indirect relationships between constructs (Bollen, 1989). To further assess the incremental validity of the group level coworker commitment to safety in the global operationalisation of safety series of hierarchical regression analysis will be conducted using injuries, near miss incidents and both active and proactive workers safety behaviours as outcomes.

Hypothesis 10: The influence of global safety climate on safety outcomes will be mediated by individual safety behaviours.

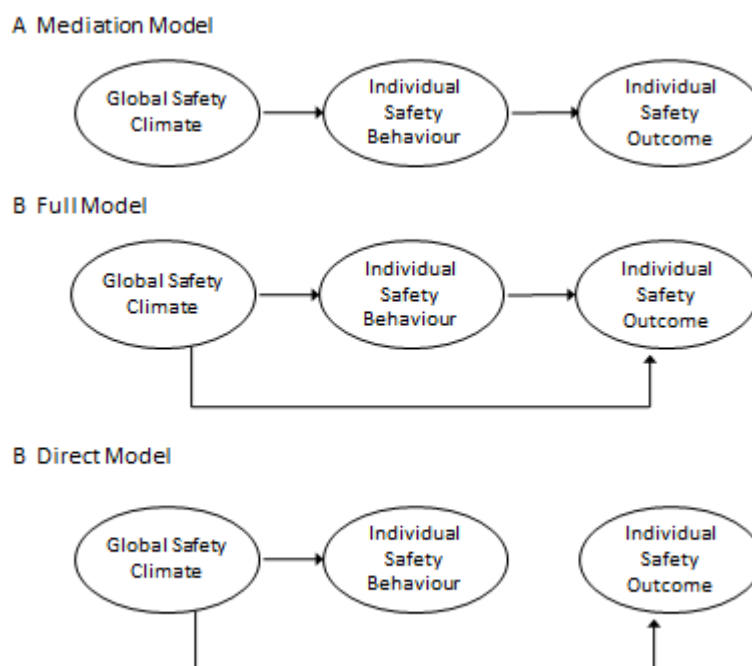


Figure 5.5. Mediation, full and direct models for the predictive relationship between global safety climate, individual safety behaviours and safety outcomes.

### 5.3.1.1. Difference in Group-level Modelling

Consistent with theoretical conceptualization of safety climate as a group level construct, results of recent meta-analyses (Beus, Payne, et al., 2010; Christian et al., 2009) have indicated that the associations between safety-related constructs are strengthened when the nonindependence of data is addressed using group-level analysis. It is possible however, that the stronger correlations observed between safety climate and accidents/injuries in the literature may also be linked to the source of data rather than the treatment of data. That is, the use of objective data such as prospective OSHA and infirmatory records, and behavioural safety audits is more common in group-level studies included in the meta-analysis, compared to the more frequently used self-reported safety behaviour and retrospective injury data in most safety climate studies. Therefore the direct comparison of results, controlling for data source and design, allows for a more effective assessment of the impact of data treatment on the strength of construct relations. It is predicted that the mediation

model will be supported when using both the ILSA and CSA group-level aggregation such that the magnitude of construct relationships will be stronger than that observed using individual-level analysis.

Hypothesis 11: The strength of associations observed between global safety climate and safety outcomes will be stronger using both ILSA & CSA aggregation than using individual-level analysis.

### **5.3.2. Work-level Safety Model**

My next objective is to use a level-of-analysis approach to examine the relationship between climate for social exchange, safety climate and safety performance. When conducting their meta-analysis on the importance of coworker influences in the workplace, Chiaburu and Harrison (2008) stated that theoretical advances could be made by examining influences emanating from coworkers, leaders and the organisation simultaneously rather than focussing on any one level of influence in isolation or collapsing scales across levels. While Chiaburu and Harrison's research focuses on general workplace performance, their findings support Zohar (2010) and Guldenmund's (2007) opinions regarding the need for safety researchers to explore how the influences exerted by different lateral and vertical social agents in the workplace affect individual workers' attitudes and safety behaviours.

In line with such recommendations, Christian et al. (2009) showed that a greater understanding of the processes involved in creating a safe workplace may be achieved by modelling the interactions of the safety climate dimensions separately. Likewise Nahrgang et al. (2011) identified different patterns of associations between safety outcomes and supportive environments that include coworker, supervisor, and management safety-related practices. In proposing a work-level model of safety I seek to examine how the proximal and distal influences of first-order dimensions of the foundation climate for social exchange and safety-specific climate impact on the safety behaviours of workers, a conceptual representation of this relationship is illustrated in Figure 5.6. The overall model will be tested using an overarching SEM analysis in which direct and indirect effects of the social exchange and safety climate constructs on workers safety behaviours can be examined. A staged approach will be

undertaken in the development of specific hypothesis to support the rationale behind the mediation model proposed. This process starts with investigating the core relationship between safety climate and workers safety behaviours using the stratified work-level conceptualisation of safety climate. Climate for social exchange is then forwarded as an antecedent of safety climate.

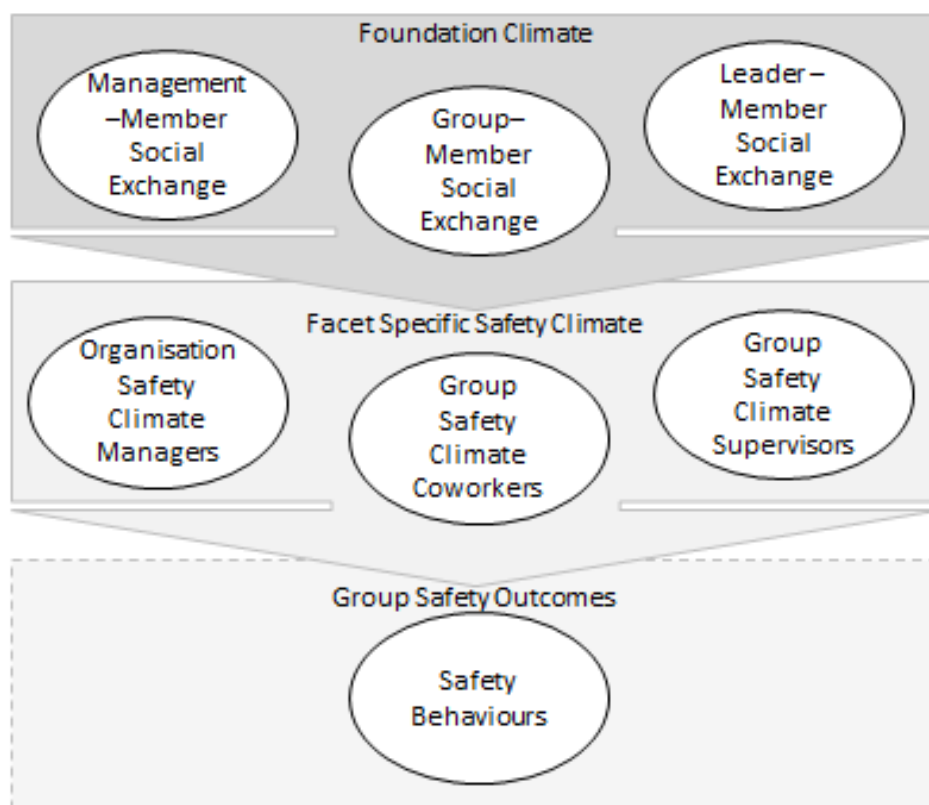


Figure 5.6. The conceptual model of foundation and facet-specific safety climates.

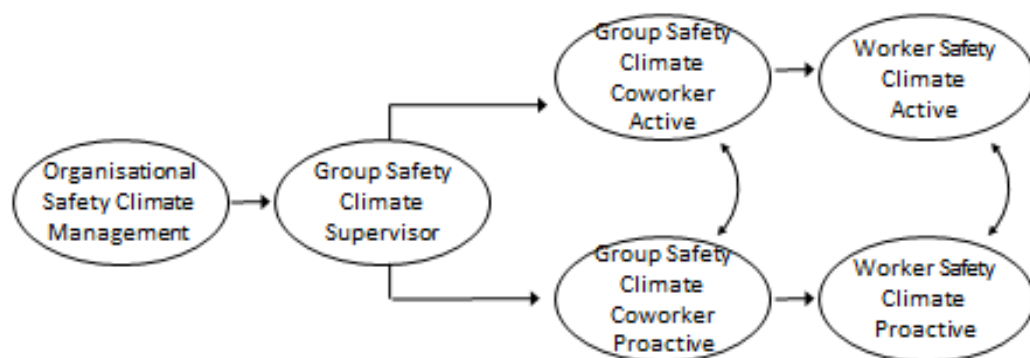
### 5.3.2.1. Safety Climate and Safety Behaviours

To first expand our understanding of how the different dimensions of safety climate influence the individual safety behaviours of workers, both the proposed active and proactive dimensions of coworker safety climate will be modelled independently. To facilitate model testing the direct, indirect and total effects of safety climate indicators on workers active and proactive safety performance will be examined. The significance of direct effects in the full model imply that an individual's perceptions of safety climate at the organisational and group-levels independently affect individual safety performance.



However, as Zohar and Luria (2005) found that supervisor commitment to safety fully mediates the relationship between manager safety climate and individual safety behaviour, an alternative explanation of the link between safety climate dimensions and individual behaviours is that the more proximal influences of supervisor and coworker commitment will mediate the relationship between more distal organisational influences of managers. In this instance the more distal influence of management commitment to safety is proposed to have both a direct and indirect influence on the formation of both dimensions of work-group safety climate (supervisor and coworker commitment) and only an indirect effect on individual safety behaviours.

In support of a mediation model, Chiaburu and Harrison (2008, p.1094) concluded that “coworker actions predict perceptual, attitudinal, and behaviour outcomes of their colleagues even when the influence of the direct leaders (on the same focal colleagues) is accounted for.” This approach acknowledges the pivotal role coworkers, as a reference group, play in the formation of behavioural norms. In this instance coworker safety climate is depicted as a key mediating influence between both manager and supervisor safety climate and individual safety behaviours as represented in Figure 5.7.



*Figure 5.7.* The hypothesised mediation model for the relationship between work-level safety climate and workers behaviours.

The mediation model proposes that the distal influences of management safety climate will impact directly on supervisor safety practices and indirectly on coworker

practices with supervisor safety climate mediating the management and coworker relationship. As the most proximal predictor, coworker safety climate is hypothesised to mediate the influence of more distal safety climate dimensions on workers safety behaviours. Furthermore it is proposed that the pattern and magnitude of associations between safety climate and the active and proactive safety behaviours of individuals will differ.

Hypothesis 12: In a stratified work-level model of safety climate coworker's commitment to safety will mediate the more distal influence of management and supervisor commitment to safety on workers safety behaviours. The mediation model will provide a better fit to the data when compared to a partial mediation model.

#### **5.3.2.2. *Social Exchange and Psychological Safety Climate***

In the work-level safety model, social exchange variables are proposed as antecedents of the three dimensions of safety climate. When reviewing the safety literature, it is apparent that attention has been focused mainly on investigating the influences of management and supervisor on safety, to the neglect of the informal influences exerted by coworkers. Furthermore, when the impact of leadership styles and social exchanges on safety have been investigated, most studies have examined separate components of the organisational hierarchy in isolation rather than adopting a level-of-analysis approach allowing the examination of potential mediation and moderation processes.

The hypothesised mediation model proposes that the perceived quality of social exchange between organisational agents and workers directly influences workers' perceptions of safety climate at the aligned hierarchical level of the organisation. The effects of quality social exchange between manager, supervisors and coworkers on workers' safety behaviours are therefore mediated through the formation of a positive safety climate across organisation-levels. The hypothesised and alternative work-level models of safety are represented in Figure 5.8 which shows the proposed relationship between climate for social exchange and the work-level dimensions of safety climate and the flow through effects to individual safety performance.

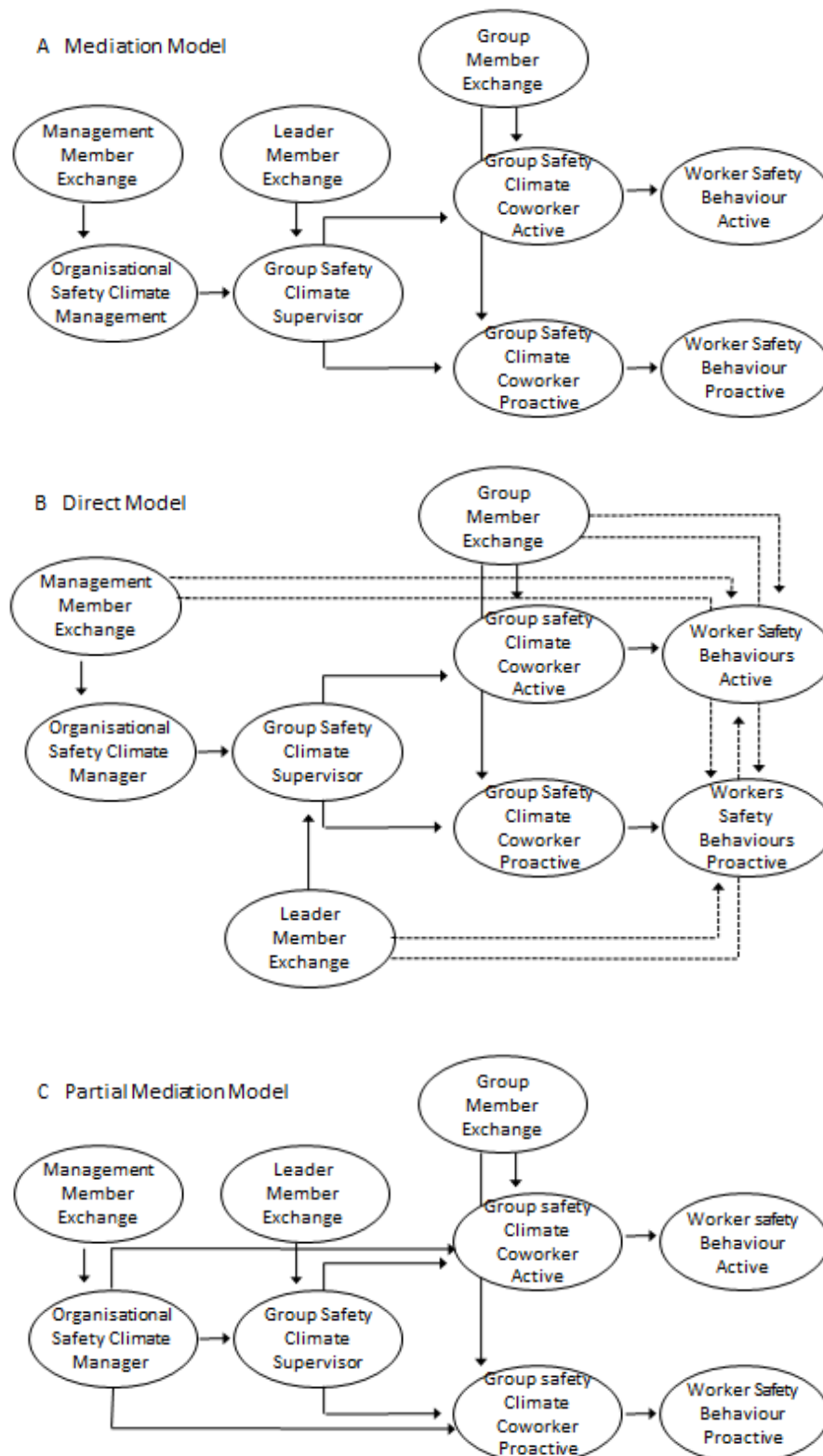


Figure 5.8. Hypothesised models of the predictive relationship between social exchange, safety climate and active and proactive safety behaviours.

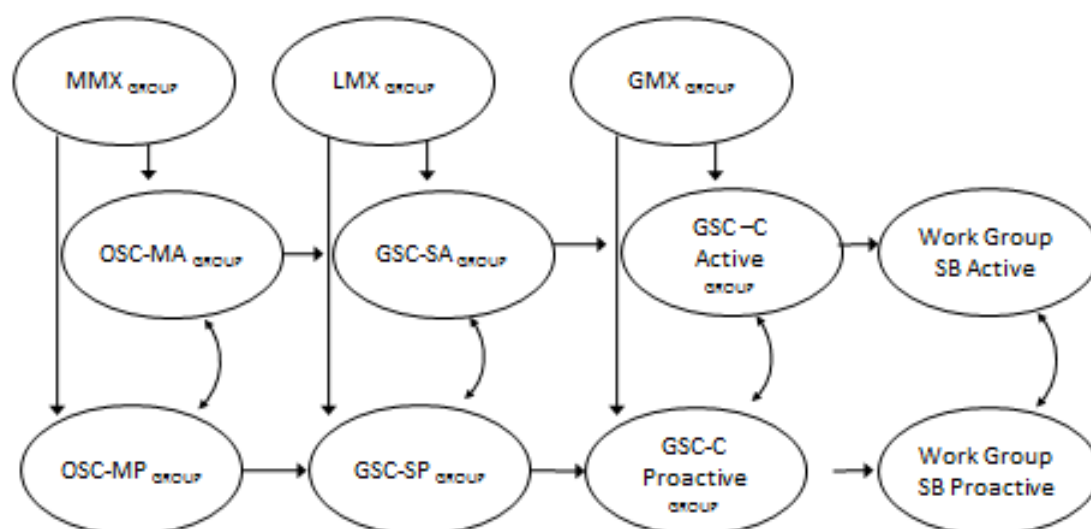
Hypothesis 13: The dimensions of climate for social exchange at distinct work-levels are proposed as antecedents of safety climate at the corresponding work-level such that:

- (a) High quality management-member social exchange supports front-line workers' positive perceptions of organisation level management safety climate.
- (b) High quality leaders-member social exchange supports front-line workers' positive perceptions of group level supervisor safety climate.
- (c) High quality management-member social exchange supports front-line workers' positive perceptions of group level co-worker active and proactive safety climate.

Hypothesis 14: The positive impact of climate for social exchange on individual workers' safety behaviours will be best represented by a fully mediated model operating through the establishment of positive safety climate when compared to a direct or partially mediated model.

#### **5.3.2.3. *Difference in Group-level Modelling***

The second set of replications examines the proximal and distal influences of aggregated social exchange and first-order safety climate dimensions on the group-level safety behaviours. In these model the ILSA derived worker safety behaviours scale forms the group-level outcome variable for both group-level analyses. However as proposed in hypothesis nine both the safety climate subscales for management and supervisors are expected to produce an expanded factor structure when data is analysed using the CSA approach. Figure 5.9 provides a representation of a possible two factor solution of both subscales. The hypothesised mediation model shows the antecedent effects of climate for social exchange on safety climate and the flow through effects of management and supervisor commitment to safety on group safety performance. The aggregated social exchange variables represent a group-level foundation climate while the safety climate dimensions constitute a group-level facet-specific climate.



*Figure 5.9.* Hypothesised model of the predictive relationship between social exchange, CSA derived safety climate dimensions and workers active and proactive safety behaviours.

All scales represented with a GROUP subscript are derived using CSA aggregation methods including OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange. Work Group Safety Behaviours- Active and Proactive are derived by direct aggregation of Individual Safety Behaviours of Workers using the ILSA approach.

Hypothesis 15: The strength of associations observed between social exchange, safety climate and safety behaviours will be stronger when analysed using CSA aggregation methodology than when assessed using individual-level or ILSA data.

## **6. Research Methodology**

### **6.1. Research Design**

My study involved the distribution of self-report questionnaires to employees in participant organisations. As such the design is cross-sectional and quantitative in nature. The sampling strategy undertaken resulted in a stratified convenience sample.

### **6.2. Organisation recruitment**

A review of current literature indicated that organisational samples have previously been largely homogenous and limited in organisational scope both internally (across organisational levels and job categories) and externally (across organisational contexts). In Australia, figures from the Performance Monitoring Reports (Workplace Relations Ministers Council, 2005) indicate that the mining, transport, manufacturing, agriculture and construction sectors have the highest rates of injury and fatalities, supporting the need for continued research in these areas.

Furthermore, the majority of research to date has focused on safety in high risk sectors such as the nuclear (Harvey et al., 2002) and oil industries (Crichton, 2005; Rundmo et al., 1998), manufacturing (Zohar & Luria, 2005), steel industry (Brown et al., 2000), agriculture (Seo, 2005; Seo et al., 2004) and the military (Zohar & Luria, 2004). However, since researchers in the sixties and seventies investigated safety in the coal mining industry (Goodman, 1979; Trist, Higgin, Murray, & Pollock, 1963; Trist, Susman, & Brown, 1977), there has been a noted lack of studies examining safety within the mining sector. As such, preference was given to recruiting organisations from the resource and industrial sectors, with a priority to access workers operating in the mining industry.

Recruitment of participant organisations was conducted over a two-year period through a process of targeted networking. The inclusion criteria for participant organisations took into consideration the size of the organisation, structure and initial willingness to provide group-level safety outcome data from organisational records. Initial organisation recruitment secured the participation of nine private sector organisations (and their aligned external contractors) representing the resource sector, manufacturing, construction, and transport industries. These included the Australian divisions of several multinational organisations in the mining, oil and gas,

and manufacturing sectors. Of these organisations, five elected to distribute the safety survey across a more than one of their work sites.

The additional six contracting companies provided external services to participant companies including; mine operations, milling, electrical, engineering, road construction, transport, catering, laboratory and mechanical contractors. The utilisation of contract workers is considered typical within the resource, transport and construction sectors in Australia. All contracting companies approached agreed to take part in the research project with the understanding that all questions should relate to personnel and systems in the overarching participant organisation.

### **6.3. Participants**

In total 1973 surveys were distributed to all employees in 9 organisations (including contractor affiliates) at 21 worksites. Overall, 514 managers, supervisors and front-line employees returned questionnaires, resulting in a response rate of 26%. While conservative response rates are generally expected in organisational settings (Rea & Parker, 1992), this relatively poor outcome can be partially explained by extremely low returns in several contracting companies in the mining and resource sectors and one of the manufacturing sites. Organisation response rates ranged from zero to 39%, with the lowest rates being observed for contracting companies in the mining sector. Organisation designators including industrial sector, contracting status, group structures, employee numbers and response rates for each organisation are provided in Table 6.1.

As both individual and multilevel analytical approaches are adopted in this research, organisations were asked to provide detailed departmental structures for all functional work-groups. While organisational structures differed across sectors, for the purposes of the study a functional work-group was defined as a group of operationally dependent workers who all report directly to a designated supervisor/team leader. One hundred and eighty six work-groups within 80 departments were identified in the consultation process. Groups ranged in size from 2 to 36 employees with an average group size of 10.10 ( $SD = 7.19$ ). Nine percent of teams were small work-groups of 2 or 3 employees; 53% of teams consisted of

between 4 and 10 members; 29% of teams with 11 to 19 members and a further 8% with over twenty workers. The process used to link individual responses to work-groups is outlined in the Procedure section.

Table 6.1 *Industry and Contracting Status, Employee Numbers and Response Rates for Participant Organisations*

Organisation	Sites	Status	Departments	Teams	Employees	Return	Rates%
1 Mining	2		8	19	227	73	32.15
Mining	1	Contract	3	7	56	4	7.14
Mining	1	Contract	4	11	196	25	12.75
Mining	1	Contract	1	5	12	3	25.00
Mining	1	Contract	1	2	43	4	9.30
Mining	1	Contract	1	2	68	0	0.00
Mining	1	Contract	1	3	54	4	7.41
2 Oil & Gas	2		11	22	182	37	20.33
3 Construction	1		1	1	41	9	21.95
4 Transport	3		8	27	201	76	37.81
5 Construction	1		6	10	60	16	26.67
6 Construction	1		1	3	47	18	38.30
7 Engineering	6		6	6	110	32	29.09
8 Manufacturing	1		5	13	238	38	15.97
9 Manufacturing	6		23	55	432	170	39.35
Total			80	186	1973	514	26.05

*Note.* Status=Contracting status; Departments= Number of Departments; Teams= Number of Work Teams; Employees=Total number of Employees; Return=Total number of responses returned; Rates%= Percentage Response Rates.

Valid survey responses were received from employees in 73% ( $N = 136$ ) of identified functional work teams. The average team size in the sample was 10.52 ( $SD = 6.91$ ). Teams represented in the sample largely replicated the population distribution described above, with 9% of teams being small work-groups of 2 or 3 employees, 48% of teams with between 4 and 10 members, 34% of teams with 11 to 19 members and a further 8% with over twenty workers. While overall team response rates provided a fair representation of the organisational structures, response rates within each group varied considerable across and within organisations. As stated previously employees from fifty teams provided no valid data, being



largely teams from the mining/resource contracting companies. Forty percent of groups had a response rate of greater than 50% of workers within the team with an average group response rate of 42%. As part of the survey, workers were asked how many people were in their team/workgroup. When this information was compared against the actual team compositions provided by the organization, significant differences were observed ( $M_{\text{worker}} = 9.63$ ,  $M_{\text{org}} = 12.17$ :  $t(311)=4.63$ ,  $p<.001$ ) with workers generally underestimating the group size. In addition, no statistically significant correlation between actual and perceived team size was found.

The total sample included personnel from all organisational work-levels, however individual and group-level analysis reported in this thesis was conducted on the front-line employee data only. Based on the organisation employment records provided, front-line employees represented 73% of the original workforce. The low overall response rate of 23% resulted in a final sample of 342 front-line workers (66.5% of total sample responses).

The front-line workforce sample was predominantly male (83.7%). Given the correspondence with gender distributions originally provided by the organisations, this proportion is considered representative of the gender composition in the organisations participating in the study. The age of front-line employees ranged from 19 to 69 with a mean of 41.9 ( $SD= 12.4$ ). The age distribution of the workforce indicates a relatively mature employee pool with only 23% of front-line workers being under the age of 30.

In relation to educational status 14.6% of employees completed 10 years schooling; a further 22.4% twelve years of schooling; 47.8% reported having completed additional trade certificates or apprenticeships; 13% of front-line employees had completed a university degree; and only 1.2% a postgraduate degree. With regard to job type, thirty job classifications were identified. The major categories were trade-related jobs including fitters, turners, mechanics, carpenters, boilers makers, caterers, cleaners, storemen and electricians; technical positions such as machine operators, plant operators, mill operators, laboratory technicians and process technicians; transport workers including forklift drivers, ground transport officers and truck drivers; administration positions including clerks, payroll officers, Occupational

Health and Safety representatives, Human Resources personnel, project and environmental officers; and professional positions such as civil, electrical and mining engineers, geologists, surveyors and metallurgists. The majority of participants were employed on a full-time basis (84.2%), a further 4.5% were casual workers and only 2% indicated being part-time employees. Nine percent of respondents did not specify their employment category.

In relation to employment characteristics several questions were asked including employment status, company tenure and job tenure. Additional measures of industry experience and trade/professional experience were also collected. These inclusions were relevant to the participant organisations due to the labour market context associated with the economic boom conditions in Western Australia existing at the time of survey distribution (Australian Bureau of Statistics, 2006). This context involved acute skilled and unskilled labour shortages which resulted in an unprecedented influx of new workers into the high paying resource and mining sectors and a high incidence of job migration of experienced personnel within and between organisations and industries. Indications of the labour force volatility in my sample organisations are reflected in the tenure and experience statistics provided below.

For the participants the average time of employment with their current organisation was 6.39 years ( $SD = 7.74$ ) with 23.6% of participants indicating that they had been with their organisation for less than one year and a further 20% for less than two years. Job tenure statistics showed that 36% had been in their current jobs for 1 year or less and 73% for less than five years ( $M = 4.66$ ,  $SD = 6.13$ ). While these figures seem to indicate a relatively inexperienced workforce across these industry groups, professional and industry experience statistics provided an alternative picture that supports the inflated turnover rates and job migration pattern identified by company representatives and labour force trends (Australian Bureau of Statistics, 2006). Industry experience was higher on average ( $M = 10.78$ ,  $SD = 10.02$ ) than either company or job tenure. Likewise trade or professional experience ( $M = 12.49$ ,  $SD = 10.49$ ) indicated a more experienced labour force than that inferred from job tenure statistics. Eleven percent of the sample reported that they were relatively new to their current industry (i.e., less than one year in the industry) or had limited

professional experience (22% under three years). In line with the relatively high average age of the sample, half the sample reported having over ten years of experience in their current trade or profession. Based on organisation records provided, industry statistics, and labour trends in the employment sectors included in the study, the sample is considered representative of the target population rather than the general population.

#### **6.4. Instruments**

Several new measures were developed for use in this study including a group-level measure of safety climate targeting the impact of coworker commitment to safety; a complimentary individual safety performance measure incorporating active and proactive safety behaviours; a measure of management-employee social exchange; and a measure of group member social exchange. The development of these instruments drew largely from current measures of safety climate (Zohar & Luria, 2005), leader-member exchange (Graen & Scandura, 1987; Graen & Uhl-Bien, 1995; Hofmann & Morgeson, 1999; Hofmann et al., 2003) and safety citizenship behaviours (Hofmann et al., 2003). Collection of all quantitative data was via a self-report survey of front-line workers (See Appendix A).

The following description of scales provides a brief definition of each instrument, item examples, response formats used and for established measures an indication of their psychometric properties. Furthermore, as the incorrect usage of referent levels in aggregated data has been seen as problematic (Chan, 1998), particular care was taken to ensure focal and collective referents were explicit and consistent in and between function domains represented in each climate scale.

In line with Flin's (2003) recommendations, to reduce the potential for ambiguity in the climate scales, I chose to differentiate between top level site/ departmental management and lower level, group leader/supervisors using terms appropriate for each participant organisation but congruent according to hierarchical structures. Figure 6.1 provides examples of the referent used and shows the potential for scale items to be customised to assess the perceptions of employees at different work levels. As participant organisations varied in size and function, minor modification

to referents (such as the use of supervisor or team leader; work-group or team; department or site) were applied to ensure contextual relevance. A major component of my thesis is the validation of factor structures for all scales using individual and group-level data, therefore further psychometric information is provided in relevant results chapters. Of importance to note however is the use of only front-line worker data in this thesis.

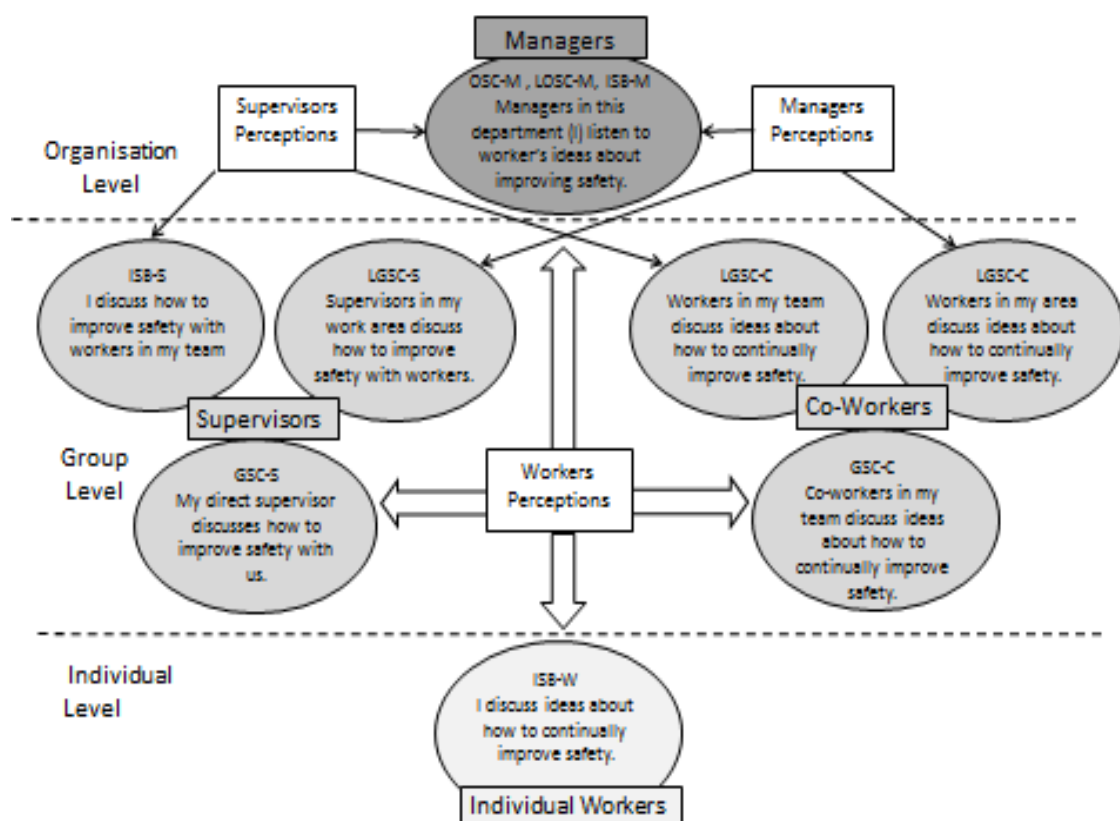


Figure 6.1. Work-level conceptualisation of safety climate subscales and item referents.

Note: OSC-M= Organisation Safety Climate-Managers (front-line worker perspective); LOSC-M= Organisation Safety Climate-Managers (supervisor perspective); ISB-M= Individual Safety Behaviours -Mangers; GSC-S=Group Safety Climate-Supervisors (front-line worker perspective); LGSC-S=Group Safety Climate-Supervisors (managers perspective); ISB-S= Individual Safety Behaviours - Supervisors; GSC-C= Group Safety Climate- Coworkers (front-line worker perspective); LGSC-C= Group Safety Climate- Coworkers (manger & supervisor perspective); ISB-W= Individual Safety Behaviours- Workers

### 6.4.1. Safety Climate Scales

Zohar and Luria (2005) provide two of the three safety climate measures tested in the proposed safety climate model. These are the organisational-level safety climate measure, tapping employees' perceptions of top management commitment to safety, and the group-level safety climate scale, assessing direct supervisors' commitment to safety. In Zohar and Luria's study, exploratory factor analysis identified three correlated factors for each scale, covering the content themes of active, proactive and declarative practices. Item redundancy and cross-loadings in their original, 27-item questionnaires for each climate level, led Zohar and Luria to reduce the number of items to 16 for each dimension.

Although the psychometric properties of both the management and supervisor scales have not been subject to extensive cross-validation, Zohar and Luria's (2005) initial results showed strong correlations between the long and short versions of their scales ( $r = .94$  and  $.95$ ,  $p < .001$ ) and high internal reliability (alpha  $.92$  and  $.95$ ). The predictive validity of each scale was also established by testing against safety engineering audits (correlation with organisational level climate,  $r = .46$ ,  $p < .01$ ) and behavioural observations (i.e., percentage of safe behaviours correlated with group-level safety climate,  $r = .38$ ,  $p < .01$ ). Discussions with participant organisations resulted in the inclusion of one additional item to both the climate scales assessing management and supervisors' stance on the importance of reporting all safety accidents and near misses.

#### 6.4.1.1. Organisation Safety Climate- Managers (OSC-M)

The 16 items making up the organisation-level safety climate - management commitment to safety scale (to be referred to as OSC-M) are listed as items 1-17 in Appendix A. The OSC-M includes statements such as: top management in my department / at this site react quickly to solve the problem when told about safety hazards, insist on thorough and regular safety audits and inspections, and consider safety when setting production speed and work schedules. The additional item reads: top management at this site emphasise the importance of reporting all safety accidents and near misses. In line with Zohar and Luria's protocols, a 5- point rating scale, ranging from 1 (*completely disagree*) to 5 (*completely agree*), was used to

gauge employees' level of agreement with each statement for all safety climate and social exchange scales. Additionally, all climate scales were derived by averaging the scores on each item, resulting in scales ranging from 1-5. Low scores indicated a poor climate rating.

#### **6.4.1.2. *Group Safety Climate- Supervisors (GSC-S)***

The 16 items of Zohar and Luria's (2005) original group-level safety climate scale were combined with one additional incident reporting statement to form the group safety climate – supervisor commitment to safety scale (to be referred to as GSC-S). The GSC-S scale includes items 26- 42 of Appendix A. Example statements are: my direct supervisor makes sure we receive all the equipment needed to do the job safely, emphasises safety procedures when we are working under pressure, and spends time helping us learn to see problems before they arise. The additional item for the GSC-S reads as follows: my direct supervisor encourages workers to report all safety accidents and near misses.

#### **6.4.1.3. *Group Safety Climate- Coworkers (GSC-C)***

As no group-level safety climate scale that specifically targets coworker commitment to safety was available, a priority of my study was to create and validate a scale measuring both active coworker practices (monitoring, complying) and proactive coworker practices (co-operating, initiating, participating, informing). To create the 17-item group-level safety climate scale (GSC-C) I integrated core items from both Hofmann et al. (2003) individual safety performance scales and Zohar and Luria's (2005) safety climate scale items. Items for the GSC-C can be seen in Appendix A (Items 51-67) and include statements such as: coworkers in my team always wear protective equipment even if it is uncomfortable, use their initiative to help solve safety-related problems, share information about safety hazards with supervisors and each other; and report all safety-related accidents and near misses as soon as they occur.

### **6.4.2. Social Exchange Scales**

As with the measures used to assess safety climate, the choice to select and adapt existing scales to examine the quality of social exchanges operating at different levels of the organisational hierarchy was based on a number of theoretical and

pragmatic criteria as discussed in the following sections. Three scales were used to assess climate for social exchange at the organisation and group level. This approach allowed the alignment of social exchange indicators with the stratified dimensions of safety climate. As described in Section 5.2.2, social exchange is conceptualised as a foundation climate, therefore the focus of each scale was directed at interdependent, within group social exchanges rather than direct, dyadic exchanges (Molm, 1994). To clarify, in the LMX scale front-line workers were asked to provide their perceptions of the general quality of the social exchanges occurring between their supervisor and members of their work-group rather than specifically with themselves.

#### **6.4.2.1. *Leader-Member Exchange (LMX)***

Liden et al. (1993) used both a member and leader version of the 7-item LMX scale in their longitudinal study of the early development of leader-member exchanges in dyads. Having additionally modified the response scale to an agree/disagree format, they found that internal consistency for both member and leader versions were above acceptable limits at all three testing stages, with Cronbach's alphas ranging between .75 to .90 over the six month lag. However, when examining the item content of different versions of the LMX (e.g., Hofmann & Morgeson, 1999; Liden et al., 1993; Scandura & Graen, 1984), an important inconsistency was identified. In Liden's (1993) version, respondents (either subordinates or leaders) rate whether the supervisor has confidence in subordinates' decision making, while the original version asks respondents if subordinates have confidence in their supervisor's decision making (Hofmann & Morgeson, 1999; Scandura & Graen, 1984). While a minor point, the two are not interchangeable. The inconsistency of this item with the rest of the scale was evidenced by poor factor loadings in Liden et al.'s factor analysis.

As the focus in this study is on leaders' behaviours the original statement tapping perceptions of supervisor's decision making was used in my study. An additional issue, raised during initial negotiations with organisation representatives, related to some of the wording of the LMX being unsuitable for the sample population. As such, when adapting the items to an agree/disagree response format, the wording of

some items was modified slightly, as show in Table B1. The most important modification, however, involved the shift of referent from a dyadic interaction (leader-member) to a collective domain (leader-group members). This change supported the measurement of LMX as a group-level climate construct, reflecting workers' general perceptions of the quality of social exchanges exhibited between their supervisor and fellow coworkers, rather than specifically with themselves.

Finally, the decision was also made to include one additional item traditionally associated with the transformational leadership style. This item taps the genuine nature of the leaders concern for employees' welfare and was considered a pertinent indicator of leader - member social exchange given the safety context of this research. LMX statements correspond to item numbers 43 to 50 in Appendix A. The additional item reads: my direct supervisor has a genuine concern for the welfare of employees in our work group. To retain continuity throughout the survey a 5-point rating scale, ranging from 1 (*completely disagree*) to 5 (*completely agree*), was again used to gauge employees' level of agreement with each statement. Average scale scores were derived for all three social exchange scales with high scores indicating higher quality social exchange relations.

#### **6.4.2.2. Manager-Member Exchange (MMX)**

In seeking to find existing instruments to measure the two additional social exchanges variables, several problems were identified. The POS scale used by Hofmann and Morgeson (1999) was a modified 9-item version of the original POS scale (Eisenberger et al., 1986). Hofmann and Morgeson's scale statements showed considerable item overlap with the LMX, but with a more ambiguous referent: *the organisation*. In developing the Management-Member exchange scale (MMX) scale I adopted the basic structure of the LMX scale, retaining four items common with the POS scale providing a degree of construct overlap. In addition I modified the general organisation referent specifically to top level site or department management in a manner consistent with the referent used in the OSC-M scale.

The seven MMX statements listed in Table B2 correspond to item numbers 18 to 24 in Appendix A. Statements include: top management at this site are honest and "up front" in their dealings with employees, understand employees' job problems and



needs, make decisions that employees feel confident to defend to other workers; and show genuine concern for the welfare of employees.

#### **6.4.2.3. *Group-Member Exchange***

In sourcing a scale to measure group member social exchanges, scales on team effectiveness (Taylor & Bowers, 1972) and Team-Member exchange quality (Seers et al., 1995) were considered. However, as discussed in Section 5.2.2.3 issues with repetition, double barrelled items and the overlap of items with the LMX led me to again modify the LMX scale described in section 6.4.3.1 to a group referent. The seven GMX items are included in Table B3 and Appendix A (Items 68 to 75). Statements include: coworkers in my team respect each other's capabilities, help each other solve work related problems, and let each other know where they stand. Again an additional statement tapping coworkers' concern for each other's welfare was included in the scale.

#### **6.4.3. Safety Outcomes**

Safety outcome measures included self-reported safety behaviours, self-reported lost time injuries, minor injuries and near miss data, and aggregated group-level safety behaviours and injury rates.

##### **6.4.3.1. *Individual Safety Performance (ISB-W)***

The operationalisation of individual safety behaviours (ISB-W) was discussed in the development of the coworker safety climate scale (see Section 6.4.1.3). As described in Section 3.3 the importance of distinguishing between active, role specified safety behaviours (compliance) and proactive, safety citizenship behaviours (participative) has been well established. In developing the GSC-C scale consideration was given to the instrument's potential utility as a measure of both individual safety behaviours for front line workers (as originally intended by Hofmann, et al. 2003) and as an aggregated group climate construct. The seventeen statements forming the ISB-W scale are provided in Appendix A (Items 76-92). The items replicate the GSC-C scale but have a direct self-referent (i.e., *I follow correct safety procedures when using equipment*). A 5-point rating scale, ranging from 1 (*completely disagree*) to 5 (*completely agree*), was again used to gauge employees' level of agreement with

each statement and the scale score obtained by averaging item scores. The scale range was from 1-5 with a high score indicating a positive rating of personal safety behaviours.

#### **6.4.3.2. *Injury and near miss statistics***

All participants were also asked to report injuries they had sustained and near miss events they experienced within the last 6 months. This time frame was selected as it has been recommended as the maximum time period that accurate recall can be sustained (Veazie et al., 1994). Three levels of injuries were assessed: lost-time injuries (LTI= inability to work for one full day/shift or more), minor injuries (i.e., micro accidents requiring company first aid as used by Zohar, 2000), and near miss incidents (i.e., an event in which workers could have or almost sustained an injury) as used by Zacharatos et al. (2005). Targeting the different levels of accident and injury severity allowed greater flexibility for profiling incident occurrence and greater statistical sensitivity in line with Christian et al.'s (2009) recommendations.

To assist participants' recollections of incidents and injuries, employees were asked to recall the number of times they experienced injuries and near misses, in eight separate categories. These included: fractures and dislocations; sprains and strains (including back injury); bruising and crushing; superficial wounds (scratches and abrasions); open wounds (cuts, lacerations and punctures); burns and scalds; eye injuries; and concussions and other head injuries. In contrast to the 5-point Likert scale used by Zacharatos and colleagues (2005) to assess frequency of occurrence, respondents were asked to record as accurately as possible the number of times they experienced injuries or incidents in each category over the past 6 months. This strategy resulted in a 3 x 8 injury/incident table as shown Part E of Appendix A .

To derive individual-level safety outcome scores the number of injuries across the eight categories were summed to form a total for each of the LTI, minor injury and near miss incident categories. To derive the group-level safety outcome scores, the average number of injuries in each of the three injury/incident categories for each work-group was calculated (Zohar, 2000). Group averages were based on the number of survey respondents from each group rather than the actual number of workers per group as identified in organisation distribution charts. Table 6.2

provides a summary of the number of individual reports (cases) and total number of injuries (frequency) experienced for each injury classifications in the front-line worker sample. The frequency ratio of LTIs to minor injuries and near miss incidents is 1:34:49.

Table 6.2 *Classification and Frequency of Injury and Near Miss Incidents*

Types of Injuries	Minor		LTI		NMI	
	Unique Cases	Freq	Unique Cases	Freq	Unique Cases	Freq
Fractures & Dislocations	11	14	2	3	15	27
Sprains & Strains (including Back injuries)	41	58	4	5	33	101
Bruises & Crushing	31	65	3	4	37	107
Superficial wounds (Scratches and abrasions)	71	199	1	1	43	166
Open wounds (Cuts, lacerations & punctures)	40	84	1	1	32	113
Burns & Scalds	16	29	0	0	24	57
Eye Injuries	14	24	0	0	26	72
Concussions (Head injuries)	9	13	0	0	22	44
<b>Total</b>	<b>233</b>	<b>486</b>	<b>11</b>	<b>14</b>	<b>232</b>	<b>687</b>

*Note.* N=319; Minor= Injury requiring company first aid; LTI=Lost-time Injury, Inability to work one full shift / day or more after injury; NMI=Near Miss Incident in which worker could have or almost sustained this type of injury; Unique Cases= Number of individual reports; Freq= Frequency derived from Cases x Occurrence rate.

In total 140 front-line employees (41.1%) reported experiencing either an injury or a near miss incident in the preceding 6-month period. Only six respondents (1.8%) failed to provide injury data. Data from one front-line employee was identified as invalid due to over-reporting of lost-time injury experiences and was excluded from the analysis. A further 13 cases reported potentially inflated injury or near miss data (i.e., frequency rates greater than ten in any one injury classification). To retain this outcome data in the analysis, the extreme responses identified were recoded down to 10. Eight front-line employees (2%) reported experiencing one or more lost-time

injuries over the reporting period, equating to 14 LTIs across the injury classifications. The majority of LTIs were associated with sprains and strains (including back injuries) and bruising or crush injuries. Nearly one third ( $n=109$ ) of front-line workers reported experiencing minor injuries that required company first aid. Seventy three front-line workers reported multiple injury occurrences. The most frequently reported minor injuries were superficial wounds such as scratches and abrasions (199 instances reported by 71 workers), however all injury types were represented in the sample.

Responses for the near miss incident classification indicated that 72 front-line workers (22%) experienced a near miss incident in the reporting period with the majority of these workers ( $n=58$ ) reporting multiple incidents across classifications. A total of 687 near miss incidents were recorded by workers for the 6-month period. Workers indicated that superficial wounds were likely to be the most common outcome of workplace safety incidents with 43 workers recording a total of 166 near miss occurrences in this classification. Given the small proportion of front-line workers reporting lost time injuries (8 cases, 2%); information from this classification was combined with the minor injury data to form an overall Injury variable. Table 6.3 shows the descriptive statistics for the safety outcome variables. Due to the extreme positive skew of the injury and near miss incident data, logarithmic transformations were performed on these variables. The resultant variables remained positively skewed.

Table 6.3 *Descriptive Statistics for Injury and Near Miss Incidents*

Variable	Mean	SD	Range	Skew	Kurtosis
1 Injury	1.45	3.71	0-31	4.40	24.22
2 Near Miss Incident	2.06	6.25	0-48	4.16	19.57

*Note.* ( $N=319$ )

## 6.5. Procedure

Ethics approval for the project was granted by Curtin University HREC (approval number HR 158/2006). Engagement of key organisational members and employee support for the study were considered crucial to the success of the research. Due to the diversity of organisations in the study, meetings with company representatives

(generally senior occupational health and safety personnel) and management teams were conducted to negotiate appropriate distribution approaches for the questionnaires and processes for feedback to the company. Provision was made during the development of the questionnaire and company negotiations to conduct follow-up longitudinal data collection and to examine work-level differences in climate perceptions. Whereas only data collected from frontline workers is reported in this thesis, information was also obtained from managers and supervisors.

Human resource databases in each organisation were used to create classification codes for each functional work team based on company, division/department and work-group unit designators (e.g., Organisation 1/Division 3/Team 2 = 0103002). The accuracy of team classification codes and final staffing numbers were verified by company representatives prior to survey distribution. Team codes were recorded on questionnaires which were then sealed in survey distribution packs. For distribution purposes individual survey packs were labelled with conventional work-level, team designators and in some instances employee names.

While distribution strategies differed slightly due to organisation size and structural differences, a standard procedure of information dissemination followed by the distribution of surveys at regular or specially convened team safety meetings was achieved. Preliminary circulation of information explaining the nature of the survey to staff was achieved via internal newsletters, bulletin boards and the electronic distribution of a notification sheet (refer Appendix C). Questionnaires were distributed to employees largely by the researcher at onsite information sessions arranged by the organisations. However, given the range of remote sites represented, access restrictions and number of shift rotations involved, this was not always possible. When it was not feasible to personally engage in the distribution of survey packs, additional information sessions were arranged with operational safety personnel to brief them on the distribution process. To aid standardisation of procedures, a customised PowerPoint presentation covering the purpose of the study and key ethical issues was provided to organisations for use by their personnel in distribution sessions.

Distribution procedures were designed to provide employees adequate time and detail to make an informed decision to participate. To further ensure that participants felt no undue pressure to complete the survey, organisations agreed that participants be allowed the freedom to complete the survey in a time set aside within their normal work hours, or if they preferred in their own time. Each survey pack included a reply paid envelop to ensure confidentiality. To protect employee privacy and ensure the anonymity of responses, the questionnaires included no direct form of personal identification, however a personal code was used to support longitudinal data matching and a group coding system was applied to allow team identification.

Employees were encouraged to return their sealed responses either to a central collection point at their organisation for forwarding, or directly to the researcher. Participants were encouraged to respond within a two-week period. Contact details of the researcher, supervisors and an independent university contact were provided at the information sessions, included on the prior notification sheets, and on survey documents to enable participants to forward any queries. Only one employee query regarding the research was received and three blank survey forms were returned. On completion of the study, all participant organisations were provided with a detailed report on the safety climate of their organisation, including work-level, team and divisional data. As outlined in the feedback agreement provide in Appendix D information in feedback reports was aggregated to ensure the protection and confidentiality of individual employees.

## **6.6. Analysis**

According to Chan's (1998) typology of composition models for multilevel analysis a combination of models can be used to develop and test multilevel hypotheses. In my study, a simple additive composition model was implemented when aggregating safety outcomes such as incidents and injuries to the group level, while a direct consensus model was considered more appropriate for the formation of the group-level safety performance indicators. Finally referent-shift consensus models were applied to derive all group-level climate measures.

Data analysis involved the validation of existing and new measures at both the individual and group-level of analysis. Scale validation was first conducted at the

individual-level of analysis using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Principal axis factoring (PAF) with varimax rotation was used for the exploratory analysis. The additional examination of the measurement models using CFA was undertaken as it provides a more rigorous test of construct validity (MacCallum, Browne, & Sugawara, 1996). Unlike EFA loadings of the predictor and criterion variables can be specified a priori in CFA. CFA therefore allows the examination of both convergent validity (i.e., the degree to which items load on their hypothesised factor) and discriminant validity (i.e., show minimal cross-loadings on other factors) (Bollen, 1989). On the basis of scale validation results, refinements of the instruments were made and testing of individual-level explanatory models using structural equation modelling (SEM) was undertaken.

To determine if potential differences in findings arise when using individual and group-level data two strategies for data aggregation described by Peterson and Castro (2006) were undertaken. The first stage of model replication adopted the ILSA approach in which group-level variables were formed by simply aggregating scale items assessed for factor structure at the individual-level of analysis. This involved testing the suitability of the data for group-level analysis at the scale level via examination ICCs (Bliese, 2000). Assessments of the hypothesised explanatory models were then performed on the ILSA aggregated variables. The second stage of model replication adopted the CSA approach in which group-level variables are formed by first testing item ICCs, aggregating items to the required level of sub unit analysis, conducting exploratory factor analysis on this group-level data and then creating group-level scales to be used in subsequent model testing.

Data inspection and EFA was conducted using SPSS 17. For single and random, multiple-item missing data cases, a strategy of data substitution was applied using the data imputation procedure in EQS 6.1 program (Bentler, 1995). All path analyses, structural and measurement models were estimated using LISREL 8.0. Analysis was based on the maximum-likelihood (ML) method, the input for the analysis being the covariance matrix for the items. When testing the hypothesized models only random error was considered.

In this thesis, I intend to conduct a series of analyses for the same purpose but using different statistical approaches. Given the resultant number of analyses undertaken consideration was given to the inflation of Type I errors. However as the testing of explanatory models was aimed at making direct comparisons across methodologies Bonferroni family-wise corrections were not applied. Instead I adopted a stringent .01 alpha convention and a more conservative interpretative approach to recognise the possibility of Type I errors. In addition to this general approach, when testing organisational differences in section 7.7 a Bonferroni correction was applied.

### **6.7. Power & Sample Size**

To facilitate the use of both exploratory and confirmatory factor techniques to examine the factor structures of constructs prior to modelling construct relationships, the data set was split using SPSS random sample generation facility into two sub samples (EFA:  $n=159$  and CFA:  $n=181$ ). To retain power in the separate factor analyses undertaken, cases with full item responses within a specific climate dimension (but not a full data set across domains) were included. Specific sample sizes for each analysis undertaken are reported in the results sections where appropriate.

In general, recommended variable-to-cases ratios to support EFA range from 10 to 20 (Thompson, 2008) with an absolute minimum of five cases per item and at least 100 cases per analysis (Gorsuch, 1983). As items numbers ranged from 8 to a maximum of 17 in the EFA procedures performed, the case to item ratios of approximately 10:1 for these analyses are considered adequate. For CFA, Anderson and Gerbing (1988) recommend a minimum sample size of 150 or more. The two randomly generated subsamples therefore provided an adequate sample for all individual-level exploratory and confirmatory analysis.

For testing of single-level structural models using SEM the total sample was used. For SEM a minimum ratio of sample size to number of free parameters of 5:1 is recommended (Bentler & Chou, 1987), necessitating an estimated minimum sample of 200. In terms of conventional SEM, MacCallum et al. (1996) provide guidelines for the calculation of power and determination of sample size. Given an expected medium effect size, and the degrees of freedom in the model, to achieve adequate



power of 0.80 using an alpha level of 0.05 the total front-line sample of 319 is considered adequate. However when group-level modelling was applied the sample size and corresponding power in the analysis was significantly reduced.

In multilevel research the target units for grouping participant data reflect the conceptual models being tested (Kreft & De Leeuw, 1998). While the highest grouping unit directly targeted in my model was management at the organisation/department level the sample size obtained and ICC<sub>1</sub> results did not support aggregation to this level (see Table 6.4 for organisational level ICC<sub>1</sub>). Aggregation was therefore restricted to the work-group level ( $N=79$ ). Despite the apparent inadequacy of the group-level sample, evidence has been presented that neither the accuracy of parameter estimates (Anderson & Gerbing, 1988) or fit indices (Bentler & Bonnett, 1980; Bentler & Chou, 1987) are adversely affected in samples as small as 50.

Table 6.4      *Organisation level ICC<sub>1</sub> and ANOVA results for Safety Climate, Individual Safety Behaviour and Social Exchange Scales.*

Item		ICC	ANOVA
1	OSC-M	0.09	$F(5,314)=3.48, p=.004$
2	GSC-S	0.01	$F(5,310)=1.95, p=.086$
3	GSC-CA	0.05	$F(5,303)=2.83, p=.016$
4	GSC-CP	0.02	$F(5,303)=2.18, p=.056$
5	ISB-WA	0.04	$F(5,309)=2.62, p=.024$
6	ISB-WP	0.01	$F(5,309)=1.63, p=.151$
7	MMX	0.15	$F(5,314)=5.07, p<.001$
8	LMX	0.02	$F(5,310)=2.09, p=.066$
9	GMX	0.01	$F(5,303)=1.88, p=.097$

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-WA= Individual Safety Behaviours- Workers Active; ISB-WP= Individual Safety Behaviours- Workers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

## 7. Construct Validation

### 7.1. Introduction

This chapter provides the results of analyses which test the construct validity of the social exchange, safety climate and individual safety behaviour scales (Objective 1 of my thesis).

### 7.2. Assumption Testing and Missing Data treatment

An assessment of missing data trends across scale items for the full sample using EQS 6.1 indicated that missing data fell into three categories: cases with single item omissions (9.5%), cases with random multiple item omissions (3%) and cases with missing sections (5%). As each data section constituted over 5% of survey items, 21 cases with sectional missing data were excluded from the main analysis.

Examination of response trends within this group showed that 17 respondents failed to provide coworker data; eight did not complete the section relating to supervisor behaviours, three failed to provide management data and seven workers did not provide information on their own safety-related behaviours. When sectional and random omissions were combined, no single item was missing in 5% of the total sample. A missing values analysis was also conducted using Little's MCAR test in SPSS 20. The chi-squared test was not statistically significant,  $\chi^2(3964, N = 337) = 3741.51, p = .994$ , indicating that the patterns of data were missing completely at random.

When assessing the psychometric properties of the measurement scales used in the study, assumption and outlier tests were conducted on the scale items for each construct. Examination of normality plots, bivariate-scatter plots and Mahalanobis' distance estimates were undertaken to assess potential outliers, and to ascertain whether the assumptions of both univariate and multivariate normality, and linearity necessary to perform PAF and CFA had been violated. Given the large number of scale items, a random selection of bivariate scatter plots were inspected for violations of linearity (Tabachnick & Fidell, 2007). A small number of univariate outliers were identified ( $z > 3.29$ ) on fourteen of the 100 scale items, however the decision was made to retain the items without modification as maintenance of response variability was considered a priority, and neither removal nor modification substantially

improved skew in the distributions. A visual inspection of normality plots and examination of both skew and kurtosis statistics indicated that the majority of items were negatively skewed and showed slight positive kurtosis. Given the nature of the survey items a degree of negative skew in the data was anticipated. The Maximum likelihood method applied in the CFA and SEM procedures is considered relatively robust to moderate violations of normality due to skewness, but not kurtosis (Hu, Bentler, & Kano, 1992).

Multivariate item-based outliers in the EFA procedures and scales-based outliers for CFA and SEM were identified using Mahalanobis' distance as recommended by Tabachnick & Fidell (2007). Inspection of the suspect cases indicated that these respondents were more prepared to use the extremes of the scales when making their ratings but no cases were found to be fixed response sets. To assess the impact of multivariate outliers on both exploratory and confirmatory procedures, analyses were conducted on both the full and reduced data sets. As outliers identified were consistent with those previously inspected and no marked differences in model fit were identified between results derived using the full and reduced sets, results for the full data sets are reported to retain power in the analysis. Additional data screening and assumptions related information is included where relevant within each results section.

### **7.3. Exploratory Factor Analysis of Safety Behaviour and Climate Indicators**

Principal axis factor analysis using varimax rotation was conducted on the first subsample ( $n=159$ ) to examine the factor structure of the individual safety behaviour, safety climate and social exchange scales. For all scales, factor structures were investigated using both original and modified scale items to examine whether potential structure differences were sample specific. For the interpretation of factors, the criterion to determine the salience of items was set at factor loadings of .55. While Thompson (2008) cites the common practice of setting coefficient values of .3 or .4, Comrey and Lee (1992) argue that factor loadings in excess of .55 provide a more stringent cut off, representing approximately 30% of overlapping variance. Items considered poor indicators of their target constructs (i.e., loadings of less than

.55) were eliminated to improve psychometric properties of the scales as per Hair et al.'s (2006) recommendations.

In both the 17-item individual safety behaviour scale (ISB-W) and coworkers safety climate scale (GSC-C) one item relating to *workers covering up for coworkers when safety rules were not followed* required reverse coding to align with the positive safety orientation of other statements. Discussion with company representatives indicated that this item had confused some workers. Subsequent examination of univariate descriptive statistics, communalities and factor loadings in an initial run of the PAF supported the removal of this item from both GSC-C and ISB-W scales. The item showed the lowest average ( $M = 3.22$ ), highest variability ( $SD = 1.29$ ), an exceedingly low communality after extraction ( $h^2 = .093$ ) and poor factor loadings ( $F_1 = .153$ ;  $F_2 = .263$ ) in the initial run of the GSC-C. The decision was made to rerun the PAF analysis in both scales on the reduced 16-item scale.

### 7.3.1. Individual Safety Behaviours (ISB-W)

In support of Hypothesis 1, a two-factor solution was obtained for the ISB-W scale when factors with eigenvalues greater than 1 were retained (Thompson, 2004). Item means, standard deviations, communalities, eigenvalues and factor loadings for the ISB-W scale are presented in Table 7.1. In total 54.87% of total variability was explained by the two-factor model for the Individual Safety Behaviours Scale. After varimax rotation Factor 1 explained 28.46% of total variance and Factor 2, 26.41%. As a strong correlation was observed between the two factors ( $R = .691$ ), an oblique rotation was also conducted. The correlated factor rotation resulted in a comparable factor solution. The following results are reported for the orthogonal solution.

Communality values for the ISB-W were high for all items except Item 1 ( $h^2 = .17$ ). The reproduced factor matrix showed that 29% of nonredundant residuals had a value greater than .05 indicating a relatively good fit for the two-factor model. Three items failed to reach the loading cut off criteria for either factor and showed substantial cross loadings. Item 1 ( $F_1 = .168$  &  $F_2 = .379$ ), Item 14 ( $F_1 = .513$  &  $F_2 = .503$ ), and Item 16 ( $F_1 = .489$  &  $F_2 = .494$ ) were therefore not included in further analyses.

Table 7.1 *Descriptive Statistics, Communalities and Factor Loadings for the Two-Factor Model of Individual Safety Behaviours*

Item	I...	Loadings				
		<i>M</i>	<i>SD</i>	<i>F</i> <sub>1</sub> <sup>b</sup>	<i>F</i> <sub>2</sub> <sup>a</sup>	<i>h</i> <sup>2</sup>
1	Refuse to ignore safety rules when work falls behind schedule	3.82	1.30	.168	.379	.17
2	Always wear protective equipment even if it is uncomfortable	4.22	0.99	.265	<b>.652</b>	.50
3	Am prepared to question coworkers who are not following safety rules	4.12	1.04	.412	<b>.690</b>	.65
4	Monitor myself and others when we are tired or stressed to ensure no-one is working unsafely	3.93	0.99	.320	<b>.703</b>	.60
5	Look out for coworkers personal safety	4.37	0.84	.264	<b>.748</b>	.63
6	Follow correct safety procedures when using equipment	4.33	0.80	.419	<b>.563</b>	.49
7	Co-operate with supervisors to develop better safety practices	4.15	0.96	<b>.634</b>	.388	.55
8	Use my initiative to help solve safety-related problems	4.30	0.76	<b>.573</b>	.387	.48
9	Get involved in the safety training programs provide by management	4.00	1.05	<b>.656</b>	.150	.45
10	Make suggestions on how to improve job safety	4.09	0.89	<b>.708</b>	.427	.68
11	Share information about safety hazards with supervisors and coworkers	4.37	0.86	<b>.647</b>	.446	.62
12	Keep myself informed about safety-related issues	3.95	0.93	<b>.740</b>	.319	.65
13	Discuss ideas about how to continually improve safety	3.87	1.05	<b>.740</b>	.426	.73
14	Speak highly of those workers who pay special attention to safety	3.91	1.09	.513	.503	.52
15	Report all safety-related accidents and near misses as soon as they occur	4.18	1.02	.510	<b>.571</b>	.59
16	Express my opinions on safety matters even if others disagree	4.25	.91	.489	.494	.48
Percentage of Variance:				28.46%	26.41%	

Note . (*n*= 156). <sup>a</sup> = Active Safety Behaviours; <sup>b</sup> = Proactive Safety Behaviours

Item 15 also showed complex loadings (in excess of .5) on both factors (*F*<sub>1</sub>= .510 & *F*<sub>2</sub>= .571), but exceeded the cut off criteria for Factor 2. Item 15 was retained as part of the active safety subscale of the ISB. It was also noted that while Item 7 loaded cleanly on the proactive factor (*F*<sub>1</sub>= .634 & *F*<sub>2</sub> = .388) for the ISB-W, it showed high cross loadings on the GSC-C (refer to section 7.3.2), meeting the cut off for inclusion

in the active safety factor. This was the only item to load inconsistently across scales and was therefore excluded.

Items loading strongly on Factor 1 in this instance reflect proactive safety practices (ISB-WP). Cronbach's alpha for the 6-item ISB-WP Scale was .891. The six items aligning with Factor 2 represented active safety practices (ISB-WA). Internal consistency for the 6-item ISB-WA scale was also considered good (Cronbach's alpha = .882). As a function of increased item numbers, when combined as a 12-item ISB-W scale, Cronbach's alpha increased to .927, indicating good internal consistency for both full and subscale versions.

### 7.3.2. Group Safety Climate- Coworkers (GSC-C)

As previously identified in the ISB-W analysis, communality values for the GSC-C scale items were high for all but one variable: *coworkers refuse to ignore safety rules when work falls behind schedule* ( $h^2 = .36$ ). In total 61.68% of variability was explained by the two-factor model. After varimax rotation, Factor 1, representing active safety behaviours, explained 32.28% of total variance and Factor 2, tapping proactive safety behaviours 29.4%. The reproduced factor matrix indicated that 20% of nonredundant residuals had a value greater than 0.05. The factor transformation matrix indicated a strong correlation ( $R = .688$ ) between factors.

Of the sixteen items in the GSC-C scale, four failed to reach the loading cut off or showed substantial cross loadings. Relatively weaker factor loadings for Item 1, examining coworkers' refusal to ignore safety rules when work falls behind schedule ( $F1 = .52$  &  $F2 = .29$ ), were expected given the lower communality value for this item. Of the three complex variables Item 14 ( $F1 = .538$  &  $F2 = .518$ ) and Item 16, ( $F1 = .543$  &  $F2 = .524$ ) failed to meet the cut off criteria. While Item 7, ( $F1 = .607$  &  $F2 = .509$ ) reached the cut off for Factor 1, as described in section 7.3.1, it was the only item with inconsistent loading on the ISB-W & GSC-C scales. High cross loadings on these items indicate that respondents find it more difficult to distinguish these coworker actions as specifically within role compliance behaviours or beyond role expectation, participative activities. Therefore, to improve scale validity these four items were removed from the GSC-C subscales used in all subsequent analyses.

Table 7.2 *Descriptive Statistics, Communalities and Factor Loadings for the Two-Factor Model of Group Safety Climate-Coworker*

Item	Coworkers in my work team....	<i>M</i>	<i>SD</i>	Loadings		
				<i>F</i> <sub>1</sub> <sup>a</sup>	<i>F</i> <sub>2</sub> <sup>b</sup>	<i>h</i> <sup>2</sup>
1	Refuse to ignore safety rules when work falls behind schedule	3.62	1.20	.522	.294	.36
2	Always wear protective equipment even if it is uncomfortable	3.82	1.17	<b>.671</b>	.288	.53
3	Are prepared to question coworkers who are not following safety rules	3.77	1.09	<b>.676</b>	.407	.62
4	Monitor each other when tired or stressed to ensure no-one is working unsafely	3.55	1.15	<b>.707</b>	.404	.66
5	Look out for each other's personal safety	3.98	1.09	<b>.761</b>	.435	.77
6	Follow correct safety procedures when using equipment	3.92	1.06	<b>.731</b>	.430	.72
7	Co-operate with supervisors to develop better safety practices	4.00	.99	<b>.607</b>	.509	.63
	Use their initiative to help solve safety-related problems	3.95	.94	.450	<b>.687</b>	.67
9	Get involved in the safety training programs provide by management	3.66	1.16	.368	<b>.647</b>	.55
10	Make suggestions on how to improve job safety	3.95	.97	.353	<b>.709</b>	.63
11	Share information about safety hazards with supervisors and each other	4.03	.97	.457	<b>.657</b>	.64
12	Keep themselves informed about safety-related issue	3.63	.98	.391	<b>.634</b>	.56
13	Discuss ideas about how to continually improve safety	3.62	1.05	.314	<b>.839</b>	.80
14	Speak highly of those workers who pay special attention to safety	3.45	1.14	.538	.518	.56
15	Report all safety-related accidents and near misses as soon as they occur	3.77	1.15	<b>.704</b>	.313	.59
16	Express opinions on safety matters even if others disagree	3.83	1.06	.543	.524	.57
Percentage of Variance:				32.28%	29.40%	

Note. *n* = 152 <sup>a</sup> = Active Safety Behaviours; <sup>b</sup> = Proactive Safety Behaviours

Items loading on Factor 1 represented compliance, reporting and monitoring safety behaviours and are subsequently labelled as active safety practices (GSC-CA).

Internal consistency (Cronbach's alpha = .915) for the 6-item GSC-CA scale was also considered good. The six items loading strongly on Factor 2 reflect more proactive or participative safety practices (GSC-CP) such as co-operating with other

workers and supervisors, using personal initiative and keeping informed. Cronbach's alpha for the 6-item GSC-CP scale was .910. When combined as a 12-item scale alpha for the GSC-C increases to .943 again indicating good internal consistency for both full and subscale versions. In sum the factor loading patterns for GSC-C items closely mirror those found for the ISB-W.

### 7.3.3. Group Safety Climate- Supervisors (GSC-S)

As illustrated in Table 7.3 results of the EFA of the seventeen GSC-S items supported a one-factor solution when the Kaiser criterion was applied.

Table 7.3 *Descriptive Statistics, Communalities and Factor Loadings for the One-Factor Model of Group Safety Climate-Supervisor*

Item	My direct supervisor...	Loadings			
		<i>M</i>	<i>SD</i>	<i>F<sub>1</sub></i>	<i>h<sup>2</sup></i>
1	Makes sure we receive all the equipment needed to do the job safely	4.01	.99	<b>.732</b>	.54
2	Checks to see if we are all obeying safety rules	3.81	1.08	<b>.848</b>	.72
3	Discusses how to improve safety	3.81	1.06	<b>.815</b>	.67
4	Uses explanations (not just compliance) to get us to act safely	3.74	1.11	<b>.831</b>	.69
5	Emphasises safety procedures when we are working under pressure	3.72	1.08	<b>.864</b>	.75
6	Frequently tells us about the hazards	3.60	1.13	<b>.805</b>	.65
7	Refuses to ignore safety rules when work falls behind schedule	3.69	1.18	<b>.599</b>	.36
8	Is strict about working safely when we are tired or stressed	3.78	1.12	<b>.752</b>	.57
9	Reminds workers who need it to work safely	3.90	.97	<b>.748</b>	.56
10	Makes sure we follow all the safety rules	3.79	1.10	<b>.862</b>	.74
11	Insists that we obey safety rules when fixing equipment or machines	3.93	1.03	<b>.785</b>	.62
12	Says a "good word" to workers who pay special attention to safety	3.53	1.25	<b>.798</b>	.64
13	Is strict about safety at the end of the shift	3.55	1.09	<b>.811</b>	.66
14	Spends time helping us learn to see problems before they arise	3.46	1.24	<b>.790</b>	.62
15	Frequently talks about safety issues	3.57	1.19	<b>.817</b>	.67
16	Insists we wear our protective equipment	4.19	.93	<b>.663</b>	.44
17	Encourages workers to report all safety accidents and near misses	4.28	.83	<b>.618</b>	.38
		Percentage of Variance: 60.34%			



To ensure that the addition of one item to the original GSC scale had not inhibited the replication of a three-factor structure identified by both Zohar and Luria (2005) and Johnson (2007), an additional PAF analysis was conducted on the sixteen original GSC items. This analysis also resulted in a one-factor solution.

Communality values for the seventeen GSC-S scale items were high for all but two variables: *my supervisor refuses to ignore safety rules when work falls behind schedule* ( $h^2 = .36$ ), and *encourages workers to report all safety accidents and near misses* ( $h^2 = .38$ ). All items exhibited factor loadings in excess of .55 (Comrey & Lee, 1992). In total 60.34% of total variability was explained by the one-factor model. The reproduced factor matrix indicated that 27% of nonredundant residuals had a value greater than 0.05. Cronbach's alpha for the 17-item GSC-S scale was .962 indicating a high degree of internal consistency.

#### **7.3.4. Organisation Safety Climate- Managers (OSC-M)**

A one-factor solution was also found for both the 17-item and original 16-item OSC-M scales. As shown in Table 7.4, communality values for the OSC-M items were high for all but two variables. In total 56.01% of total variability was explained by the one-factor model. The reproduced factor matrix indicated that 29% of nonredundant residuals had a value greater than .05. While the one-factor solutions for both GSC-S and OSC-M scales were not optimal, enforced two and three-factor solutions for both scales resulted in a relatively high number of complex variables in the rotated solutions. A high level of internal consistency was again observed for the 17-item OSC-M scale (Cronbach's alpha = .955).

#### **7.3.5. Summary**

The preliminary EFAs indicated that both the coworker safety climate and worker safety behaviour scales were best explained by two-factor structures representing active and proactive safety practices of workers as hypothesised. The removal of several items to form two 6-item subscales for both the ISB-W and GSC-C improved the construct validity and internal consistency of the scales. The one-factor solutions obtained for both supervisor and management level safety climate scales were as hypothesised. The inclusion of an item relating to the reporting of accidents and incidents in both the GSC-S and OSC-M scales did not impact on the one-factor

solutions obtained for either scale and the internal consistency of the two management level safety scales is considered excellent. Further discussion of the implications of these results is provided in Section 7.8.

Table 7.4 *Descriptive Statistics, Communalities and Factor Loadings for the One-Factor Model of Organisational Safety Climate-Managers*

Item	Top management in this department/site...	Loadings			
		<i>M</i>	<i>SD</i>	<i>F<sub>1</sub></i>	<i>h<sup>2</sup></i>
1	React quickly to solve the problem	3.80	1.14	<b>.770</b>	.59
2	Insist on thorough and regular safety audits	3.84	1.12	<b>.764</b>	.58
3	Continually improves safety levels	3.97	.99	<b>.828</b>	.69
4	Provide all the equipment needed	3.91	1.03	<b>.624</b>	.39
5	Are strict about working safely when work falls behind schedule	3.69	1.18	<b>.763</b>	.58
6	Quickly correct any safety hazards (even if it's costly)	3.49	1.15	<b>.811</b>	.66
7	Provide detailed safety reports to workers	4.05	1.03	<b>.708</b>	.50
	Consider a person's safety behaviour when promoting	3.45	1.08	<b>.633</b>	.40
9	Require each manager to help improve safety in their department	4.02	.86	<b>.672</b>	.45
10	Invest a lot of time and money in safety training	3.70	1.13	<b>.753</b>	.57
11	Use any available information to improve existing safety rules	3.89	1.04	<b>.816</b>	.67
12	Listen carefully to workers' ideas about improving safety	3.61	1.26	<b>.846</b>	.72
13	Consider safety when setting production speed and schedules	3.59	1.16	<b>.807</b>	.65
14	Provide workers with a lot of information on safety issues	3.95	1.05	<b>.804</b>	.65
15	Regularly hold safety-awareness events	3.52	1.27	<b>.689</b>	.47
16	Give safety personnel the power they need to do their job	3.74	1.12	<b>.752</b>	.57
17	Emphasize the importance of reporting all safety accidents and near misses	4.31	.80	<b>.626</b>	.39
Percentage of Variance:		56.01%			

#### 7.4. Exploratory Factor Analysis of Social Exchange Indicators

The examination of scale properties for the social exchange variables begins with the new Group-Member Exchange scale. For the Leader-Member Exchange scale the factor structures were investigated using both original and modified scale items to examine whether any potential differences in psychometric properties were sample

specific. The final exploratory analysis examines the Manager-Member Exchange scale which is followed by a brief summary of the social exchange results.

#### 7.4.1. Group-Member Exchange (GMX)

Exploratory Factor Analysis of the 8-item GMX resulted in a one-factor solution shown in Table 7.5. In total 57.88% of total variability was explained by the one-factor model. Communality values for GMX items were high for all but one item: Item 5, *coworkers in my work team “bail each other out” at their own expense when someone really needs it* ( $h^2 = .34$ ). Item 5 also showed the relatively lowest factor loading of .580. As the item exceeded the recommended cut off, the decision was made to retain the item in the scale. The reproduced factor matrix indicated a relatively good model fit with 32% of nonredundant residuals having a value greater than .05. Cronbach’s alpha for the 8 item GMX scale was .911 indicating the scale has good internal consistency.

Table 7.5 *Descriptive Statistics, Communalities and Factor Loadings for the One-Factor Model of Group-Member Exchange*

Item	Coworkers in my work team....	Loadings			
		<i>M</i>	<i>SD</i>	<i>F<sub>1</sub></i>	<i>h<sup>2</sup></i>
1	Let each other know where they stand	3.60	1.01	<b>.661</b>	.44
2	Understand each other’s job problems and needs	3.88	.96	<b>.783</b>	.61
3	Respect each other’s capabilities	3.88	1.10	<b>.852</b>	.73
4	Help each other solve work related problems	4.11	.89	<b>.863</b>	.75
5	“Bail each other out” at their own expense when someone really needs it	3.49	1.07	<b>.580</b>	.34
6	Have confidence in each other’s decisions such that they defend them to others	3.72	.99	<b>.714</b>	.51
7	Have effective working relationships with each other	4.02	.87	<b>.774</b>	.60
8	Show a genuine concern for each other’s welfare	4.10	.96	<b>.814</b>	.66
Percentage of Variance:				57.88%	

### 7.4.2. Leader–Member Exchange (LMX)

Examination of the eight LMX items also resulted in a one-factor solution. For replication purposes an additional EFA analysis was conducted on the seven original GSC items (Graen & Scandura, 1987; Graen & Uhl-Bien, 1995) also using the modified group referent. This analysis also resulted in a one-factor solution. Table 7.6 shows that communality values for the 7 and 8-item versions were all adequate. In total 63.13% of total variability in the 8-item scale was explained by the one-factor model. The reproduced factor matrices indicated a relatively good model fit with 32% nonredundant residuals having a value greater than .05 in the 8-item version and 28% in the original 7-item version.

Table 7.6 *Descriptive Statistics, Communalities and Factor Loadings for the One-Factor Model of Leader-Member Exchange*

Item	My direct supervisor...	Loadings					
		<i>M</i>	<i>SD</i>	<i>F</i> <sub>8item</sub>	<i>h</i> <sup>2</sup>	<i>F</i> <sub>original</sub>	<i>h</i> <sup>2</sup>
1	Lets all members of the team know where they stand	3.90	1.14	<b>.756</b>	.57	<b>.758</b>	.57
2	Understands our teams job problems and needs	3.90	.99	<b>.790</b>	.63	<b>.792</b>	.63
3	Recognises the potential of all employees in our work group	3.74	1.09	<b>.814</b>	.66	<b>.823</b>	.68
4	Use their available power to solve our work related problems	3.94	.99	<b>.765</b>	.59	<b>.780</b>	.61
5	Would "bail out" team members at his/her own expense if they really need it	3.40	1.18	<b>.704</b>	.50	<b>.695</b>	.48
6	Makes decisions that team members would defend and justify to other workers	3.72	1.03	<b>.824</b>	.68	<b>.819</b>	.67
7	Has effective working relationships with employees in our work group	3.93	1.06	<b>.861</b>	.74	<b>.849</b>	.72
8	Has a genuine concern for the welfare of employees in our work-group	4.02	1.09	<b>.830</b>	.69		
Percentage of Variance:				63.13%		62.31%	

A high degree of internal consistency was observed for both the modified 8-item LMX scale ( $\alpha=.93$ ) and the original 7-item scale ( $\alpha=.92$ ). Results indicate that the inclusion of Item 8, dealing with workers' perceptions of the genuine concern held for them by their immediate supervisors, fitted well within the existing factor structure of the LMX scale and did not compromise the psychometric properties of the instrument. For all subsequent analyses the LMX 8-item version will be utilised.

### 7.4.3. Manager–Member Exchange (MMX)

As with results for the two previous social exchange measures, analysis of the 8-item MMX resulted in a one-factor solution (see Table 7.7). In total 71.88% of total variability was explained by the one-factor model with all items exhibiting strong factor loadings and high communality values. The reproduced factor matrix indicated a relative good model fit with 17% of nonredundant residuals having a value greater than 0.05. Cronbach's alpha for the 8-item MMX scale was .953.

Table 7.7 *Descriptive Statistics, Communalities and Factor Loadings for the One-Factor Model of Manager-Member Exchange*

Item	Top management in this department/site...	Loadings			
		<i>M</i>	<i>SD</i>	<i>F<sub>1</sub></i>	<i>h<sup>2</sup></i>
1	Are honest and "up front" in their dealings with employees	3.46	1.28	<b>.853</b>	.73
2	Understand employees' job problems and needs	3.26	1.26	<b>.869</b>	.76
3	Recognise the contributions of employees	3.42	1.23	<b>.837</b>	.70
4	Can be trusted to do what is best for employees	3.31	1.24	<b>.874</b>	.76
5	Are understanding when employees make honest mistakes	3.69	1.11	<b>.778</b>	.61
6	Make decisions that employees feel confident to defend to other workers	3.40	1.12	<b>.880</b>	.77
7	Have effective working relationships with employees	3.44	1.25	<b>.834</b>	.69
8	Show genuine concern for the welfare of employees	3.68	1.24	<b>.853</b>	.73
Percentage of Variance:				71.88%	

#### 7.4.4. Summary

Factor validation results for the social exchange variables indicate that all three scales conform to one-factor structures with sound psychometric properties.

#### 7.5. Confirmation of Factor Structures

Having completed the initial examination of factor structures using individual-level data from the first randomly selected subsample, the next phase of my research seeks to further establish the construct distinction between scales and subscales to be used in the explanatory models. Two forms of CFA were utilised: item and scale level analyses. All item level CFAs were conducted using the second random split sample ( $n=180$ ). Scale based CFAs were conducted on the full front-line worker sample ( $N=319$ ). Maximum likelihood estimation was applied in all models. A summary of scale treatment is provided in Table 7.8.

Table 7.8 *Summary of Item and Scale-level Confirmatory Factor Analyses*

Unit of Analysis	Target Agent	Instrument			
Item $n=180$	<b>Worker</b>	ISB-WA			
		ISB-WP			
	<b>Coworker</b>		GSC-CA GSC-CP GMX		
	<b>Supervisor</b>			GSC-S LMX	
	<b>Manager</b>				OSC-M MMX
Scale $N=319$	<b>Worker-</b>	ISB-WA	GSC-CA		
	<b>Coworker</b>	ISB-WP	GSC-CP		
	<b>Coworker-</b>		GSC-CA		
	<b>Supervisor-</b>		GSC-CP	GSC-S	
	<b>Manager</b>		GMX	LMX	OSC-M MMX

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-WA= Individual Safety Behaviours- Workers Active; ISB-WP= Individual Safety Behaviours- Workers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

First, item-level CFAs were undertaken to examine the discriminant validity of the active and proactive factor structures previously identified for the ISB-W and GSC-C scales. Second, a scale level CFA was conducted to determine the discriminant validity of the ISB-W and GSC-C. Item-level CFAs were also used to examine workers' capacity to discriminate between safety climate and social exchange items within each of the organisational hierarchical work domains. The final section presents the results of scale-based CFAs conducted to investigate the nature of higher order structures in the scales across hierarchical levels of the organisation.

In all CFA testing the hypothesised models were compared for fit against the theoretical models for the null hypothesis (Independence) and the single-factor model (Sobel & Bohrnstedt, 1985). To comply with recommendations regarding the evaluation of nested models (Bentler & Bonnett, 1980; Hair et al., 2006; Kline, 2005), multiple fit indices used in my study include: chi-square ( $\chi^2$ ), the comparative fit index (CFI), normed fit index (NFI), the standardised root mean square residual (SRMR), and the root mean square error of approximation (RMSEA).

While Bentler and Bonnett (1980) recognize that the chi-square statistic is sensitive to sample size and therefore should not be relied upon as a sole indicator of fit, its utility in evaluating comparative fit of nested models is supported (Thompson, 2008). Cut-off criteria for fit statistics can vary, however CFI and NFI values greater than .95 are generally considered to represent acceptable fit (Bentler & Bonnett). Hu and Bentler (1999) recommend SRMR values be less than or equal to 0.08, while Kline (2005) indicates that SRMR values less than .10 are acceptable. For the RMSEA index, values less than 0.05 (Steiger, 1989) or 0.06 (Hu & Bentler) have been associated with good fitting models, with RMSEA values greater than 0.10 indicating relatively poor fit (Kline, 2005). Ninety percent confidence intervals for RMSEA are also reported in all subsequent analyses.

#### **7.5.1. Subscale Distinction ISB-W Active and Proactive - Item CFA**

To further test hypothesis one, a CFA was performed on the 12 items retained for the ISB-W scale to examine if the factor structure of individual safety behaviours would be best represented by a correlated two-factor structure representing active and

proactive safety behaviours when tested against single and uncorrelated two factor models. Inspection of multivariate outliers within the subsample indicated no problematic cases. Four cases with random missing data in the ISB-W items were removed from the analysis ( $n=176$ ). Assumptions tests for multivariate normality and linearity were undertaken showing only minor deviations in the data.

As shown in Table 7.9, the independence model of uncorrelated items for the ISB-W scale was easily rejected. Assessment of fit indices for both the one-factor and uncorrelated two-factor model also indicated inadequate fit to the data. In contrast, the hypothesised correlated two-factor model was found to fit reasonably well. A series of chi-square difference tests added further support for the utility of the correlated two-factor model above the one-factor or uncorrelated two-factor solutions.

Table 7.9 *Fit and Model Differences tests for Models of ISB-W*

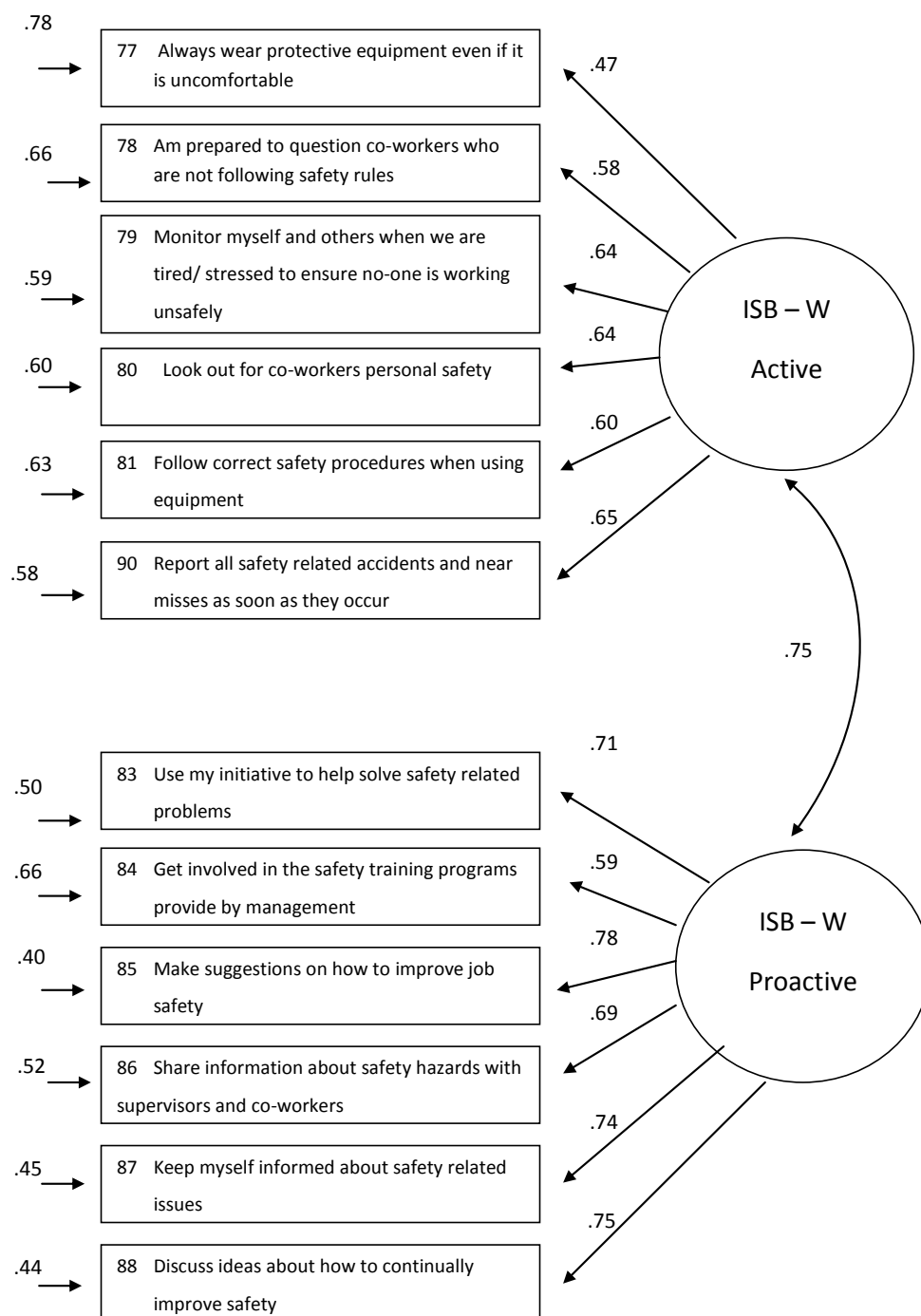
Model	$\chi^2$	<i>df</i>	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1. Independence	1721.7***	66	--	--	--	--
2. One-factor	190.14***	54	.93	.90	.08	.12 (.10, .14)
3. Two Factor Uncorr	199.73***	54	.91	.89	.23	.11 (.09, .13)
4. Two Factor Correlated	120.75***	53	.96	.93	.06	.08 (.06, .10)
Difference ( $\Delta\chi^2$ ) #4 -#1	1600.95***	13				
Difference ( $\Delta\chi^2$ ) #4 -#2	69.39***	1				
Difference ( $\Delta\chi^2$ ) #4 -#3	78.98***	1				

*Note.*  $n=176$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

While post hoc Lagrange multiplier tests indicated further model modification could be made linking Item 77 to the Proactive factor and Item 85 to the Active factor,



improvements to overall model fit statistics were not substantial and therefore the modification was not made. The final correlated two-factor model, including significant standardised coefficients, is presented in Figure 7.1. These results replicate the loadings observed on the EFA and add further support to Hypothesis 1.



*Figure 7.1.* Final correlated two-factor CFA model of active and proactive individual safety behaviours with significant coefficients in standardised form.

Note ISB-WA= Individual Safety Behaviours- Workers Active; ISB-WP= Individual Safety Behaviours- Workers Proactive

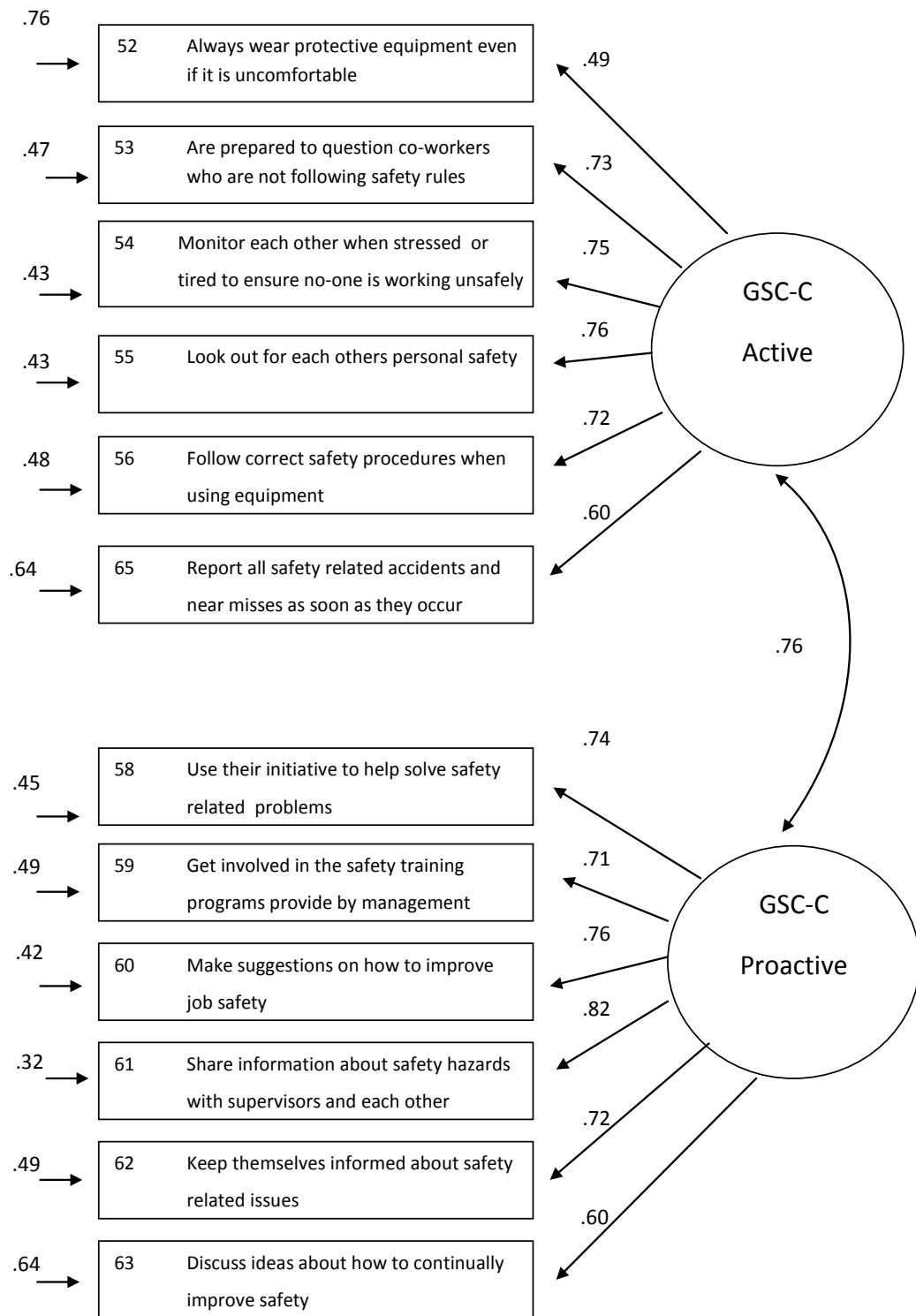
### 7.5.2. Subscale Distinction GSC-C Active and Proactive - Item CFA

The next CFA was performed on the 12 items retained for the GSC-W scale to validate the correlated two-factor structure proposed in Hypothesis 2. No multivariate outliers within the subsample were indicated however six cases with missing data were removed from the analysis ( $n=174$ ). The independence model of uncorrelated items for the GSC-C scale was easily rejected while assessment of fit indices for both the one-factor model and uncorrelated two-factor model indicated that these models did not provided an adequate fit to the data (see Table 7.10). The hypothesised correlated two-factor model provided a good fit and is presented in Figure 7.2. These results add support to Hypothesis 2.

Table 7.10 *Fit and Model Differences Tests for Models of GSC-C*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1.Independence	2352.09***	66	--	--	--	--
2.One-factor	212.31***	54	.93	.91	.08	.14 (.12, .16)
3.Two Factor Uncorr	222.99***	54	.93	.91	.27	.12 (.10, .14)
4.Two Factor Correlated	125.03***	53	.97	.95	.05	.08 (.06, .10)
Difference ( $\Delta\chi^2$ ) #4-#1	2227.06***	13				
Difference ( $\Delta\chi^2$ ) #4-#2	87.28***	1				
Difference ( $\Delta\chi^2$ ) #4-#3	97.96***	1				

Note.  $n=174$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation  
 $p<.05$ , \*\*  $p<.01$ , \*\*\*  $p<.001$



*Figure 7.2* Final correlated two-factor CFA model of active and proactive GSC - Coworkers with significant coefficients in standardised form.

Note: GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive

### 7.5.3. Construct Distinction: ISB-W and GSC-C Scale CFA

Hypothesis 3 proposed that workers will differentiate between measures of coworker commitment to safety, (as indexed by GSC-C) and their personal commitment to safety (ISB-W). To clarify the construct distinction between group-level safety climate and individual safety behaviours, a scale- based CFA was conducted. Having created average scale scores for the Active and Proactive safety subscales of both the ISB-W and GSC-C, inspection of distributions and both univariate and multivariate outliers were undertaken on the CFA random split subsample.

Ten cases with missing data in either the ISB-W or GSC-C subscales were removed from the analysis ( $n=171$ ). A small number of potential univariate outliers (9 cases) representing respondents with low scores on the subscales were identified. These cases were retained as they were considered meaningful to the interpretation and context of the analysis. Univariate distribution patterns for three of the four subscales showed slight negative skew and kurtosis. As indicated in Table 7.11 only ISB-WP deviated from this trend, being negatively skewed but with a positive kurtosis value. Graphs of individual-level scale distributions are provided in Appendix E.

Table 7.11 *Means, Standard Deviations, Alpha and Zero-Order Correlations for ISB-W and GSC-C Scales in the CFA Sub-Sample*

Variable	Mean	SD	Skew	Kurtosis	$\alpha$	1	2	3
1 ISB-WA	4.19	0.59	-.58	-.27	.75			
2 ISB-WP	4.04	0.70	-.83	.69	.85	.60**		
3 GSC-CA	3.85	0.71	-.33	-.35	.82	.52**	.40**	
4 GSC-CP	3.89	0.70	-.38	-.26	.88	.41**	.50**	.62**

*Note.*  $n=171$ ; \* $p < .01$ , \*\*  $p < .001$ ;  $\alpha$ = Cronbach's Alpha reliability; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-WA= Individual Safety Behaviours- Workers Active; ISB-WP= Individual Safety Behaviours- Workers Proactive.

Only one multivariate outlier cases was identified (Mahalanobis  $>18.46$ ).

Investigation of this case indicated that the worker in question was generally very negative in his responses about coworkers active and proactive safety actions. While workers were also negative towards their own performance of proactive safety

behaviours they responded more positively in regard to active (compliance) behaviours. Analysis was conducted both with and without this outlier case and as no substantial difference in results was observed the outlier was retained. Assumption tests for multivariate normality and linearity were undertaken showing only minor deviations.

The hypothesised correlated two-factor model was compared against the independence model, a single model, and uncorrelated two-factor model. During initial processing of the models a problem was encountered when running the uncorrelated two-factor model. The problem concerned the Theta-Delta matrix not being positive definite and resulted in the generation of large negative error terms. As the advised course of action (removing iteration restrictions) was not successful in fixing the problem, an alternative approach was taken. This involved calculating reliabilities of the subscales (see Table F1) and including the appropriate derived term ( $1-\alpha$ ) in the analysis as error variances. For consistency this inclusion of error terms was made for all models. Comparisons of the parameters generated when models were initially run with the error terms freed to vary and then subsequently imposed, indicated that parameter estimates were generally consistent across procedures and fit statistics slightly more conservative in the solutions with modelled error.

Model fit statistics and chi-square difference tests are displayed in Table 7.12. The independence model, one-factor model and uncorrelated two-factor model all provided a poor fit. While the hypothesised correlated two-factor model (Model 4) provided a better fit to the data, several key fit indices fell just outside recommended limits. Inspection of the Lagrange multiplier test indicated that the inclusion of an error covariance between ISB-WA and GSC-CA would further improve model fit. A post hoc modification was performed and the resultant model (Model 5) proved to be a good fit to the data. A series of chi-square difference tests supported the correlated two-factor model with error covariance, above alternate solutions. While improving model fit, the addition of the error covariance between the two Active safety subscales resulted in little change to the parameter estimates generated for both the hypothesised and final models. The final model is presented in Figure 7.3.

Table 7.12 *Fit and Model Difference Tests for ISB-W and GSC-C Models*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1.Independence	270.29***	6	--	--	--	--
2.One-factor	84.82***	6	.70	.69	.12	.34 (.29, .39)
3.Two Factor Uncorr	88.75***	6	.69	.67	.29	.26 (.21, .31)
4.Two Factor Correlated	27.99***	5	.91	.90	.07	.15 (.09, .21)
5.Mod Two Factor Corr	13.44 **	4	.96	.95	.06	.11 (.05, .19)
Difference ( $\Delta\chi^2$ ) #5 -2	71.38***	2				
Difference ( $\Delta\chi^2$ ) #5-4	14.55***	1				

Note.  $n=174$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation: Mod =Modified; . \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

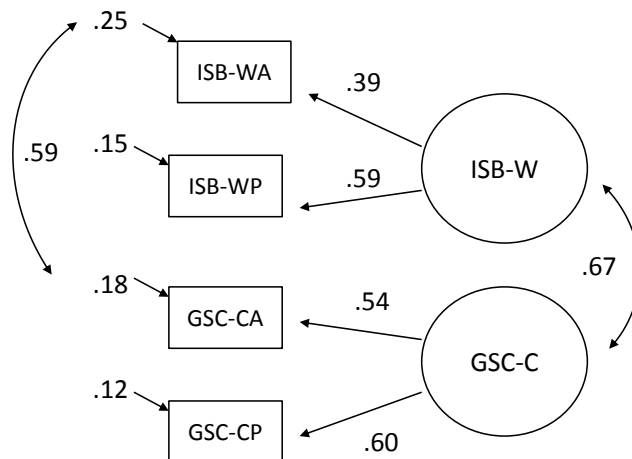


Figure 7.3. Final correlated two-factor model of active and proactive ISB-W and GSC-C with significant coefficients in standardised form.

Note: GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-WA= Individual Safety Behaviours- Workers Active; ISB-WP= Individual Safety Behaviours- Workers Proactive

While a strong correlation exists between individual safety behaviours and coworker behaviours the improved fit of the two-factor model with correlated error terms compared to the single-factor model supports the discriminant validity of the ISB-W and GSC-C scales. In combination these results support Hypotheses 3.

#### **7.5.4. Climate Construct Distinction: Item Level CFA**

To establish the construct distinction between safety climate and social exchange measures proposed in Hypothesis 6, item-based confirmatory factor analysis was first performed on the safety climate and social exchange scales within each work-level of the organisational. Scale-level CFA was then conducted to assess the higher order nature of the constructs across hierarchical levels. The first analysis undertaken determined the capacity for respondents to distinguish between coworkers' commitment to safety (as indexed by GSC-CA and GSC-CP), and the quality of social exchanges occurring amongst team members (GMX). The second analysis assessed respondents' capacity to make distinctions between supervisor commitment to safety (as indexed by GSC-S) and the quality of their supervisors' social exchanges with team members (LMX). The third analysis, focused on the organisational level, examining the distinction between workers' perceptions of their managers' commitment to safety (OSC-M) and the perceived quality of managements' social exchanges (MMX) with workers.

To optimise power in the analysis the decision was made to select the eight strongest loading items identified in earlier exploratory and confirmatory factor analysis to represent each safety climate scale. For group-level coworker safety climate the four strongest loading items from each of the active and proactive scales were used. For the social exchange scales the seven strongest items were selected. This involved dropping the item relating to coworkers or supervisors "bailing out" team members at their own expense.

This series of separate CFAs was again conducted on the second random split subsample. Cases with missing data for all items in the relevant scales were removed for each analysis resulting in final samples for coworker, supervisor and management

scales of 174, 177 and 180 respectively. Inspection of outliers within the subsample indicated no problematic cases. Assumptions tests for multivariate normality and linearity were undertaken showing only minor deviations in each of the data sets.

#### 7.5.4.1. GSC-C and GMX

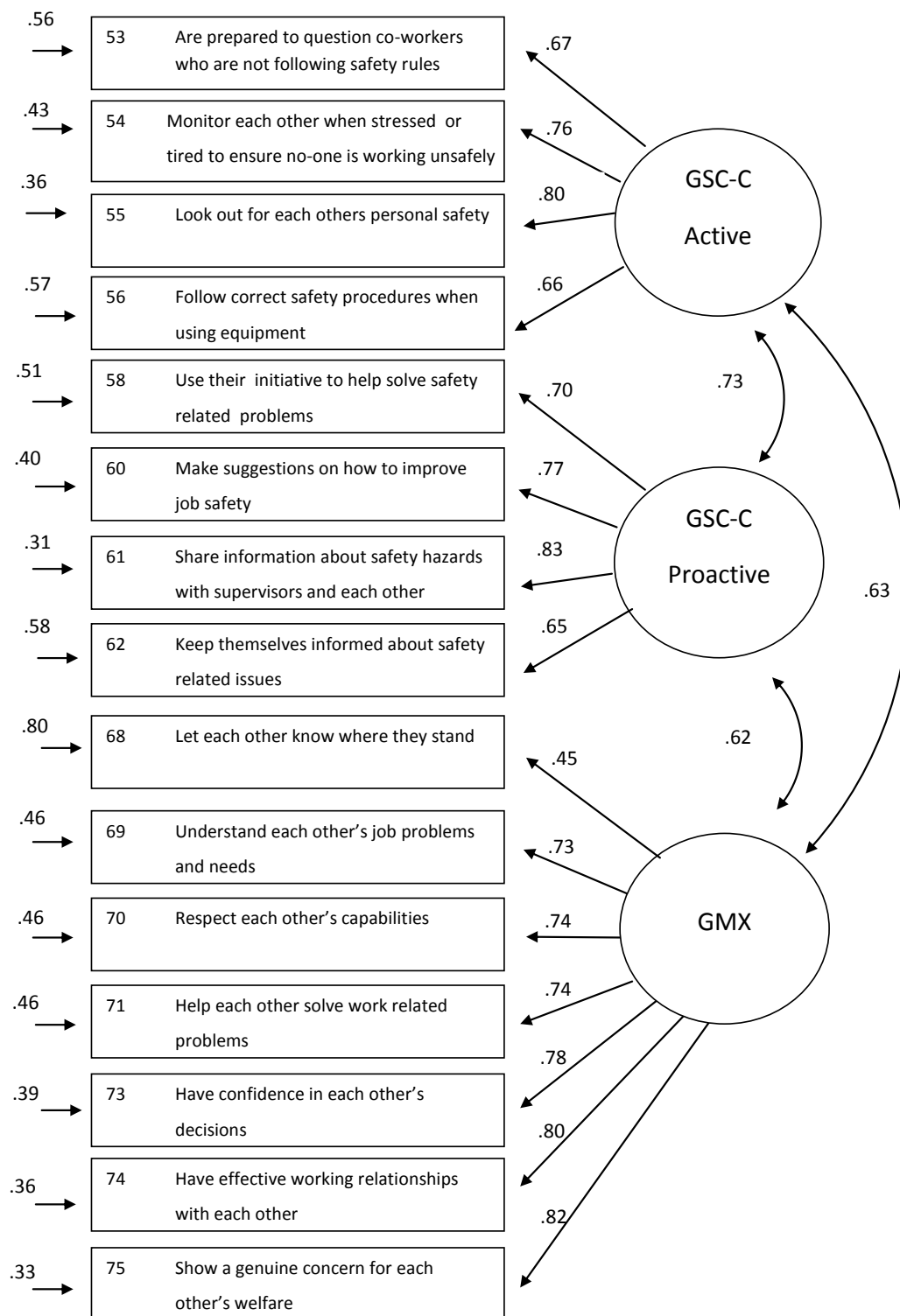
As indicated in Table 7.13 the theoretical models were compared against the correlated two-factor model uncorrelated three-factor model and the hypothesised correlated three-factor model. The final correlated three-factor model for GSC-CA, GSC-CP and GMX with significant standardised coefficients is presented in Figure 7.4. The independence model of uncorrelated items was easily rejected, as was the one-factor model. Assessment of fit indices for the alternative models also indicated that these did not provide the best possible fit to the data.

Table 7.13 *Fit and Model Differences Tests for CFA of Group-level Safety Climate-Coworker and Group Member Social Exchange*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	< .08	< .10
1.Independence	3185.40***	105	-	-	-	-
2.One-factor	443.46***	90	.89	.86	.10	.18 (.16,.19)
3.Two Factor Correlated	264.23***	89	.94	.92	.07	.11 (.10,.13)
4.Three Factor Uncorrelated	358.16***	90	.91	.89	.27	.13 (.12,.15)
5.Three Factor Correlated	201.46***	87	.96	.94	.06	.09 (.07,.10)
Difference ( $\Delta\chi^2$ ) #5 -#2	242***	3				
Difference ( $\Delta\chi^2$ ) #5 -#3	62.77***	2				
Difference ( $\Delta\chi^2$ ) #5-#4	156.7***	3				

Note.  $n=174$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$





*Figure 7.4* Final correlated three-factor model of GMX, active GSC-C and proactive GSC-C with significant coefficients in standardised form.

Note: GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; GMX=Group Member Exchange

The hypothesised correlated three-factor model provided a good fit to the data, with the all fit indices except the NFI falling within recommended limits. The chi-square difference tests again supported the correlated three-factor model above alternate factor solutions. The superior fit of the three-factor correlated model and pattern of factor correlations support Hypothesis 7 that employees discriminate between safety-specific behaviours of coworkers and the quality of informal workplace social exchanges occurring within their teams.

#### 7.5.4.2. GSC-S and LMX

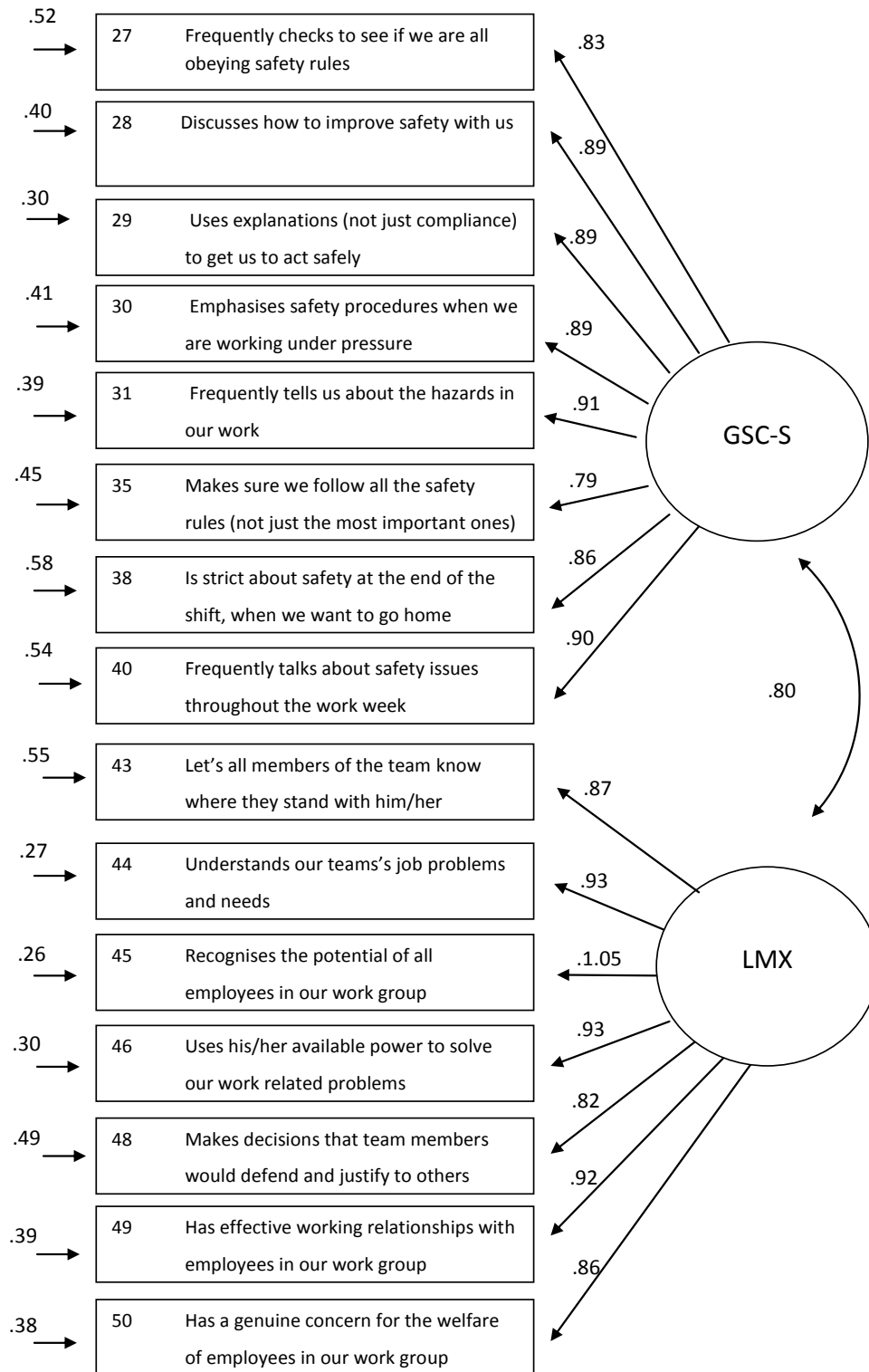
To further establish the discriminant validity of the LMX and GSC-S scales the theoretical independence model was tested against a single factor, uncorrelated two-factor model and the hypothesised correlated two-factor model. Full fit statistics are provided in Table 7.14 and the final model for GSC-S and LMX is presented in Figure 7.4.

Table 7.14 *Fit and Model Differences Tests for CFA of Group-level Safety Climate-Supervisor and Leader- Member Social Exchange*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	< .08	< .10
1.Independence	6525.63***	105	-	-	-	-
2.One-factor	431.52***	90	.95	.93	.07	.19 (.17,.20)
3.Two Factor Uncorr	345.44***	90	.96	.95	.37	.11 (.09,.12)
4.Two Factor Correlated	201.53***	89	.98	.97	.04	.08 (.07,.10)
Difference ( $\Delta\chi^2$ ) #4 -#2	229.99***	1				
Difference ( $\Delta\chi^2$ ) #4 -#3	143.91***	1				

*Note.* N=177;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation .

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$



*Figure 7.4.* Final correlated two-factor model of LMX and GSC-C with significant coefficients in standardised form.

Note: GSC-S= Group Safety Climate- Supervisor; LMX=Leader Member Exchange

The independence model of uncorrelated items was easily rejected. While the one-factor and uncorrelated two-factor solutions were acceptable, results of the chi-square difference tests supported the hypothesised model above alternate factor solutions. The correlated two-factor model provided the best fit to the data, with the fit indices within recommended limits for all bar the RMSEA.

#### 7.5.4.3. *OSC-M and MMX*

To establish whether workers could discriminate between the MMX and OSC-M scale items the hypothesised correlated two-factor model was tested against the theoretical models and uncorrelated two-factor model. The final, highly correlated two-factor model for OSC-M and MMX including significant standardised coefficients is presented in Figure 7.5 and assessment of fit provided in Table 7.15.

Table 7.15 *Fit and Model Differences Tests for Organisation-level Safety Climate-Managers and Manager- Member Social Exchange*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1.Independence	6038.91***	105	-	-	-	-
2.One-factor	312.29***	90	.96	.95	.06	.13 (.12,.15)
3.Two Factor Uncorr	403.55***	90	.95	.93	.36	.12 (.11,.14)
4.Two Factor Correlated	222.11***	89	.98	.96	.05	.10 (.08,.11)
Difference ( $\Delta\chi^2$ ) #4 -#2	90.18***	1				
Difference ( $\Delta\chi^2$ ) #4-#3	181.44***	1				

Note.  $n=180$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation .

\* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

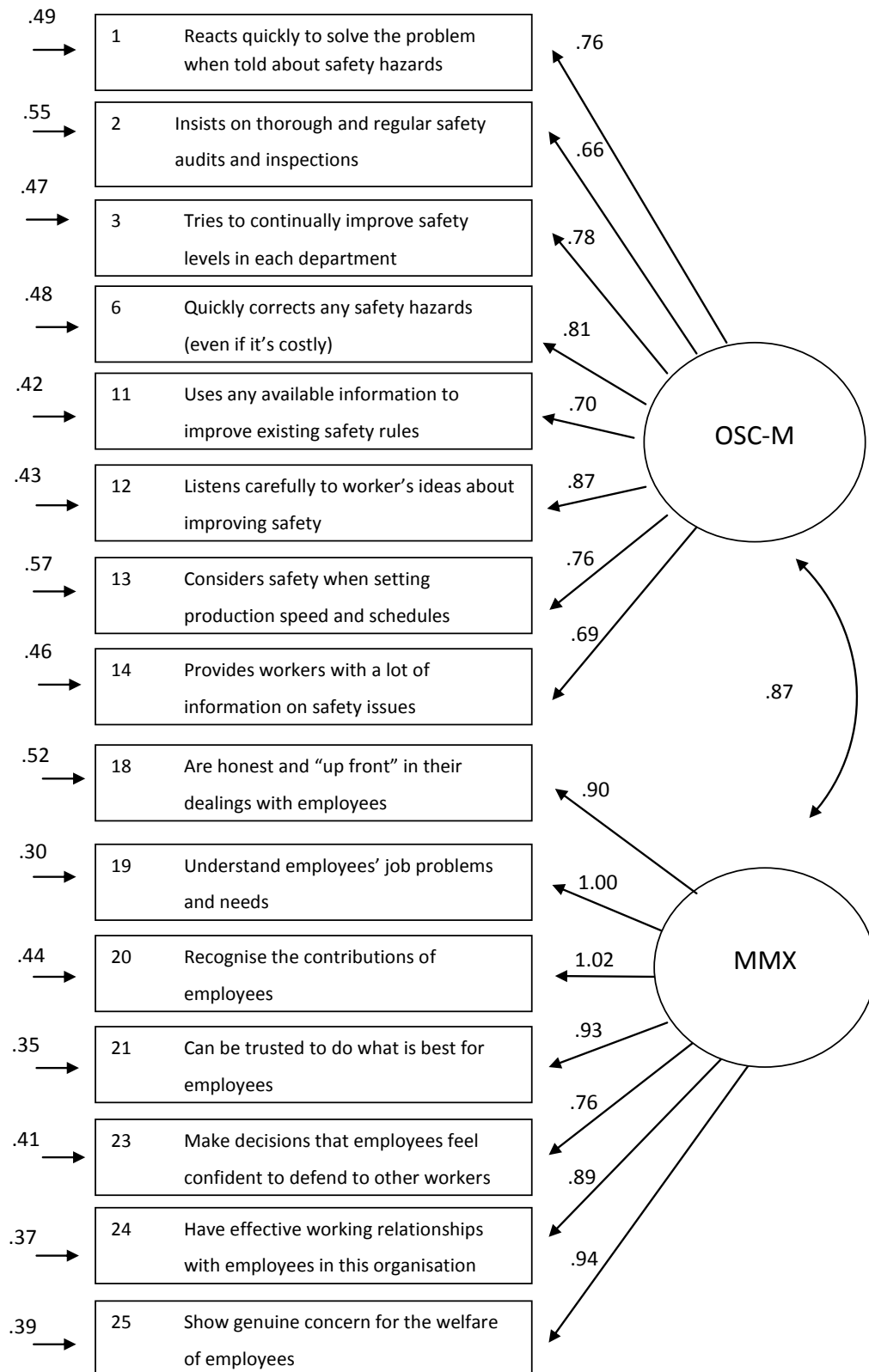


Figure 7.5. Final correlated two-factor model of MMX and OSC-M with significant coefficients in standardised form.

Note: OSC-M= Organisational Safety Climate- Manager; MMX=Manager Member Exchange

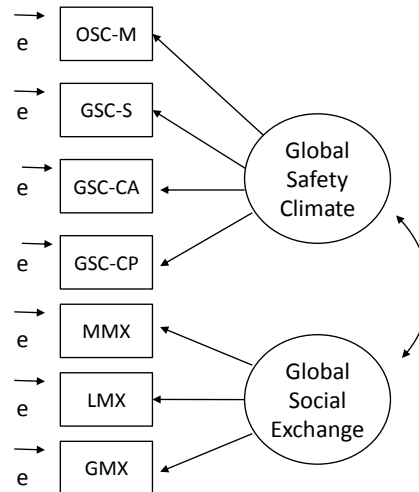
The independence model of uncorrelated items was again easily rejected. Assessment of the fit indices showed that the single factor model provided a relatively good fit to the data. However, the hypothesised correlated two-factor model was found to be the best fitting solution with all estimates of fit falling within recommended limits.

The above results support the construct distinctions between safety climate and social exchange measures within each organisational level proposed in Hypothesis 8. The initial item-level CFA for coworker scales indicated the covariation between the two safety climate subscales was stronger than that found for either scale with GMX. For the supervisor and management analysis, strong covariations between the safety climate and social exchange scales were noted. To further assess the nature of construct convergence across the organisational hierarchy, confirmatory factor analysis was also conducted on the first-order safety climate and social exchange scales.

#### **7.5.5. Climate Construct Distinction: Higher Order Scale CFA**

In this section a series of theoretical models were developed to test Hypothesis 7 that front-line workers will discriminate between safety climate factors and social exchange constructs within corresponding hierarchical levels. As a precursor to structural modelling to be undertaken in Chapters 8 and 9, this scale-level model testing was conducted on the combined workers' sample. Social exchange and safety climate scales were constructed by averaging the items identified in the exploratory and confirmatory factor analysis.

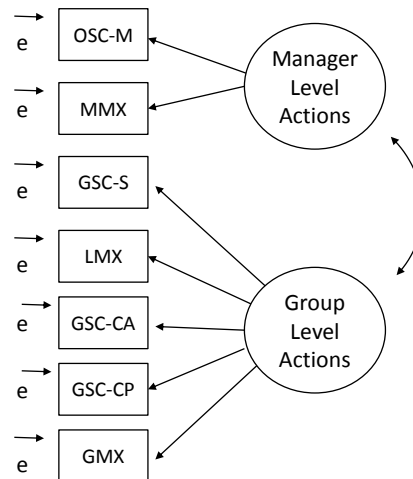
The first hypothesised model, illustrated in Figure 7.6, examines the alignment of workers' perceptions within construct domains by proposing a two-factor model of global safety climate and social exchange. This model offers support for the use of global safety climate and social exchange measures across organisational levels in predictive models. In contrast, the alternative models (see Figures 7.7 & 7.8) depict a stronger alignment of workers' perceptions within organisational levels than within construct domains.



*Figure 7.6.* Two-factor model of global safety climate and social exchange.

OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactice; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

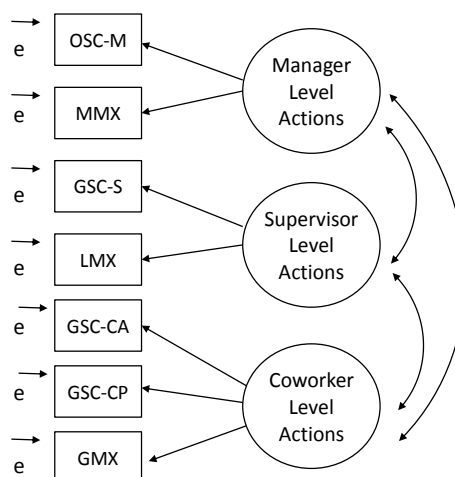
In line with Zohar and Luria's (2005) recognition of the importance of supervisor behaviours in the development of group-level climate, the alternative model represents a two-factor model of organisation and group-level actions in which supervisor and coworker safety commitment and social exchange are closely aligned.



*Figure 7.7.* Two-factor model of organisation-level safety climate and social exchange.

OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactice; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

The third model further stratifies the hierarchy of workers' perceptions to clearly distinguish between workers' perceptions of management, supervisor and coworker actions. A stronger correspondence of workers' perceptions within hierarchical levels of the organisation than within construct domains would provide support for the use of first-order work-level models of safety climate and social exchange variables in predictive models.



*Figure 7.8.* Three-factor model of organisation-level safety climate and social exchange.

OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

In the full sample, 21 cases (6%) had missing data for one or more scales. Only cases with valid data on all safety climate and social exchange scales were included in the analysis ( $N=319$ ). Data inspection indicated that all scales were slightly negatively skewed (see Appendix E). The few univariate outliers identified represented respondents with more extreme negative views of the safety climate and social exchanges operating within the work environment, their data was retained in the analysis. Table 7.16 shows the descriptive statistics, scale reliabilities and correlations for the safety climate and social exchange scales. Model fit statistics and chi-square difference tests are displayed in Table 7.17.



Table 7.16 Means, Standard Deviations and Zero-Order Correlations for Safety Climate and Social Exchange Scales.

Variable	Mean	SD	Items	$\alpha$	1	2	3	4	5	6
1 OSC-M	3.79	0.78	17	.95						
2 MMX	3.46	0.98	8	.94	.83**					
3 GSC-S	3.78	0.82	17	.96	.65**	.64**				
4 LMX	3.80	0.90	8	.93	.48**	.56**	.78**			
5 GSC-CA	3.82	0.82	6	.88	.49**	.50**	.52**	.36**		
6 GSC-CP	3.84	0.77	6	.90	.53**	.54**	.57**	.41**	.70**	
7 GMX	3.80	0.73	8	.90	.31**	.37**	.30**	.33**	.59**	.56*

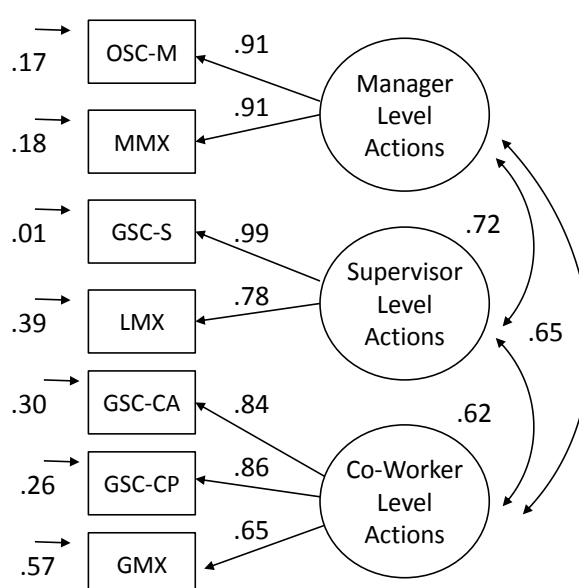
Note. N=319;  $\alpha$  = Cronbach's Alpha; \* $p < .05$ , \*\* $p < .01$ , Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

Table 7.17 Assessment of Fit and Model Differences for CFA of Safety Climate and Social Exchange Scales

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1.Independence	1968.40***	21	-	-	-	-
2.One-factor	394.40***	14	.80	.80	.10	.29 (.27,.32)
3.Two Factor Global Corr	390.91***	13	.81	.80	.10	.29 (.27,.32)
4.Two Factor Level Corr	281.28***	13	.86	.86	.09	.27 (.24,.29)
5.Three Factor Level Corr	65.67***	11	.97	.97	.03	.12 (.09,.15)
Difference ( $\Delta\chi^2$ ) #5-#3	325.73***	2				
Difference ( $\Delta\chi^2$ ) #5-#4	215.61***	2				
Difference ( $\Delta\chi^2$ ) #3-#2	3.49	1				

Note. N=319;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation  
\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

The independence model, one-factor model and correlated two-factor global model provided poor fit. The two models proposing stronger links within organisational levels than within construct domains showed an improvement in fit. When organisational levels were fully stratified, the fit statistics for the three-factor correlated model were substantially improved. The superior fit of the three-factor model compared to both the two-factor models is also shown by the significant chi square difference tests undertaken. The final correlated three-factor model for OSC-M, MMX, GSC-S, LMX, GSC-CA, GSC-CP and GMX, including significant standardised coefficients, is presented in Figure 7.9.



*Figure 7.9.* Standardised coefficients for the three-factor model of organisation-level safety climate and social exchange.

OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

The high zero-order correlations and pattern of loadings indicate that a greater degree of construct convergence between social exchange and safety climate is found for the more distal management-level actions than for group-level supervisor or coworker behaviours. That is, in support of Hypothesis 7, front-line workers find it more difficult to distinguish between management commitment to safety and social exchanges with employees in their work area than they do when rating either their supervisor or fellow coworkers. Contrary to expectation, the association between the

two group-level climate dimensions (supervisors and coworkers) was shown to be weaker than the relationship between management and supervisor-level higher order factors.

#### **7.5.6. Summary**

When considered in combination with the results of the item-based CFA reported in Section 7.3 and both the zero-order correlations and the pattern of factor correlations between scales described above, overall my results indicate that there is a stronger correspondence of workers' perceptions of organisational agent's actions within workplace hierarchical levels than within construct domains. Whereas front-line workers can distinguish between safety climate and social exchange variables for specific organisational referents, it appears that the degree of construct distinction diminishes as organisational distance between the respondent and target agents increases. The fully stratified work-level model provided a superior fit compared to the global construct domain model, offering support for the use of first-order safety climate and social exchange variables in predictive models. Support was found for Hypothesis 7 in that front-line workers were found to discriminate between first-order safety climate factors representing management, supervisor and coworker commitment to safety and social exchange constructs within corresponding hierarchical work-level domains. Constructs representing supervisor and coworker safety climate and social exchanges did not converge at the group-level, but rather retained a further level of distinction.

#### **7.6. Safety Climate Level and Strength**

In this section of the individual-level scale validation results my intention is to present the reader with a brief description of the safety climate profiles found in the participant organisations. These organisational profiles index both safety climate level and strength and are used to assess Hypothesis 8. Previously, Zohar and Luria (2005) have used mean scores to represent climate level and standard deviation scores as an index of climate strength. Climate variability is gauged by determining group or organisation-level differences in climate level (as was discussed in section 2.7.1). While climate levels form the basic unit of analysis in the majority of extant safety climate research (and in this thesis), recognising and assessing the shared

nature of perceptions implicit in the definition of climate scales is also considered an important issue (Luria, 2008).

In this section therefore, analyses are conducted to test the hypothesis that front-line workers will discriminate between safety climate factors and individual safety behaviours by comparing climate level and variability of scales across the organisational sample. As proposed in Hypothesis 3, individual workers are expected to rate their own levels of safety performance in a more positive light compared to their perceptions of normative safety behaviours exhibited by workers in their teams. Furthermore, it is hypothesised that the level of agreement between workers found when assessing their coworkers' safety behaviours (GSC-C) should be weaker than the level of agreement observed for workers assessing their own behaviours. Hypothesis 9 proposed that workers will differentiate between measures of management, supervisor and coworker safety climate such that average scores (climate level) will be highest for ratings at the respondents' work-level and diminish with increased organisational distance. It is also proposed that less response variability will be found when workers' complete rating scales within their own work-level than when they rate the safety behaviours of more distal organisational agents.

In line with Zohar and Luria's (2005) conventions for deriving climate level and strength, mean and standard deviation scores were calculated for the active and proactive subscales of both the ISB-W and GSC-C. Climate level and strength were also derived for OSC-M and GSC-S scales. The total sample ( $N=319$ ) was used for this set of analyses. Aggregated results are reported for organisations with more than 10 valid responses from front-line employees ( $n=6$ ).

#### **7.6.1. ISB-W and GSC-C Scales**

Summary statistics and contrasts for the Active and Proactive subscales of individual and coworkers safety behaviours are included in Tables 7.18 and 7.19 respectively. To further investigate the nature and consistency of observed trends, results for each of the participant organisations on both Active and Proactive subscales are also described.

When assessed across the overall front-line sample, workers rated their own safety behaviours in a more positive light than that of their coworkers. Paired samples *t*-tests indicated that this trend held for both Active safety practices, ( $M_{\text{ISB-WA}} = 4.19$ ;  $M_{\text{GSC-CA}} = 3.82$ ) and Proactive safety subscales, ( $M_{\text{ISB-WA}} = 4.06$ ;  $M_{\text{GSC-CA}} = 3.85$ ). In support of Hypothesis 3 the level of agreement amongst workers was also shown to be stronger for both the ISB-W subscales ( $SD_{\text{Active}} = 0.67$ ;  $SD_{\text{Proactive}} = 0.72$ ) than for the GSC-C subscales ( $SD_{\text{Active}} = 0.82$ ;  $SD_{\text{Proactive}} = 0.77$ ).

### Active Subscales

On average, workers rated their own active safety behaviours 0.36 scale points higher than their coworkers, representing a medium effect (Cohen, 1988). When aggregated to the organisational level the scores for safety climate levels as indexed by the GSC-CA<sub>ORG</sub> scale were marginally lower than for the ISB-WA<sub>ORG</sub>. A series of paired *t*-tests were conducted to test if the trend was consistent across organisations. To reduce type I errors a strict Bonferroni correction was made ( $\alpha=.008$ ). The results are presented in Table 7.18. For the Active safety subscales differences between individual and coworker behaviours were statistically significant in four organisations. The small sample sizes (resulting in a lack of power in the analysis) may have contributed to the nonsignificant results for Organisations 2 and 4.

Table 7.18. Means, Standard Deviations and Contrast Statistics for ISB-W and GSC-C Active Subscales

Variable	N	ISB-WA		GSC-CA		<i>t</i>	$M_{\text{diff}}$	95% CI		<i>d</i>
		Mean	SD	Mean	SD					
Org 1	72	4.27	0.68	3.84	0.97	5.43*	0.43	0.27	0.59	0.52
Org 2	30	4.07	0.64	3.84	0.61	2.04	0.23	-0.01	0.47	0.37
Org 3	39	4.08	0.75	3.74	0.84	3.48*	0.34	0.14	0.54	0.43
Org 4	16	4.57	0.43	4.48	0.48	1.50	0.09	-0.39	0.22	0.20
Org 5	29	4.29	0.53	3.82	0.60	4.83*	0.47	0.27	0.67	0.83
Org 6	116	4.13	0.69	3.74	0.83	6.32*	.039	0.27	0.51	0.51
Total	319	4.19	0.68	3.82	0.82	10.27*	0.37	0.29	0.43	0.50

*Note.* Total = Includes all valid individual cases from the total sample; \* $p < .008$ ; CI=confidence interval -lower limit & upper limit; *d*=Cohen's *d* GSC-CA= Group Safety Climate- Coworkers Active; ISB-WA= Individual Safety Behaviours- Workers Active; Org=Organisation

Level of agreement at an organisational level for the ISB-WA and GSC-CA scales was generally stronger for the self-report version of the scales compared to the rating of coworkers, with only one organisation (Org 2) showing a reversal of this trend. Standard deviation scores for the ISB-WA ranged from 0.43 to 0.75 while climate strength for the GSC-CA scale showed greater variability across organisations, ranging from 0.48 to 0.97.

### *Proactive Subscales*

As illustrated in Table 7.19, for Proactive safety behaviours, individual self- ratings were 0.21 scale points higher than ratings made of coworkers within their teams.

Table 7.19 Means, Standard Deviations and Contrast Statistics for ISB-W and GSC-C Proactive Subscales.

Variable	N	ISB-WP		GSC-CP		<i>t</i>	<i>M diff</i>	95% CI		<i>d</i>
		Mean	SD	Mean	SD					
Org 1	72	4.09	0.80	3.81	0.82	3.61*	0.28	0.13	0.45	0.35
Org 2	30	3.97	0.71	3.83	0.60	1.27	0.14	-0.08	0.35	0.21
Org 3	39	3.89	0.82	3.78	0.86	1.09	0.11	-0.10	0.33	0.13
Org 4	16	4.34	0.59	4.39	0.54	-0.38	-0.05	-0.28	0.19	0.09
Org 5	29	4.19	0.63	3.90	0.67	2.33	0.29	0.04	0.56	0.45
Org 6	116	4.07	0.66	3.81	0.76	3.91*	0.26	0.13	0.39	0.37
Total	319	4.06	0.72	3.85	0.77	5.67*	0.21	0.14	0.29	0.29

*Note.* Total = Includes all valid individual cases from the front-line sample. \* $p < .008$ ; CI=confidence interval -lower limit & upper limit:  $d$ =Cohen's  $d$ ; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-WP= Individual Safety Behaviours- Workers Proactive; Org=Organisation

Whereas this difference was also statistically significant the effect size is considered small. Mean difference scores between ISB-WP<sub>ORG</sub> and GSC-CP<sub>ORG</sub> ranged from 0.04 scale to 0.30. Results for Organisation 4 went against the general trend of individual safety behaviours being rated more positively than coworker behaviours. Only two organisations showed statistically significant differences between ISB-WP<sub>ORG</sub> and GSC-CP<sub>ORG</sub> scores, however these effects were small. Level of agreement was generally stronger for the self-report ISB-WP scale compared to the

rating of coworkers GSC-CP scale (Organisations 2 and 4 showed a reversal of this trend).

### 7.6.2. GSC-S and OSC-M Scales

As show in Table 7.20, results for the OSC-M and GSC-S scales indicated that front-line employees generally view their managers' and supervisors' commitment to safety in a positive light. The indicators of climate strength for the management and supervisor climate scales were generally consistent with the degree of variability observed for the group-level coworker climate scales and again showed slightly greater variance than that observed for either of the individual safety behaviour scales.

For the combined sample, repeated measures comparisons showed that individual workers' consistently rated their own safety behaviours higher than ratings for all safety climate subscales with slightly larger differences emerging for the Active subscale. The above results offer some support to the proposal that systematic biases may be observed in the pattern of workers' responses to safety climate measures based on organisational distance of the focal referent from the respondent.

Table 7.20 *Means and Standard Deviations for Climate scales.*

Variable	N	OSC-M		GSC-S		GSC-CA		GSC-CP	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Org 1	72	3.86	0.73	3.86	0.80	3.84	0.97	3.81	0.82
Org 2	30	3.50	0.70	3.75	0.63	3.84	0.61	3.83	0.60
Org 3	39	3.73	0.68	3.65	0.79	3.74	0.84	3.78	0.86
Org 4	16	4.45	0.49	4.23	0.88	4.48	0.48	4.39	0.54
Org 5	29	3.75	0.69	3.75	0.81	3.82	0.60	3.90	0.67
Org 6	116	3.78	0.86	3.73	0.86	3.74	0.83	3.81	0.76
Total Sample	<b>319</b>	<b>3.79</b>	<b>0.78</b>	<b>3.78</b>	<b>0.82</b>	<b>3.82</b>	<b>0.82</b>	<b>3.85</b>	<b>0.77</b>

*Note.* Total Sample= Includes valid cases from organisations not reported; OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; Org = Organisation

However when comparisons between all safety climate scales were undertaken (rather than comparing against individual self-ratings), no statistical support was

found for Hypothesis 8. That is, ratings of safety climate scales were not found to be significantly higher at the respondent's work-level or diminish with increased organisational distance. This overall result was not consistent across organisations with three of the participant companies showing significant differences between management safety climate and the active dimension of coworker safety climate (Org 2, 5 & 6). When analysed at the organisation-level only Organisation 2 produced significant results in the pattern proposed in Hypothesis 9.

### 7.7. Organisation Climate Profiles and Variability

When aggregated to the organisational level, a clearer understanding of the different climate profiles of each organisation may be obtained by plotting climate levels against climate strength. A composite profile of the four safety climate scales for each organisation is provided in Figure 7.10.

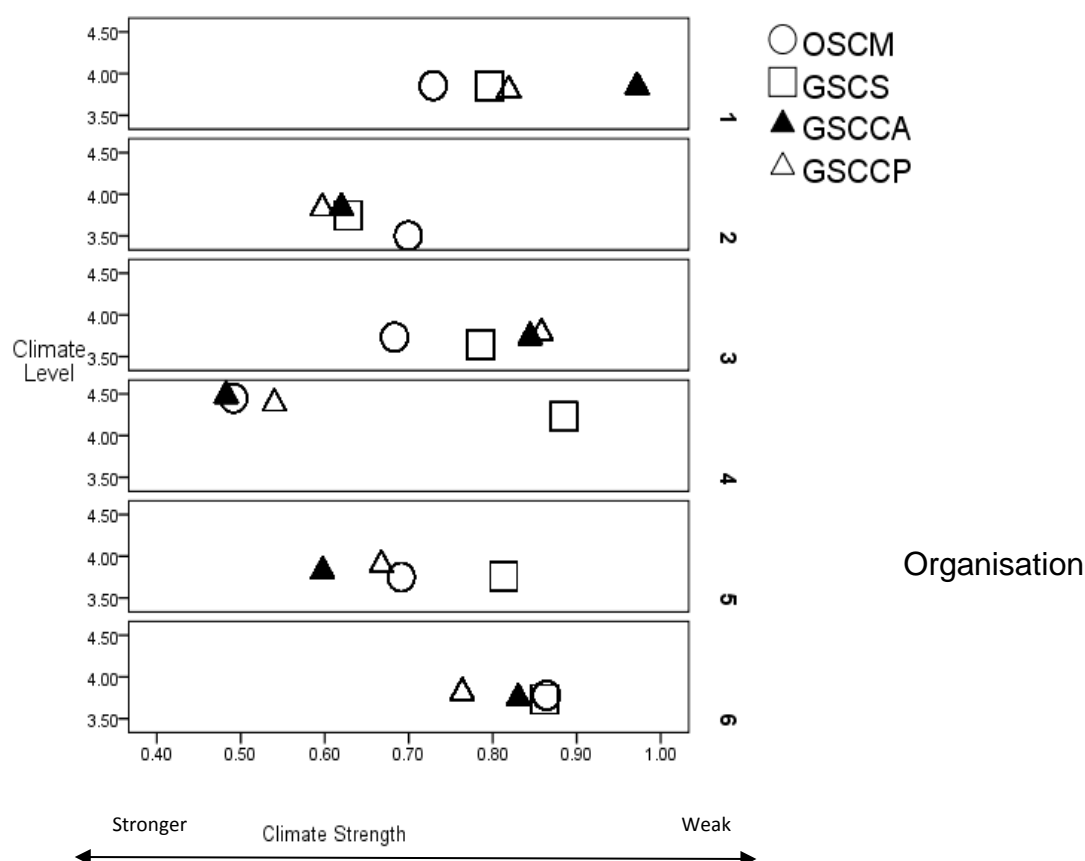


Figure 7.10. Organisation profiles representing climate level and strength of safety climate subscales.

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers



As standard deviation scores are used to index climate strength, smaller deviation scores represent stronger organisational climates and relatively larger scores weaker climates. Of particular interest is the unique pattern of relative climate level and strength observed within and between each organisation. When considered in combination with CFA findings reported previously, these profiles show that employees distinguish between safety climate dimensions targeting specific organisational referents in their distinct organisational context. The diversity of response patterns observed offers support for the utility of the safety climate scales as both a diagnostic tool.

### 7.7.1. Group Safety Climate-Coworkers

Results indicated that homogeneity of variance was adequate within the six organisations for both the active (ICC=.048) and proactive subscales (ICC=.019) of the GSC-C, however there was a slightly less within-group variability in the proactive subscale. As shown in Figure 7.11, when the data was aggregated, Organisation 4 had the highest GSC-CA climate level. Climate strength for the GSC-CA<sub>ORG</sub> was also strongest in Organisation 4 and relatively weakest in Organisation 1. The combination of level and strength for Organisation 4 represents a very strong, positive group safety climate in the coworker active safety practices dimension. Workers in Organisations 2 and 5 were also relatively consistent in their ratings of their coworkers' active safety practices; however they were less positive in their assessments (a strong, moderately positive safety climate).

The test for homogeneity of variance across organisations was significant  $F(5,296)=2.40, p=.037$ . Calculation of the F max ratio ( $F_{max}=4.06$ ) also indicated that the inequality of variances was a potential issue. As such the one-way ANOVA and subsequent post hoc analyses were tested against robust Welch statistics. The ANOVA was statistically significant  $Welch F(5, 85.48) = 5.75, p<.001$ , Cohen's  $f=.20$ , indicating that front-line workers' perceptions of coworkers proactive safety practices varied across organisations. Post hoc analysis using Tamhane  $t$  statistic, showed that no significant differences in climate level were found between organisations 1, 2, 3, 5 and 6. However, Organisation 4 was found to have a significantly higher GSC-CA climate level ( $M=4.48$ ) than the other organisations.

Cohen's  $d$  for the post hoc comparisons ranged from 0.29 to 0.39, amounting to small effects (Cohen 1988).

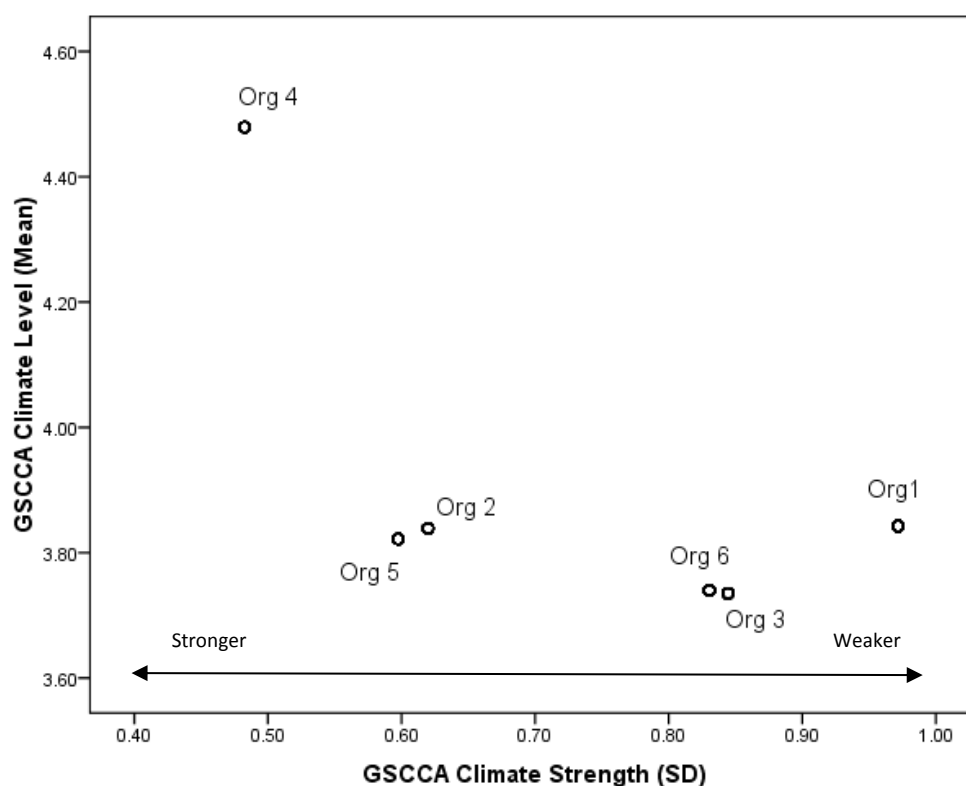


Figure 7.11. Climate level and strength for active GSC-Coworkers.

The safety climate levels for the GSC-CP<sub>ORG</sub> scale ranged from 3.78 in Organisation 3 to 4.39 for Organisation 4 (see Figure 7.12). Climate strength for the GSC-CP<sub>ORG</sub> was again strongest in Organisation 4 ( $SD=0.54$ ) and relatively weakest in Organisation 3 ( $SD=0.86$ ). Testing conducted to assess the homogeneity of variance across groups was not significant  $F(5,296)=1.32$ ,  $p=.255$  indicating that there was no violation of this assumption ( $F_{max}=2.52$ ). The omnibus  $F$  for the overall analysis was not statistically significant  $F(5,296)=1.80$ ,  $p=.112$ , Cohen's  $f=.17$  indicating that front-line workers' perceptions of coworkers' proactive safety behaviours varied little across organisations. Post hoc analyses were not conducted.

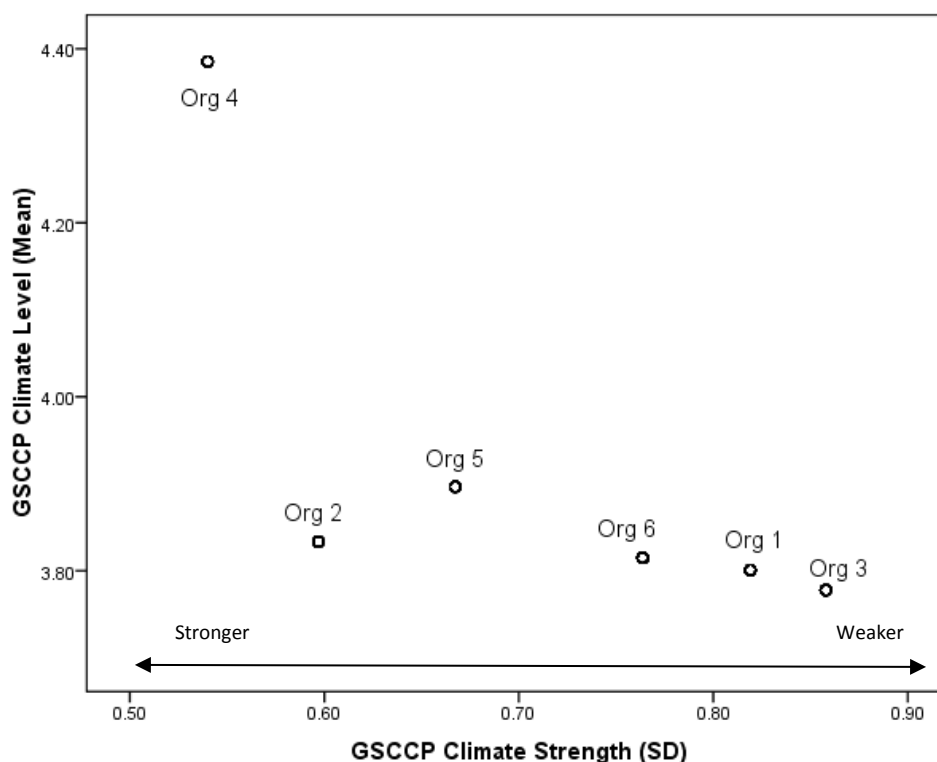


Figure 7.12. Climate level and strength for proactive GSC-Coworkers.

### 7.7.2. Group Safety Climate-Supervisor

Results indicated that homogeneity of variance for the GSC-S scale ( $ICC=.007$ ) was relatively high within the six organisations. The safety climate levels for the GSC- $S_{ORG}$  scale ranged from 3.65 in Organisation 3 to 4.23 for Organisation 4 (see Figure 7.13). Climate strength for the GSC- $S_{ORG}$  was strongest in Organisation 2 ( $SD=0.63$ ) and relatively weakest in Organisation 4 ( $SD=0.88$ ). This combination of measures of level and strength for Organisation 4 represents a relatively weaker, positive organisational safety climate in the supervisor dimension, indicating greater disparity between the supervisor safety practices observed by employees. In contrast, while front-line employees in Organisation 2 are more consistent in rating their perceptions of supervisory commitment, they tend to rate their immediate supervisor's commitment to safety in a less positive light.

The one-way between-groups ANOVA conducted to assess the differences between climate levels for the GSC-S across organisations was not statistically significant  $F(5,296)=1.39, p=.227$ , Cohen's  $f=.15$ . The test for homogeneity of variance across groups was not significant  $F(5,296)=1.16, p=.330$ ;  $F_{max}=1.99$ ; indicating no

violation of this assumption. This result indicates that front-line workers' perceptions of supervisor commitment to safety varied little across organisations.

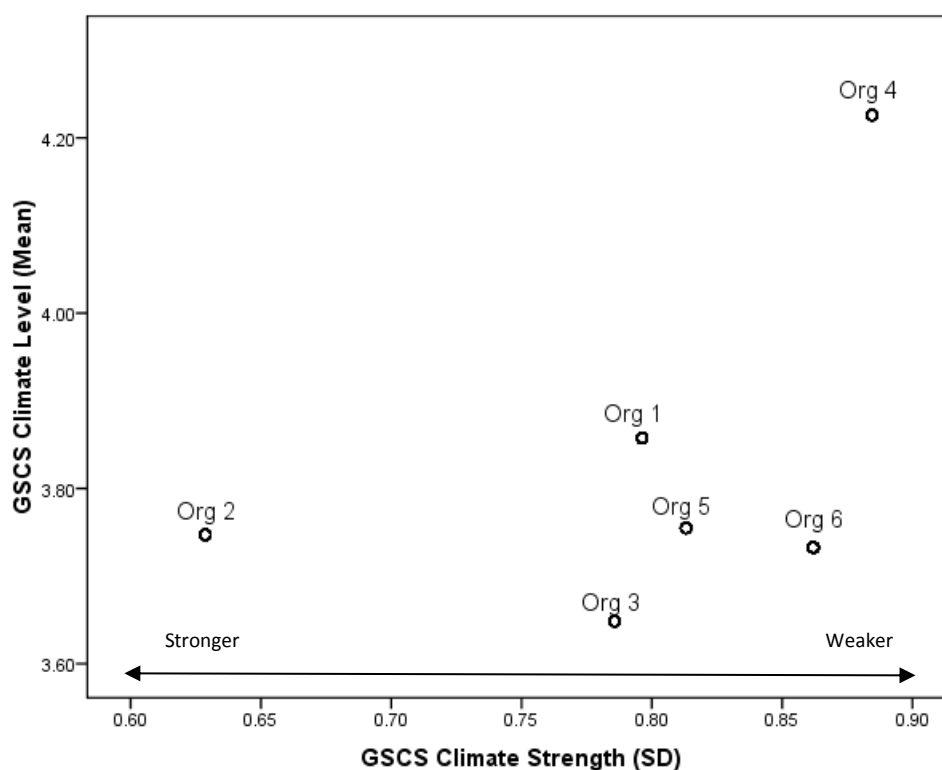


Figure 7.13. Climate level and strength for GSC-Supervisors.

### 7.7.3. Organisational Safety Climate-Management

Results for the OSC-M scale indicated that homogeneity of variance was also low within the six organisations (ICC=0.08). Figure 7.14 illustrates that climate level for the OSC-M<sub>ORG</sub> ranged from a low of 3.50 scale points in Organisation 2 to a high of 4.45 in Organisation 4. Climate strength for the OSC-M<sub>ORG</sub> was also strongest in Organisation 4 and relatively weakest in Organisation 6. This combination of level and strength for Organisation 4 again represents a strong, positive organisational safety climate in the management dimension compared to relatively weaker, positive climates in the remaining organisations.

The test for homogeneity of variance across organisations for the OSC-M<sub>ORG</sub> was not significant  $F(5,296)=1.69, p=.137$ , however calculation of the F max ratio indicated that a moderate problem with inequalities of variance existed ( $F_{max}=3.10$ ). The ANOVA was statistically significant  $Welch F(5, 83.66)=6.51, p<.001$ ,

Cohen's  $f = .24$ , indicating that front-line workers' perceptions of management commitment varied across organisations.

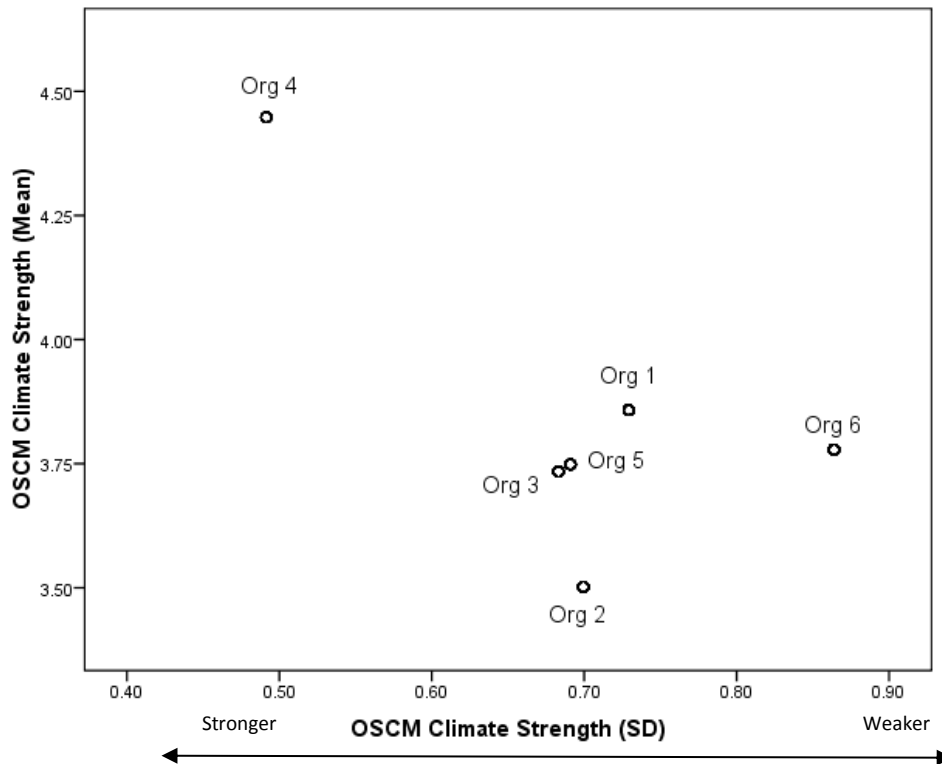


Figure 7.14. Climate level and strength for OSC-Managers.

Post hoc analysis using Tamhane  $t$  statistic, showed that Organisation 4 had a significantly higher OSC-M climate level ( $M = 4.45$ ) than all other organisations. No significant differences in climate level were found between organisations 1, 2, 3, 5 and 6. Cohen's  $d$  for the post hoc comparisons ranged from 0.32 to 0.46, amounting to small to medium effects (Cohen 1988).

#### 7.7.4. Summary

In support of Hypothesis 3, the above results show that workers rated their own safety behaviours in a more positive light than they rated their coworkers. This trend held for both active safety practices and proactive safety subscales in the sample, however more robust effects (medium) were observed for active safety behaviours. When results for individual organisations were considered different patterns emerged. For active safety practices higher and more homogenous ISB-W scores

were found consistently across organisations (only two organisations showed no significant difference between ratings). In contrast, when proactive safety practices were examined at the organisational level, mean difference scores in only two organisations were significant. Also in support of Hypothesis 3, the level of agreement amongst workers was shown to be stronger for both the ISB-W subscales than for the GSC-C subscales.

With regard to Hypothesis 9, while my results did not show strong evidence of systematic work-level related biases in workers' ratings of safety climate levels, differences in response patterns emerged when examined at the organisational level. In particular workers perceived coworker active safety practices to be higher in relation to management safety climate. The series of tests conducted to assess climate variability across organisations also indicated that only workers' ratings of the active dimension of coworker safety climate and management safety climate varied significantly across organisations supporting the collapsing of data across organisations in the structural modelling.

### **7.8. Factor Structures for Aggregated Group Safety Climate**

Results for the exploratory factor analyses conducted on the group-level data are described in the following sections. A total of 112 function work-groups were represented in the total sample, however 32 of these groups consisted of only one respondent. At the expense of power in the analysis, only work-groups with more than one respondent per group were retained in the group-level EFA ( $N=80$ ). While Hofmann et.al (2003) have recommended the retention of work units with three or more members for climate research 9% of teams in my sample were small work-groups of two or three employees and 53% had less than ten members. As previous studies (see Oliver et al., 2006) have used a three member criteria to conduct organisational level analysis the inclusion of functional work-groups with valid data from two group members is considered representative and methodologically sound given the size of identified work-groups in the sample.

The average group size in the reduced data set was 3.85 ( $SD= 2.19$ ) with a range from 2 to 11 workers per group. To assess if the exclusion of groups with only one respondent would bias the results a series of independent t-test were performed on a

random selection of items comparing responses for the retained groups with excluded groups. Results indicated no significant differences across the range of items.

Exploratory factor analysis conducted on the aggregated items of the three social exchange variables reproduced the one-factor structures previously identified in the individual-level analysis and are therefore not reported below.

To justify the aggregation of social exchange and safety climate items to the group-level as recommended in the CSA approach, within-group homogeneity and between-group variance was assessed. Intraclass correlations (*ICC*) and results of one-way analyses of variance using work-group as the independent variable and individual scale scores as the dependent variable are presented in Appendix F. Results indicated sufficiently high ICCs and between-group variability to support aggregation at the item level for the coworker items ( $M=.10$ , Range .02 -.27), supervisor items ( $M=.14$ , Range .08 -.21) and management items ( $M=.16$ , Range .07 - .23). ANOVA results indicated that only six items (five from the coworker item list) did not show statistically significant differences in aggregated responses between work groups. On the basis of both  $ICC_1$  and ANOVA results all items were retained for the group level EFA.

Exploratory factor analysis conducted on the aggregated items of the three social exchange variables reproduced the one-factor structures previously identified in the individual-level analysis and are therefore not repeated below.

### **7.8.1. Coworker Safety Climate (AGSC-C)**

As illustrated in Table 7.21 the factor structure for the AGSC-C scale items when applying the CSA approach resulted in a marginally improved factor solution. While fundamentally replicating the two-factor structure of the individual-level EFA, both the number of items failing to reach the cut off criteria and the number of complex variables identified were reduced using the CSA approach. Also after initial aggregation of items, Communality values were high ( $h^2 > .50$ ) for all items. In total 63.89% of variability was explained by the two-factor model. After varimax rotation, Factor 1 explained 34.55% of total variance and Factor 2, 29.34%. The reproduced factor matrix indicated that 31% of nonredundant residuals had a value

greater than 0.05. The factor transformation matrix also indicated a strong correlation ( $r = .671$ ) between factors.

Table 7.21 *Descriptive Statistics, Communalities and Factor Loadings for the CSA Aggregated Two-Factor Model of Group Safety Climate – Coworker*

Item	Coworkers in my work team...	Loadings				
		<i>M</i>	<i>SD</i>	<i>F<sub>1</sub><sup>a</sup></i>	<i>F<sub>2</sub><sup>b</sup></i>	<i>h<sup>2</sup></i>
1	Refuse to ignore safety rules when work falls behind schedule	3.59	.79	<b>.687</b>	.256	.54
2	Always wear protective equipment even if it is uncomfortable	3.83	.89	<b>.818</b>	.228	.72
3	Are prepared to question coworkers who are not following safety rules	3.81	.71	<b>.717</b>	.323	.62
4	Monitor each other when tired or stressed to ensure no-one is working unsafely	3.51	.73	<b>.666</b>	.449	.65
5	Look out for each other's personal safety	3.99	.79	<b>.768</b>	.399	.75
6	Follow correct safety procedures when using equipment	3.99	.73	<b>.723</b>	.459	.73
7	Co-operate with supervisors to develop better safety practices	3.91	.68	<b>.627</b>	.458	.60
8	Use their initiative to help solve safety-related problems	3.91	.71	<b>.625</b>	.467	.61
9	Get involved in the safety training programs provide by management	3.95	.61	.243	<b>.786</b>	.68
10	Make suggestions on how to improve job safety	3.69	.74	.439	<b>.676</b>	.65
11	Share information about safety hazards with supervisors and each other	3.91	.65	.460	<b>.774</b>	.81
12	Keep themselves informed about safety-related issue	4.05	.57	.284	<b>.572</b>	.41
13	Discuss ideas about how to continually improve safety	3.63	.65	.321	<b>.817</b>	.77
14	Speak highly of those workers who pay special attention to safety	3.33	.69	.532	.465	.50
15	Report all safety-related accidents and near misses as soon as they occur	3.74	.73	<b>.619</b>	.430	.57
16	Express opinions on safety matters even if others disagree	3.83	.69	.468	<b>.635</b>	.62
Percentage of Variance:				34.55%	29.34%	

Note .  $N=80$  <sup>a</sup> = Active Safety Behaviours; <sup>b</sup> = Proactive Safety Behaviours

The nine items loading on Factor 1 represented active safety practices associated with following procedures and monitoring safety compliance (AGSC-CA). The six items loading strongly on Factor 2 (AGSC-CP) reflected proactive safety practices. Item 8, *coworkers use their initiative to help solve safety-related problems* (.625) was the only statement to shift from loading on the proactive safety factor on the individual EFA to the Active safety factor in the CSA factor solution. Internal



consistency of the group-based subscales was again considered good (Cronbach's alpha: Active =0.93, Proactive=0.91).

### 7.8.2. Supervisors Safety Climate (AGSC-S)

Unlike results for the individual-level factor solution, EFA of the CSA aggregated GSC-S items resulted in a two-factor solution. As illustrated in Table 7.22 communality values for the seventeen AGSC-S scale items were high for all but two variables.

Table 7.22 *Descriptive Statistics, Communalities and Factor Loadings for the CSA Aggregated Two-Factor Model of Group Safety Climate – Supervisor*

Item	My direct supervisor...	Loadings				
		<i>M</i>	<i>SD</i>	<i>F</i> <sub>1</sub> <sup>b</sup>	<i>F</i> <sub>2</sub> <sup>a</sup>	<i>h</i> <sup>2</sup>
1	Makes sure we receive all the equipment needed to do the job safely	4.05	.66	<b>.562</b>	.421	.49
2	Checks to see if we are all obeying safety rules	3.73	.72	<b>.668</b>	.499	.69
3	Discusses how to improve safety	3.69	.74	<b>.806</b>	.279	.73
4	Uses explanations (not just compliance) to get us to act safely	3.68	.71	<b>.713</b>	<b>.563</b>	.83
5	Emphasises safety procedures when we are working under pressure	3.67	.67	<b>.768</b>	.428	.77
6	Frequently tells us about the hazards	3.63	.67	<b>.791</b>	.322	.73
7	Refuses to ignore safety rules when work falls behind schedule	3.65	.79	.315	<b>.672</b>	.55
8	Is strict about working safely when we are tired or stressed	3.70	.69	.275	<b>.797</b>	.71
9	Reminds workers who need it to work safely	3.82	.60	.529	.519	.55
10	Makes sure we follow all the safety rules	3.75	.73	.537	<b>.722</b>	.81
11	Insists that we obey safety rules when fixing equipment or machines	3.88	.60	<b>.602</b>	.510	.62
12	Says a "good word" to workers who pay special attention to safety	3.44	.79	<b>.582</b>	<b>.564</b>	.66
13	Is strict about safety at the end of the shift	3.51	.72	.480	<b>.690</b>	.71
14	Spends time helping us learn to see problems before they arise	3.38	.80	.400	<b>.766</b>	.75
15	Frequently talks about safety issues	3.49	.78	<b>.706</b>	.392	.65
16	Insists we wear our protective equipment	4.04	.59	.517	.376	.41
17	Encourages workers to report all safety accidents and near misses	4.20	.57	<b>.583</b>	.303	.43
Percentage of Variance:				34.55%	29.34%	

Note .N=80 <sup>a</sup> = Active Safety Behaviours; <sup>b</sup> = Proactive Safety Behaviours

In total the two-factor model explained 65.24% of total variability. After varimax rotation Factor 1, explained 35.75% of the total variance and Factor 2, 29.49%. The reproduced factor matrix indicated that 23% of nonredundant residuals had a value greater than 0.05. The factor transformation matrix also indicated a strong correlation ( $r = .667$ ) between factors.

The two-factor solution resulted in eight items loading on the first factor and five items on the second. Of the four remaining items, two exhibited factor loadings less than the .55 cut off recommended by Comrey and Lee (1992) and a further two complex variables loaded highly on both factors. Factor 1 (AGSC-SP) represents proactive supervisory practices associated with informing, guiding and providing workers with operational support. Factor 2 (AGSC-SA) represents active supervisory practices with a focus on monitoring and controlling workers to ensure compliance with safety procedures. Cronbach's alpha values for both group-based subscales were again high (Active =0.92, Proactive=0.93).

### 7.8.3. Managers Safety Climate (AOSC-M)

In contrast to the single-factor solution found for OSC-M in the individual- level EFA, when principal axis factoring was conducted on the seventeen aggregated scale items 63.90% of total variability was explained by a two-factor model.

Communalities were high for all variables. Total variance explained after orthogonal rotation was 32.62% for Factor 1 and 31.28% for Factor 2. The two-factor solution resulted in seven items loading on the first factor and nine items on the second. As shown in Table 7.23, only Item 1, referring to top management's capacity to *react quickly to solve problems*, loaded on both factors. However several other items (6, 10, 11, and 16) had cross loadings close to the cut off criteria.

The reproduced factor matrix indicated a good fit for the model (26% of nonredundant residuals had a value greater than 0.05) and the factor transformation matrix indicated a strong correlation ( $R = .699$ ) between factors. Factor 1 (AOSC-MA) represents active management safety practices relating to controlling and monitoring safety standards, while Factor 2 (AOSC-MP) reflects proactive managerial practices associated with promoting the ongoing exchange of safety-related information, improvement of standards and investment in employees.

Cronbach's alpha for both group based management subscales were good (Active =0.92, Proactive=0.94).

Table 7.23 *Descriptive Statistics, Communalities and Factor Loadings for the CSA Aggregated Two-Factor Model of Organisational Safety Climate-Managers*

Item	Top management in this department/site...	Loadings				
		<i>M</i>	<i>SD</i>	<i>F</i> <sub>1</sub> <sup>a</sup>	<i>F</i> <sub>2</sub> <sup>b</sup>	<i>h</i> <sup>2</sup>
1	React quickly to solve the problem	3.80	.71	<b>.574</b>	<b>.558</b>	.64
2	Insist on thorough and regular safety audits	3.84	.70	.487	<b>.623</b>	.63
3	Continually improves safety levels	3.96	.67	.428	<b>.711</b>	.69
4	Provide all the equipment needed	3.89	.76	<b>.651</b>	.333	.53
5	Are strict about working safely when work falls behind schedule	3.56	.79	<b>.841</b>	.347	.83
6	Quickly correct any safety hazards (even if it's costly)	3.483	.72	<b>.680</b>	.549	.77
7	Provide detailed safety reports to workers	4.10	.59	.196	<b>.763</b>	.62
8	Consider a person's safety behaviour when promoting	3.25	.76	<b>.619</b>	.293	.47
9	Require each manager to help improve safety in their department	3.82	.66	<b>.608</b>	.336	.48
10	Invest a lot of time and money in safety training	3.57	.84	.543	<b>.575</b>	.63
11	Use any available information to improve existing safety rules	3.81	.66	.525	<b>.686</b>	.75
12	Listen carefully to workers' ideas about improving safety	3.52	.76	<b>.714</b>	.401	.67
13	Consider safety when setting production speed and schedules	3.51	.75	<b>.747</b>	.365	.69
14	Provide workers with a lot of information on safety issues	3.94	.70	.434	<b>.768</b>	.78
15	Regularly hold safety-awareness events	3.52	.81	.366	<b>.631</b>	.53
16	Give safety personnel the power they need to do their job	3.73	.66	.525	<b>.571</b>	.60
17	Emphasize the importance of reporting all safety accidents and near misses	4.24	.60	.417	<b>.624</b>	.56
Percentage of Variance:				32.62%	31.28%	

Note . *N*=80; <sup>a</sup> = Active Safety Behaviours; <sup>b</sup> = Proactive Safety Behaviours

#### 7.8.4. Summary

Results of exploratory factor analysis of the CSA derived group-level data failed to support a three-factor structure for either the management or supervisor level safety climate scales as had been found in previous studies using individual-level data (see Johnson, 2007; Zohar & Luria, 2005). As the two-factor solutions representing active and proactive safety practices for all three aggregated safety climate scales

exhibited some complex loadings, enforced three-factor solutions were conducted; however this specification resulted in a substantially higher number of complex variables in the rotated solutions and was therefore rejected.

The two-factor solution for management safety climate also corresponds to the factor solution obtained in the leader sample. Consequently, whereas the treatment of the Supervisor and Management safety climate scales as one-dimensional constructs is defensible when conducting individual-level analysis, the CSA approach appears more appropriate for the factor analysis and modelling of climate related constructs at the group-level.

## **7.9. Discussion**

The overall aim of my thesis is to investigate how the relationship between climate for social exchange and employee perceptions of management, supervisor and work-group safety climate, influences individual employees' compliance and proactive safety behaviours and incident/injury rates. The first step in the achievement of this goal was the validation of measures to be used in individual-level predictive models. The focus of this discussion section is therefore to highlight key points of interest that emerged in the validation process. As a starting point, I will first discuss results pertaining to individual workers' safety performance and coworker safety climate. Attention will then shift to the interpretation of results for the validation of the two established supervisor and management safety climate scales and the derived social exchange scales. The discriminant validity of safety climate and social exchange scales will be evaluated. My results for the scale validations will be discussed in relation to the extant literature and implications for the research domain provided.

### **7.9.1. Individual Safety Performance and Coworker Safety Climate**

An important objective in my thesis was the operationalisation of a multilevel safety climate construct that expanded upon Zohar's Organisational Safety Climate Scale (Zohar, 2003) using a level-of -analysis approach to incorporate the active and proactive safety practices of coworkers' at the group-level. The decision to base the coworker safety climate items on Hofmann et al.'s (2003) measure of compliance and participative workers' safety behaviours and Zohar and Luria's (2005) safety climate scales appears justified, with results of the individual-level exploratory and

confirmatory factor analyses supporting the proposed two-factor structure of active and proactive safety practices for both the individual and coworker referent scales. This conceptualisation of coworker group safety climate is consistent with Jiang et al.'s (2010) operationalisation of perceived colleagues' safety knowledge and behaviour, however the expanded two dimensions of the GSC-C scale provides a broader item representation of the safety-specific construct domain.

In the process of scale development particular care was taken to ensure that items represented safety-specific behaviours rather than supportive or internal group process indicators. My review of recent meta-analyses (Beus, Payne, et al., 2010; Christian et al., 2009; Nahrgang et al., 2011) highlighted potential problems with how coworker generic and safety behaviours are often clumped together or used interchangeably with little regard for the specificity of item content. This concern reflects back to the previously described lack of distinctions drawn between foundation and facet-specific climates. As such, I argue that this operationalisation of coworker dimension of safety climate improves upon protocols and measures previously utilised in the literature.

Items in both the individual and coworker scales generally loaded cleanly on the two factors (active compliance safety factors and proactive safety practices) and similarities in complex loading patterns and poor communalities for some items in the exploratory factor analysis were apparent across both scales. The decision to drop items to improve construct discriminant validity resulted in both full scales being reduced to 12 items. Both revised scales exhibit strong psychometric properties, having excellent internal consistency and both face and discriminant validity.

The active dimension of the two worker level scales incorporates typically "within job role" safety expectancies while the proactive dimension incorporates "beyond job role" or safety citizenship expectancies (Hofmann et al., 2003). However, as the focus of safety within an organisation shifts from an emphasis on basic compliance towards prioritising personal ownership of safety as a generic value across all levels of the organisation, proactive behaviours previously considered discretionary are

more likely to be deemed nondiscretionary. This organisation transition may in part account for some of the cross-loading variables encountered in my study.

Furthermore, in differentiating between the psychometric properties of the active and proactive subscales, it appears that the potential for item and scale-level ceiling effects are more likely to impact on individual ratings of active safety behaviours. Support for this is seen in higher mean scores and reduced variability for the individual self-report active items and subscale than for the proactive items and subscale. As ratings for specific indicators, tapping nondiscretionary role expectations, approach the maximum scale limits, reduced response variability may compromise item utility in factor analysis and as individual predictors in explanatory models (Little et al., 1999).

While not considered problematic in my study due to the combining of data from a range of organisations, several of the active items in the individual safety performance scale were very high in several participant organisations. While dropping such items may be justifiable on statistical grounds, their exclusion could potentially compromise the face validity of the scale in practical applications. For example when providing organisations with diagnostic feedback based on safety climate profiles, such items generally represent expected minimal safety standards. As a baseline for safety behavioural audits and feedback the inclusion of such measures therefore enhances the credibility of the individual active safety performance scale.

Confirmatory factor analyses also supported the correlated two-factor solutions proposed in Hypothesis 1 and 2 for both the individual safety behaviours scale and coworker safety climate. While the importance of distinguishing between role specified safety compliance behaviours (active) and participative safety citizenship behaviours (proactive) in measures of individual safety performance has been well established (S. Clarke, 2006), my results add to the extant literature in transferring this practical distinction to coworker practices. By modifying the referent applied, I have shown that scale items can be used to meaningfully assess both the focal individuals' rating of coworker commitment to safety (GSC-C) and self-report ratings of the focal individuals' safety behaviour (ISB-W).

In support of Hypothesis 3 a scale-based confirmatory factor analysis indicated that while a strong positive correlation between the two scales was evident, front-line workers clearly differentiate between the coworker safety climate and their own safety behaviour. In particular, the clear trend for individual workers to rate their own safety behaviours in a more positive light than their fellow coworkers is consistent with self-serving biases typically observed in attribution theory research (Bradley, 1978; DeJoy et al., 2004). As stated in my rationale, the consistency of this trend may be largely due to workers attributing their own *good* safety performance to controllable, stable, internal causal factors; while at the same time attributing any safety deviance or violations to less stable, uncontrollable, external factors, thereby creating a positively biased personal safety schema. In contrast, when rating their colleagues, workers would be more likely to attribute observations of both compliant and aberrant safety practices of their various coworkers to dispositional characteristics (Ross, 1977), resulting in a more diffused assessment of overall safety performance and subsequently greater response variability in coworkers ratings.

As shown in my results the level of agreement observed between workers when assessing their own behaviours exceeded the level of agreement between workers in assessing coworkers' behaviours. That is, the strength of coworker safety climate for the overall sample and at the organisational level was weaker than the variability observed for individual safety performance. Furthermore this trend towards lower ratings with greater response variability was also observed across the remaining management and supervisor safety climate dimensions.

Previously, Pousette et al. (2008) observed higher levels of consensus for safety climate constructs than personal attitude variables. They compared ICCs for individual attitude scales with supervisor and manager safety climate measured at the departmental level in 12 natural social units across four companies. In contrast, my results compared standard deviation scores for individual safety performance and for coworker, supervisor and management-level safety climate aggregated to the organisational level and in the overall sample. Whereas the use of different climate strength indices may have contributed to the differences in results, I believe that

interpreting the apparent differences between individual and climate-based constructs is enhanced by using an attribution theory perspective.

Again the greater degree of variability in the coworker scale compared to individual worker items and scales may be explained by the reduced influence of socially desirable responses when rating coworkers. That is, individual workers are likely to rate their own safety performance in a more positive light and in a more consistent manner across the range of items than their coworkers' behaviour. As safety is generally considered a socially desirable attribute in organisations it is not surprising that the majority of workers would likely believe and report that they *personally do the right thing* but are willing to admit that their coworkers are not as vigilant towards safety. Given the greater potential for positive bias in individual performance scores, I would argue that a more accurate picture of workers' group-level safety performance may be gauged from the ratings of coworker actions than aggregated personal performance scores.

An additional reason for the difference in response patterns between the individual behaviour scale and coworker safety climate may be associated with the use of a group referent. The issue of what constitutes an accurate referent in group-level analysis is a complex issue. Whereas a referent shift from *I* to *coworkers in my team* appears relatively straight forward, it is difficult to determine exactly who and what behaviours workers are including in their assessment of the team. In this instance the three information cues in Kelley's (1973) covariation model of causal attributions (consensus, consistency and distinctiveness) provide a guide for comparative purposes. For example, compared to when respondents are asked to rate themselves, there is a far greater diversity of focal targets when using a group referent (i.e., which workers are included in the subjective assessment or how many workers perform this particular way) which broadly aligns with Kelley's consensus cue. Second, with the group referent there are larger margins for response inconsistency across time (i.e., have identified coworkers acted safely all the time, most of the time or only occasionally). And third, in terms of distinctiveness the group referent gives greater scope for divergence of safety activity across the task domain (i.e., do selected coworkers perform safely on some tasks but not others).



The potential reasons for who or why team members are included or excluded are far ranging and may include in-group/ out- group distinctions, group size, and work area or functional proximity. As the size of work-groups increases the likelihood of workers perceiving greater diversity in their coworkers' safety behaviours would influence the heuristic used to judge group-based responses, which would subsequently result in increased response variability. As such, while obtaining measures of coworker safety practices may benefit from reduced incidence of responses bias due to social desirability, the measure may be subject to reduced reliability linked to greater subjective selection of who is included in the group referent. However, the use of consensus informational cues are also likely to result in the diffusion of small numbers of extremely positive or deviant cases in the work-group (eliminating perceptual outliers), potentially providing a more balanced perspective of the group safety norm.

Therefore, in addition to its primary role in expanding existing safety climate inventories to include the group safety practices of front-line workers, the development of the coworker safety climate scale may provide an alternative and more effective measure of worker safety performance. My results indicate that both the active and proactive coworker subscales are likely to provide valid assessments of workplace safety practices that are less susceptible to self-report bias than individual safety performance scales. This trend has implications for researchers in that the use of coworker information may reduce the potential for ceiling effects in survey data and show increased response variability for predictive models. In practical terms the use of a team member referent in the coworker safety climate scale offers practitioners the scope to obtain group-based safety performance norms from the workers' perspective which can be meaningfully compared against the perceptions of team leaders and managers as illustrated in Figure 6.1. Such triangulation would provide a more accurate representation of group safety norms and offers the scope to investigate perceptual difference in climate perceptions as a focal construct in its own right.

When the coworker scale was reassessed using the CSA approach to aggregation an equivalent two-factor structure was achieved. However the shift to group-level data

resulted in less complex variables in the solution, which in turn led to more items being retained in the scales. In sum, the development of this scale constitutes one of the major contributions of this study to the existing field of knowledge, as it provides an instrument that comprehensively covers an expanded content domain with scope for multiple applications.

### **7.9.2. Supervisor and Management Safety Climate**

The use of Zohar and Luria's (2005) measures of supervisor and management commitment to safety as part of my operationalisation of a work-level safety climate construct, offered the opportunity to ground my thesis within some of the most well established safety climate research. Hypothesis 4 and 5 proposed that the factor structures of the organisation- level management safety climate scale and group-level supervisor safety climate scale would both be best represented by one factor structures when tested against imposed two & three factor models. In support of Hypothesis four and five, when factor structures were examined using individual-level data a one-factor solution was found for both the OSC-M and GSC-S scales. While my validation results failed to support the three-factor structure solutions for both safety climate scales previously found by Zohar and Luria (2005) or for supervisor-level safety climate identified by Johnson (2007), the incongruence of findings may be in some degree linked to sample composition and in the case of Johnson's findings to methodological differences. However, as both of these previous studies identified strong correlations between factors it is plausible to conclude that a one-factor solution may offer a more accurate representation of the two leadership-level safety climate constructs.

The identification of one-factor solutions for both the OSC-M and GSC-S scales in my sample indicates that workers do not clearly distinguish between the various types of management and supervisor safety practices, but may use a general heuristic for gauging their leaders' overall commitment to safety. This finding offers some support for the idea that greater organisational distance between focal targets (leaders) and workers would influence the respondents' capacity to differentiate between active and proactive safety practices represented at that work-level. Given the more proximal relationship between supervisors and workers, if organisational

distance was playing a strong role in perceptual differentiation of content domains, it would be more likely that a two-factor solution would have emerged in the supervisor safety climate scale than in the management scale. However, in terms of both factor structure and climate level there is no evidence to support my hypothesis that workers will show greater capacity to distinguish between active and proactive safety practices in the more proximal group-level supervisor safety climate index or rate supervisors in a more positive light than managers.

An alternate argument that may be forwarded to support workers use of a general heuristics when they are asked to rate organisational level constructs such as management commitment to safety or the quality of social exchanges with management, is the typical application of generic referents such as *management* or *the organisation* in these types of scale. Such nonspecific referents would potentially increase both the range of agents available to respondents when using consensus cues and the range of relevant safety practices considered when using distinctiveness cues during informational processing.

To reduce the potential for focal target ambiguity, Flin (2003) recommended that the pertinent levels of management being investigated are clarified when undertaking safety climate studies. Zohar (2010) has also recognised the need to ensure item content in safety climate scales is work-level specific and not bundled together ad hoc. It could therefore be argued that in reducing the potential for target agent ambiguity and increasing item specificity, the need for respondents to apply broader ranging generic heuristics in their perceptual decision making would also be minimised. Therefore, in line with Flin and Zohar's recommendations, during the development of my questionnaire, I ensured that the management and supervisor referents were clearly specified, that terms to describe supervisors and managers were consistent with use in each sampled organisation, and that item content was relevant to the work-level of interest.

For example, the inclusion of extra items relating to the reporting of safety incidents in both the OSC-M and GSC-S were intended to be work-level specific. That is, in the coworker safety climate scale this item focused on procedural compliance or

performance of the task (*Coworkers report all safety-related accidents and near misses as soon as they occur*); for supervisors the focus was placed on supporting procedures and task performance (*My direct supervisor encourages workers to report all safety accidents and near misses*); and at the Management level the focus was on raising awareness of the importance of procedure (*Top management at this site emphasize the importance of reporting all safety accidents and near misses*).

In particular, attention was paid to ensuring the specific leadership referents applied were relevant in terms of the common usage of leadership positions in each participant organisation (e.g., supervisor = team leader, shift boss, process line manager); consistent across organisations in terms of the internal hierarchical structures; and finally, specific in terms the leader's relationship to the respondent rather than generic. For example, workers were asked about their direct supervisor or top managers rather than supervisors or managers in general across the organisation. Also top level managers in a facility/department/site were the highest level of management in large or multinational participant companies, thereby excluding executive and board level management from this study. Although verbal feedback from participant organisations indicated that workers clearly understood who they were meant to be rating, it is difficult to determine if the use of specific referents in the questionnaire led to any improvement in response outcomes and I cannot discount that their use may have in some way contributed to the different factor structures found in my results.

When the scales were reanalysed using the CSA approach for group-level data, two-factor solutions representing active and proactive safety practices were found for both the manager and supervisor safety climate. This result indicates that when the nonindependence of data within organisations is recognised, and within-group variability is reduced by collapsing data prior to the evaluation of factor structures, different structural pattern may emerge. The identification of group-defined safety climate subscales provides the opportunity to track the differential relationship between active and proactive managerial and supervisory practices with safety outcomes including compliance and participatory safety behaviours in multilevel analysis. This opportunity was not afforded in ILSA approach using scales structures derived using individual-level data.

To summarise, my overall results indicate that while the treatment of the supervisor and management safety climate measures as one-dimensional constructs may be appropriate when conducting individual-level analysis with workers, scales derived using this simple structure may not be applicable when conducting group-level analysis. Furthermore, as the CSA approach to data aggregation has been proposed as the correct methodology to use when dealing with climate-based composite models, the two-factor solutions identified for all three safety climate scales arguably provide the most accurate representation of the construct structures.

### **7.9.3. Climate for Social Exchange and Safety Construct Distinction**

A further objective of my study was to investigate how the quality social exchanges within organisations influence employees' perceptions of safety climate and their safety behaviours. Hypothesis 6 and 7 tested the first step in this process by setting out to determine if front-line workers could discriminate between safety climate and social exchange constructs when tested as both first-order and higher order structures.

In line with the approach taken by Wallace, et al., (2006) and recommendations provided by Zohar (2010) my intention was to operationalise a work-level foundation climate for social exchange by aligning three social exchange indicators with the stratified dimensions of safety climate. To appropriately reflect the emergent properties of collective climate constructs (Chan, 1998; Glick, 1985), a referent shift composition model was applied for the social exchange scales requiring a shift of focus in each of the social exchange scales to the group-level referent rather than on individual-level direct, dyadic exchanges (Molm, 1994) as is more typically used. Overall my results support the construct distinction between safety climate and climate for social exchange measures within each organisational level proposed in Hypothesis 7 a, b and c. It appears that a worker's ability to discriminate between safety-related practices and more general social exchange practices is stronger when rating the activities of proximal organisational agents and reduces as the organisational distance between agents increases.

### **7.9.3.1. *Group-Member Social Exchange***

The development of a work-group focused social exchange scale constitutes one of the key contributions of this thesis. As the scale is broadly based on Seer, et.al's (1995) Team-member exchange, Hypothesis 6 proposed that exploratory factor analysis of the scale would produce a one-factor structure. My results supported this hypothesis and the new scale was found to have good internal consistency. Results for the item level CFA determined that workers could clearly distinguish between coworkers' active and proactive safety practices and the quality of social exchanges occurring amongst team members supporting Hypothesis 7c. Correlations between the active and proactive co-worker safety climate subscales were found to be stronger than correlations found between either active and proactive co-workers safety climate and group member social exchange, supporting Hypothesis 7d . As a potential antecedent of safety climate, my results identified strong correlations between the social exchange and coworker safety climate indicators. However the magnitude of correlations did not indicate that multicollinearity would emerge as a problem in predictive models.

While no safety-related studies have included these constructs as separate entities within their predictive models, the recognition of the discriminant validity of coworker safety climate and social exchange draws attention to the importance of treating team process and safety climate variables as separate entities given the integrated nature of the constructs. This issue reflects the same concerns expressed by Zohar and Luria (2005) regarding the distinction between leadership and safety climate. While past studies and meta-analyses have tended to merge internal group process and coworker safety practices within an overarching domain of coworker social support for safety (Beus, Payne, et al., 2010; Christian et al., 2009; Nahrgang et al., 2011) this practice overlooks the potential value to be gained from separating the various elements of workplace safety context.

### **7.9.3.2. *Leader-Member Exchange***

In support of Hypothesis 6 my scale validation produced results consistent with past studies in finding that LMX was best represented as a one-factor structure with good psychometric properties (Graen & Uhl-Bien, 1995; Hofmann et al., 2003). The inclusion of an extra item assessing a leader's consideration for the welfare of team

members did not compromise the factor structure or internal consistency of the scale. Again, in accordance with Zohar and Luria (2005) recognition of the need to establish the discriminant validity of safety climate and leadership style inventories, results from both item and scale-level confirmatory factor analyses established that workers distinguished between the two supervisor work-level constructs, by basing leadership perceptions on relationship referents and climate perceptions on commitment referents, supporting Hypothesis 7c. Furthermore, the magnitude of the correlation between supervisor social exchange and safety climate indicates that workers find it harder to discriminate between the constructs, potentially using a more general heuristic to this more distal organisational agent than for coworkers.

### **7.9.3.3. *Manager-Member Exchange***

The examination of a social exchange construct at a management/ organisational level in safety climate research has previously been undertaken using measures or derivations of Perceived Organisational Support (POS) (Eisenberger et al., 1986; Hofmann & Morgeson, 1999). However issues with regard to double barrelled items and the use of a potentially ambiguous *organisation* referent led me to derive the Manager-Member exchange scale to provide a more content and referent-specific measure of social exchange at this higher organisational work-level.

Given the simple dimensionality previously found for the POS and LMX scales used as a basis for my operationalisation of the MMX, Hypothesis 6 proposed that the MMX would be best represented by a one-factor structure. My results supported this hypothesis and further indicated that the psychometric properties of the MMX were sound and commensurate with existing POS measures. Again results for both item and scale confirmatory factor analyses supported the discriminant validity of the social exchange and safety climate scales at the management level; supporting Hypothesis 7a.

However, as proposed in Hypothesis 7 e, the exceedingly high correlation between manager-member exchange and management-level safety climate and the relatively good fit of the one-factor model indicate that the distinction between constructs is far less definitive. It appears that when workers appraise the more distal practices of

managers the positive or negative heuristic used may be far more generalised, leading to less variance across their ratings of items.

In sum the validation of the three social exchange scales showed that all scales had a unidimensional structure. Furthermore, it appears that the use of more specific referents in the MMX scale and a referent shift to the group in the LMX did not compromise the psychometric properties of these scales. These changes facilitate the treatment of all three social exchange constructs as dimensions of a foundation climate for social exchange rather than as individual-level measures of dyadic social exchanges. The inclusion of items relating to target organisational agents' concern for the general welfare of employees showed strong correlations with other social exchange items in all three scales and did not compromise the discriminant validity of the social exchange and safety climate scales.

Hypothesis 7e proposed that correlations between safety climate and social exchange constructs within hierarchical levels (i.e. organisation and group levels) would be stronger than those observed within construct domains (i.e. safety climate and climate for social exchange). In terms of scale level confirmatory assessment of factor structures, the content domain model representing separate global climates for safety and social exchange was not supported. The alternate proposal for a two-factor, work-level model separating organisation-level, management practices from the work-group practices of supervisor and coworkers was not supported. Instead the fully stratified three-factor model, based on the separation of constructs into the three hierarchical work-levels represented in the study provided the best fit. Stronger correlations were observed between management and supervisor work-levels in the three-level model than between the group-level scales. One possible reason for this result is the greater degree of specificity in the management-level referent used in the scale. By restricting the management referent to the site/department level, rather than to more distal, top level management at a head office or executive level in the multinational companies involved in this study, the relationship between managers and supervisors was likely to be less diffused. That is, workers appear to be more likely to view their direct supervisor as a part of the overall management team rather than as a member of their functional work team.



Finally, the greater degree of convergence between management and supervisor social exchange and safety climate has both theoretical implications for the modelling of predictive relationships in this thesis and in future research. The investigation of any explanatory model of safety climate that includes the influence of social exchange variables as a foundation climate requires the establishment of discriminant validity between safety climate and social exchange constructs operating at different work-levels within the organisation and the testing of temporal precedence in future studies. The close associations observed between management-level social exchange and safety climate may create collinearity problems. Furthermore, my results indicate a stronger correspondence of workers' perceptions within hierarchical levels of the organisation rather than within construct domains. The finding that employees can distinguish between safety climate and social exchange variables for specific organisational referents, offers support for the use of first-order safety climate and social exchange variables in predictive models.

#### **7.9.4. Organisation Safety Climate Profiles**

A further aim of my research was to present one format option for reporting organisational safety climate profiles based on climate level, strength and variability. The heterogeneous nature of my sample population provides scope to investigate the capacity of the safety climate measure to discern both work-level and organisational differences. As indicated in Nahrgang et al.'s (2011) meta-analysis, patterns of associations between safety-related constructs can vary considerably across industry settings. The variability in safety climate constructs amongst organisations represented in my results provides evidence for situational specificity (Clarke, 2006). However when taking into consideration the aggregation statistics produced at both the organisation (i.e., the for organisation profiles) and group-level (i.e., for the CSA item EFA) it appears that the group is the most appropriate level of aggregation for all climate scales including management-level constructs.

Hypothesis 8 proposed that front-line workers would differentiate between measures of management, supervisor and coworker safety climate such that: (a) average scores (climate level) would be highest for ratings at the respondents' work-level and diminish with increased organisational distance; and (b) the level of agreement

would be strongest for scales targeting the respondents' own work-level (climate strength). When evaluating the overall climate levels based on front-line worker responses and the separate organisational safety climate profiles, it was apparent that self-other biases were more obvious in workers' ratings of managers and supervisors commitment to safety compared to ratings of coworker commitment. A process of biased attributions potentially contributed to workers providing relatively higher ratings of coworker climate measures than for more distal supervisor and managers offering partial support for Hypothesis 8. Partial support was also found for the proposal that less response variability would be found when workers complete rating scales within their own work-level than when they rate the safety behaviours of more distal organisational agents.

#### 7.9.5. Summary

In terms of the theoretical framework of this thesis and broader literature, the inclusion of safety-specific content organised around the practices of agents traversing the organisational hierarchy, acknowledges both the multidimensional and multilevel nature of safety climate. The utilisation of domain-aligned safety content (e.g., communication, rule compliance, monitoring and training), with more clearly defined referents, answers Zohar's (2010) call for the adoption of a level-of-analysis approach in safety climate research. Such an approach offers opportunities for researchers and safety practitioners to track areas of strength and weakness in the chain of safety activity; identify incongruent practices across work-levels; and identify core tensions in safety priorities between organisational agents. Finally, by adopting a multilevel approach to climate research, I was able to describe the organisational-level safety climate of participant companies not only in terms of the orientation (level) of safety climate, as has been done in the majority of safety studies, but also in terms of the within and between-group patterns of variability (Dragoni, 2005) which have attracted far less attention from researchers.

## 8. Explanatory Models- Global Safety Climate

### 8.1. Introduction

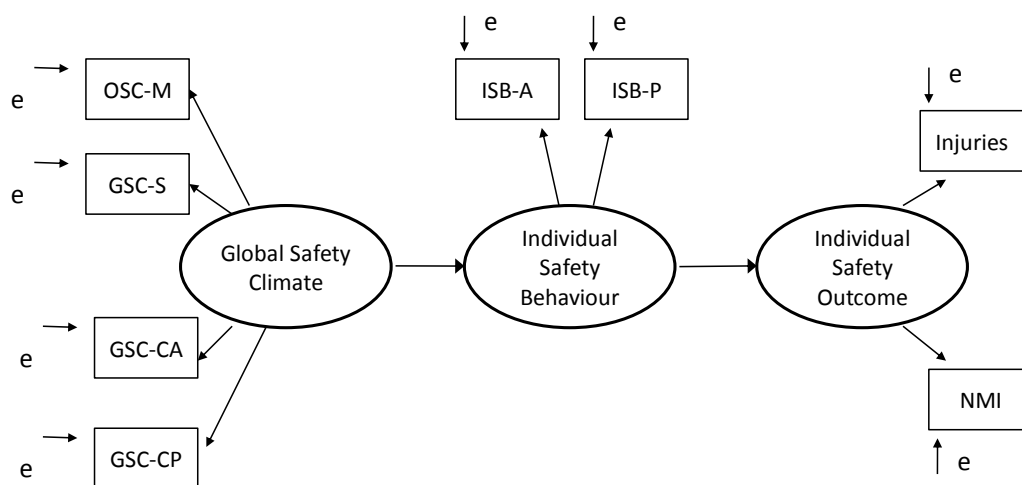
In this chapter I report the results for Hypothesis 10 and 11 examining the link between a global operationalisation of safety climate and individual safety outcomes. A series of structural models are tested to investigate the relationship between global safety climate (a latent variable with work-level dimensions of safety climate as indicators), individual safety performance (a latent variable with both active and proactive safety behaviours as indicators) and individual safety outcomes (a latent variable with injuries and near miss incidents as indicators).

Section 8.2 reports results for the first stage of group-level model testing using the ILSA approach to aggregation. As the ILSA approach simply requires the aggregation of scales based on individual-level factor structures, all variables in the hypothesised models will be identical in structure to those used for individual-level analysis (reported in Appendix E) but will potentially vary in magnitude and variability. This protocol has been the approach typically taken in *organisational* safety climate studies using group-level methodologies. Results for this series of analysis will be interpreted against the relatively few empirical studies that have investigated group-level associations. Section 8.3 reports results for the second stage of group-level model replication based on the CSA approach. This alternative aggregation approach is undertaken to investigate if concerns raised regarding the lack of rigour in multilevel data treatment are warranted. For reference and comparative purposes Appendix E reports results for individual-level data modelling, reproducing the operationalising of *psychological* safety climate as a global construct, as has been most frequently been reported in the literature.

### 8.2. Model Specification

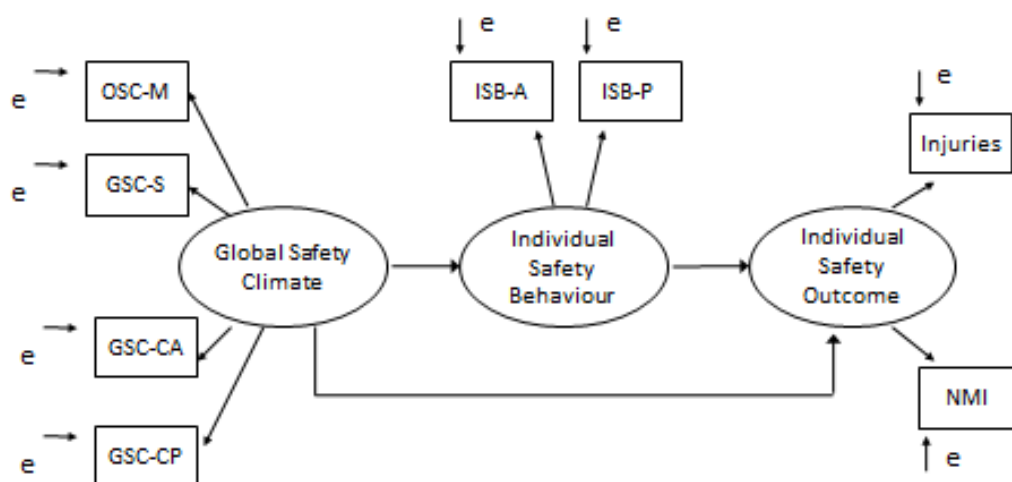
Hypothesis 10 proposed that the influence of global safety climate on self-reported safety outcomes will operate through the individual safety behaviours of workers. Figure 8.1 depicts the hypothesised mediation model. Two alternative models are also tested: the full model, specifying both direct and indirect effects between safety climate and safety outcomes (Figure 8.2); and the direct model in which safety

climate is hypothesised to directly influence both individual safety behaviours and injuries and incidents (Figure 8.3).



*Figure 8.1.* Mediation model of the predictive relationship between global safety climate, individual safety behaviours and safety outcomes.

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-A= Individual Safety Behaviours- Workers Active; ISB-P= Individual Safety Behaviours- Workers Proactive; NMI= Near Miss Incidents



*Figure 8.2.* Full model of the predictive relationship between global safety climate, individual safety behaviours and safety outcomes.

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-A= Individual Safety Behaviours- Workers Active; ISB-P= Individual Safety Behaviours- Workers Proactive; NMI= Near Miss Incidents

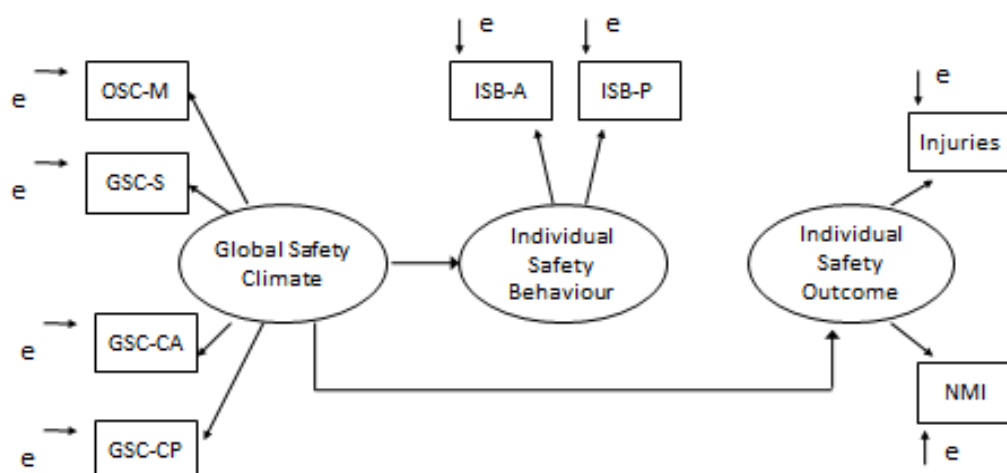


Figure 8.3. Direct model of the predictive relationship between global safety climate, individual safety behaviours and safety outcomes.

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-A= Individual Safety Behaviours- Workers Active; ISB-P= Individual Safety Behaviours- Workers Proactive; NMI= Near Miss Incidents

In all the SEM analyses, maximum likelihood estimation was applied and the hypothesised models were compared for fit against the theoretical model for the null hypothesis (Sobel & Bohrnstedt, 1985). To comply with recommendations regarding the evaluation of nested models (Bentler & Bonnett, 1980; Hair et al., 2006; Kline, 2005) multiple fit indices were used.

### 8.3. ILSA Group-level Analysis

Using the individual-level factor structures identified through the original EFA analysis reported in Chapter 7, group-level variables were derived by aggregating scales across functional work-groups. To justify the aggregation of climate and individual safety behaviour scales to the group-level within-group homogeneity and between-group variance was assessed. Intraclass correlations (*ICC*) were calculated to assess within group homogeneity. A one-way analysis of variance using work-group as the independent variable and individual scale scores as the dependent variable were conducted to test between-group variance. The results are presented in Table 8.1. Results indicated sufficiently high within group homogeneity and between-groups' variability to support group-level aggregation for all scales.

Table 8.1 *Intra Class Correlations and ANOVA for Safety Climate, Social Exchange and Safety Behaviours for ILAS Aggregated Work-groups*

Scale	ICC	Work-group ANOVA
OSC-M	.263	$F(79,225)=2.40, p=.001$
GSC-S	.209	$F(79,223)=1.96, p=.001$
GSC-CA	.183	$F(79,218)=1.89, p=.001$
GSC-CP	.129	$F(79,218)=1.55, p=.007$
ISB-WA	.167	$F(79,221)=1.81, p=.001$
ISB-WP	.122	$F(79,221)=1.52, p=.010$
MMX	.204	$F(79,225)=1.95, p=.001$
LMX	.212	$F(79,223)=2.03, p=.001$
GMX	.089	$F(79,218)=1.45, p=.019$

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-WA= Individual Safety Behaviours- Workers Active; ISB-WP= Individual Safety Behaviours- Workers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

Inspection of the injury and near miss data identified three groups with unusually high combined scores. These groups were removed from the analysis. A total of 77 function work-groups with two or more respondents were retained for the SEM analyses. Table 8.2 shows the descriptive statistics and zero order correlations for the safety climate scales, safety behaviours and both injury and incident statistics aggregated to work-groups. Bivariate correlations amongst the safety climate dimensions ranged from .53 to .76 (compared to a range of .49 to .70 found for the individual- level analysis). As previously observed, the highest correlation was between the AGSC- Coworker active and proactive subscales. Correlations exceeding .7 were also observed between AOSC-M and both supervisor and coworker-proactive safety climate dimensions.

Statistically significant negative correlations were also found between the safety climate and the majority of safety outcome data. While the correlations between individual safety behaviours and both injury and incident outcomes are stronger than those observed for the individual-level data set, nonsignificant correlations were again found for group injuries. These weaker bivariate relationships were found

between injuries and AGSC-S and both the aggregate group safety behaviour scales (the small sample size is likely to have contributed to the nonsignificance of these weaker correlations). A strong positive correlation (.56) was also observed between self-reported injury and incident rates.

Table 8.2 *Means, Standard Deviations and Zero-Order Correlations for Safety Climate and Safety Outcomes for ILAS Aggregated Work-groups*

Variable	Mean	SD	Items	1	2	3	4	5	6	7
1 AOSC-M	3.75	0.56	17							
2 AGSC-S	3.76	0.54	17	.71**						
3 AGSC-CA	3.82	0.59	6	.55**	.53**					
4 AGSC-CP	3.82	0.52	6	.72**	.62**	.76**				
5 AGSB-WA	4.14	0.47	12	.47**	.55**	.75**	.63**			
6 AGSB-WP	4.02	0.48	12	.62**	.63**	.62**	.73**	.72**		
7 ALogINJ	0.25	0.28		-.35**	-.19	-.25*	-.33**	-.20	-.16	
8 ALogINC	0.29	0.38		-.39**	-.31**	-.37**	-.34**	-.42**	-.38**	.56**

Note: AOSC-M= Aggregated Organisation Safety Climate-Managers; AGSC-S=Aggregated Group Safety Climate-Supervisors; AGSC-CA= Aggregated Group Safety Climate- Coworkers Active; AGSC-CP= Aggregated Group Safety Climate- Coworkers Proactive; AISB-WA= Aggregated Individual Safety Behaviours- Workers Active; AISB-WP= Aggregated Individual Safety Behaviours- Workers Proactive; ALogINJ = Aggregation of Logarithmically transformed Injuries; ALogINC = Aggregation of Logarithmically transformed Near Miss Incidents;  $N=77$ ; \* $p<.05$ , \*\* $p<.01$

In an initial SEM run inspection of modification indices indicated that the addition of error covariances between the safety climate variables and also between AGSCCA and GSBWA would substantially improve fit. All models were therefore rerun with the error covariance between AOSC-M and AGSC-S, AGSC-CA and AGSC-CP, and AGSC-CA and GSBWA freed. The independence and full models provided inadequate fit to the data. Fit indices for the full model with freed error covariance indicated that this model provided a good fit. The mediation and equivalent direct path models provided an equally good fit, with neither model showing substantial improvement over the full model. Model fit statistics and results of the chi-square difference tests undertaken are displayed in Table 8.3.

With fit equivalent across models attention is turned to the structural coefficients for the SEM, as reported in Table 8.4 to determine the most parsimonious model.

Examination of the structural equations showed that the pathway between aggregated

global safety climate and group safety behaviours was statistically significant in all models indicating that aggregated ratings of safety climate are a strong positive predictor of individuals' self-reported safety behaviours at the group-level.

Table 8.3 *Assessment of Fit and Model Differences for ILSA Group-level Predictive Models of Global Safety Climate, Safety Behaviours and Safety Outcomes*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1.Independence	591.52***	28	-	-	-	-
2.Full	57.25***	17	.93	.90	.06	.17 (.12,.22)
3.Full with error	21.99n.s	14	.99	.96	.04	.08 (.00,.15)
4.Mediation with error	22.35n.s	15	.99	.96	.05	.08 (.00,.14)
5.Direct with error	22.07n.s	15	.99	.96	.04	.08 (.006,.14)
Difference ( $\Delta\chi^2$ ) #1-#2	569.53***	14				
Difference ( $\Delta\chi^2$ ) #2-#3	32.16***	3				
Difference ( $\Delta\chi^2$ ) #4-#3	0.36 n.s	1				
Difference ( $\Delta\chi^2$ ) #5-#3	0.08n.s	1				

*Note.*  $N=77$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

Testing of the full and direct models allowed the evaluation of the direct relationships between global safety climate and safety outcomes. The direct pathway from GSC to GSO was statistically significant in the direct pathway indicating that positive perceptions of safety climate are associated with lower rates of self-reported injury and incidents. However this direct pathway was not significant in the full model offering support for the mediation hypothesis. In the full model the direct pathway between group safety behaviours and outcomes also failed to reach



statistical significance. When the direct relationship between safety climate and outcomes was constrained in the mediation model, the parameter estimate for GSB to GSO increased substantially (-0.19,  $p < .05$ ). These results indicate that when reanalysed at the group-level, support was found for Hypothesis 10 that safety behaviours mediate the relationship between safety climate and outcomes such as injuries and near miss incidents. In further support of the mediation hypothesis the indirect effects of Global Safety Climate on Safety Outcomes were significant.

Table 8.4 *Parameter Estimates for ILSA Group-level Models Predicting Safety Outcomes*

Path	Full Model			Mediated Model			Direct Model		
	St	Unst	SE	St	Unst	SE	St	Unst	SE
Direct Effect									
GGSC→GSB	0.89	0.75***	.12	0.90	.75***	.12	0.89	0.74***	.12
GSB→GSO	-0.16	-0.08n.s	.18	-0.44	-0.19*	.09			
		(-0.43,0.28)			(-0.37,-.01)				
GGSC→GSO	-0.34	-0.13n.s	.16				-0.51	-0.21**	.08
		(-0.44,-0.17)						(-0.36,-0.06)	
Indirect Effect									
GGSC→GSO		-0.06	.14		-0.14*	.07			
Total Effects									
GGSC→GSO		-0.19*	.08		-0.14*	.07			

*Note.* N=77; GGSC= Group-level Global Safety Climate, GSB= Group Safety behaviour, GSO= Group Safety Outcomes; St= Standardised; Unst= Unstandardised; Estimate 95% confidence interval in parenthesis, SE=Standard Error, \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

The total effects of Global Safety Climate and Safety Behaviours on group injuries and incidents are reported in Table 8.5. Results indicate different patterns of associations with far stronger predictive relationships being observed between the rate of Near Miss Incident reporting and both Safety Climate and Safety Behaviours. Standardised structural coefficients, error terms and modelled error covariance for the final mediation model are presented in Figure 8.4.

Table 8.5 *Total Effects for ILSA Group-level Global Safety Climate, Safety Behaviours and Safety Outcomes*

Path	GGSC		GSB	
	Unst	SE	Unst	SE
Total Effects				
→GSBWActive	0.75***	.12		
→GSBWProactive	0.88***	.12		
→GINJ	-0.14*	.07	-0.19*	.09
→GINC	-0.35***	.10	-0.46***	.12

Note. GGSC= Group-level Global Safety Climate, GSB= Group Safety behaviour, GINJ= Group Injuries; GINC= Group Near Miss Incidents; Unst= Unstandardised; SE=Standard Error, \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

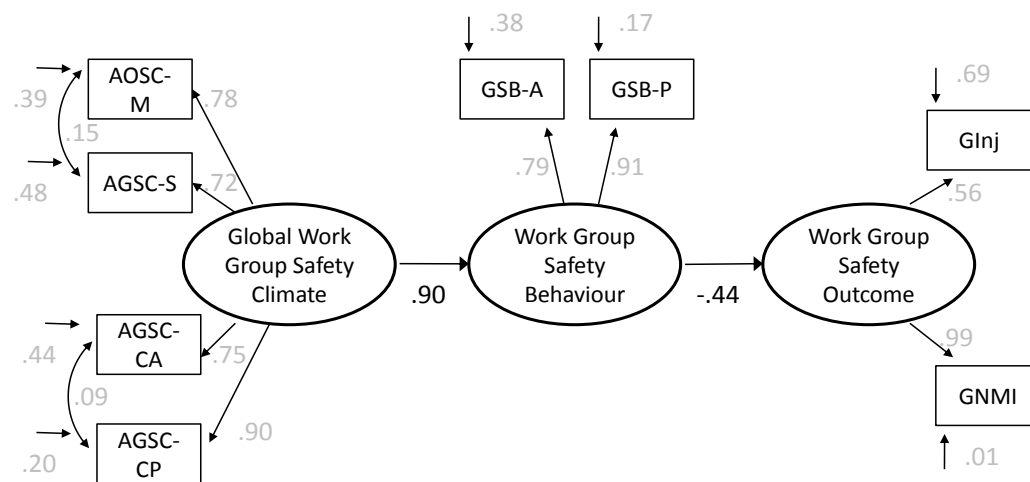


Figure 8.4. Significant standardised coefficients for the group-level mediation model of global safety climate, group safety behaviours and outcomes.

Note: AOSC-M= Aggregated Organisation Safety Climate-Managers; AGSC-S=Aggregated Group Safety Climate-Supervisors; AGSC-CA= Aggregated Group Safety Climate- Coworkers Active; AGSC-CP= Aggregated Group Safety Climate- Coworkers Proactive; GSB-A= Aggregated Safety Behaviours- Workers Active; GSB-P= Aggregated Safety Behaviours- Workers Proactive; GInj = Aggregation Injuries; GNMI = Aggregation Near Miss Incidents

To determine the practical significance of the findings, disturbance terms for the endogenous variables in the mediation model were assessed. The percentage of explained variance for Group Safety Behaviours was 80% and Group Safety Outcomes 20%. The moderate effect size observed for the prediction of Group Safety Outcomes using group-level analysis was considerably larger than that

observed when data was processed using the individual-level analysis. Again the large effect size achieved for the prediction of group safety behaviours reinforce current opinions that the safety performance of workers may be explained by the prevailing safety climate operating within an organisations. Furthermore, while the mediation model proposed in Hypothesis 10 was not supported when individual-level analysis was utilised, results support the proposed mediation model at the group-level using ILSA aggregation.

Hypothesis 11 proposed that the strength of associations observed between global safety climate and safety outcomes will be stronger using both ILSA & CSA aggregation than using individual-level analysis. Partial support was therefore found for Hypothesis 11 as evidence of stronger associations between constructs was observed in both the bivariate correlations and parameter estimates. Despite the smaller sample size the strength of the relationships between constructs resulted in the emergence of good fitting models. Furthermore the aggregation of data resulted in much larger proportions of variance in the criterion measures being accounted for. While a 10% increase in explained variance was noted for the group safety behaviours, the increase for group safety outcomes was a noteworthy 18%.

#### **8.4. CSA Group-level Analysis**

The next stage of model replication adopted the CSA approach in which group-level variables were formed by first aggregating items to the required level of sub unit analysis (functional work-groups) and then conducting EFA to create group-level scales for subsequent use in model testing. Results for the CSA based factor analysis performed on the specific climate variables for the group-level data set were reported in Section 7.8. An initial difference between the CSA based model and ILSA model is the identification of subscales for both the supervisor and management level safety climate construct in the CSA factor analysis. Table 8.6 shows the descriptive statistics and zero-order correlations for the safety climate scales, safety behaviours and both injury and incident statistics aggregated to work-groups. Distributions for the group-level variables are provided in Appendix G.

Table 8.6      *Means, Standard Deviations and Zero-Order Correlations for Safety Climate and Group Safety Outcomes in the CSA Aggregated Work-group Sample*

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1 AOSC-MA	3.60	0.60	.92								
2 AOSC-MP	3.86	0.56	.82**	.94							
3 AGSC-SA	3.64	0.62	.73**	.61**	.92						
4 AGSC-SP	3.82	0.54	.67**	.61**	.82**	.93					
5 AGSC-CA	3.82	0.56	.62**	.50**	.53**	.50**	.93				
6 AGSC-CP	3.79	0.54	.73**	.67**	.59**	.60**	.76**	.91			
7 AGSB-WA	4.14	0.47	.50**	.42**	.57**	.50**	.72**	.65**			
8 AGSB-WP	4.02	0.48	.60**	.54**	.50**	.63**	.62**	.72**	.72**		
9 ALogINJ	0.25	0.28	-.36**	-.29**	-.15	-.16	-.28*	-.32*	-.20	-.16	
10 ALogINC	0.29	0.38	-.37**	-.39**	-.31**	-.29*	-.38**	-.36*	-.42**	-.38*	.56**

*Note.* N=77;  $\alpha$  = Cronbach's Alpha derived from group-level data on the diagonal; \* $p < .05$ , \*\* $p < .01$ ; AOSC-MA= Aggregated Organisation Safety Climate-Managers Active; AOSC-MP= Aggregated Organisation Safety Climate-Managers Proactive; AGSC-SA=Aggregated Group Safety Climate-Supervisors Active; AGSC-SP=Aggregated Group Safety Climate-Supervisors Proactive ; AGSC-CA= Aggregated Group Safety Climate- Coworkers Active; AGSC-CP= Aggregated Group Safety Climate- Coworkers Proactive; AGSB-A= Aggregated Safety Behaviours- Workers Active; AGSB-P= Aggregated Safety Behaviours- Workers Proactive; GInj = Aggregation Injuries; GNMI = Aggregation Near Miss Incidents

Bivariate correlations amongst the safety climate dimensions ranged from .50 to .82 (compared to a range of .49 to .70 found for the individual-level analysis and from .53 to .76 for the ILSA group data). The highest intercorrelations between the climate scales were observed for the active and proactive subscales of AOSC-Manager and AGSC-Supervisor. No change in the strength of the association between AGSC-Coworker active and proactive subscales occurred as a result of the slight reconfiguration of these scales.

Statistically significant negative correlations were also found between the safety climate and safety outcome data. In particular strong correlations were observed between both active and proactive group safety behaviours and the six safety climate scales. As the ILSA derivations of the GSB-W subscales were considered the appropriate forms to use in this group-based analysis the correlations between group safety behaviours and both injury and incident outcomes are as previously reported. No significant correlations were found between supervisor safety action and group injuries.

Model fit statistics and results of the chi-square difference tests undertaken are displayed in Table 8.7. The independence model and the full model provided a poor fit to the data. Inspection of modification indices indicated that the addition of several error covariances would substantially improve fit. All models were therefore rerun with the error covariance between the active and proactive safety climate indicators for AOSM, AGSC-S and AGSC-C freed. In addition the corresponding error covariances between active and proactive indicators of AGSC-S and AGSC-C with AGSB were freed.

Table 8.7 *Assessment of Fit and Model Differences for CSA Group-level Predictive Models of Global Safety Climate, Safety Behaviours and Safety Outcomes*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1.Independence	989.82***	45	-	-	-	-
2.Full	132.41***	32	.89	.87	.07	.19 (.15,.23)
3.Full with error	44.96*	26	.98	.95	.05	.09 (.02,.13)
4.Mediation with error	45.60*	27	.98	.95	.05	.08 (.02,.13)
5.Direct with error	45.50*	27	.98	.95	.05	.08 (.01,.13)
Difference ( $\Delta\chi^2$ ) #1-#2	857.41***	13				
Difference ( $\Delta\chi^2$ ) #2-#3	87.45***	6				
Difference ( $\Delta\chi^2$ ) #4-#3	0.64 n.s	1				
Difference ( $\Delta\chi^2$ ) #5-#3	0.54n.s	1				

Note. N=77;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Fit indices for the full model with error covariance showed a significant improvement in fit. The respecified mediation and direct path models provided an equally good fit, with neither model showing substantial improvement over the full

model. With fit equivalent across models attention is turned to the structural coefficients for the SEM, as reported in Table 8.8 to determine the most parsimonious model.

Table 8.8 *Parameter Estimates for CSA Group-level Models Predicting Safety Outcomes*

Path	Full Model			Mediated Model			Direct Model		
	St	Unst	SE	St	Unst	SE	St	Unst	SE
Direct Effect									
GGSC→GSB	0.84	0.61*** (0.43,0.80)	.09	0.85	.62*** (.44,0.81)	.09	0.85	0.61*** (0.43,0.80)	.09
GSB→GSO	-0.25	-0.11n.s (-0.36,0.14)	.13	-0.46	-0.19* (-0.36,-.01)	.09			
GGSC→GSO	-0.27	-0.09n.s (-0.28,-0.10)	.09				-0.52	-0.18** (-0.31,-0.06)	.06
Indirect Effect									
GGSC→GSO		-0.07n.s	.08		-0.12*	.06			
Total Effects									
GGSC→GSO		-0.15*	.06		-0.12*	.06			

*Note.* GGSC= Group-level Global Safety Climate, GSB= Group Safety behaviour, GSO= Group Safety Outcomes; St= Standardised; Unst= Unstandardised; Estimate 95% confidence interval in parenthesis, SE=Standard Error, \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

Examination of the structural equations showed that the pathway between global safety climate and group safety behaviours was statistically significant in all models indicating that CSA aggregated ratings of safety climate remain strong positive predictors of individuals' self-reported safety behaviours at the group-level. The direct pathway from GGSC to GGSO was statistically significant in the direct model; however it was not significant in the full model offering support for the mediation hypothesis. When the direct relationship between safety climate and outcomes was constrained in the mediation model, the parameter estimate for GGSB to GSO increased substantially (-0.19,  $p<.05$ ). In further support of the mediation hypothesis the indirect effects of Safety Climate on Safety Outcomes were significant.

For the CSA derived data, the total effects of Global Safety Climate and Safety Behaviours on group injuries and incidents, reported in Table 8.9 show that stronger

predictive relationships are again observed between the rate of near miss incident reporting and both Safety Climate and Safety Behaviours than found for injury data. Standardised structural coefficients, error terms and modelled error covariance for the final mediation model are presented in Figure 8.5.

Table 8.9 *Total Effects for Group-level Safety Climate and Safety Outcomes*

Path	GGSC		GSB	
	Unst	SE	Unst	SE
Total Effects				
→GSB-Active	0.62***	.09		
→GSB-Proactive	0.69***	.09		
→GINJ	-0.12*	.06	-0.19*	.09
→GINC	-0.29***	.08	-0.47***	.12

Note. N=77: GGSC= Group-level Global Safety Climate, GSB= Group Safety behaviour, GINJ= Group Injuries; GINC= Group Near Miss Incidents; Unst= Unstandardised; SE=Standard Error, \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

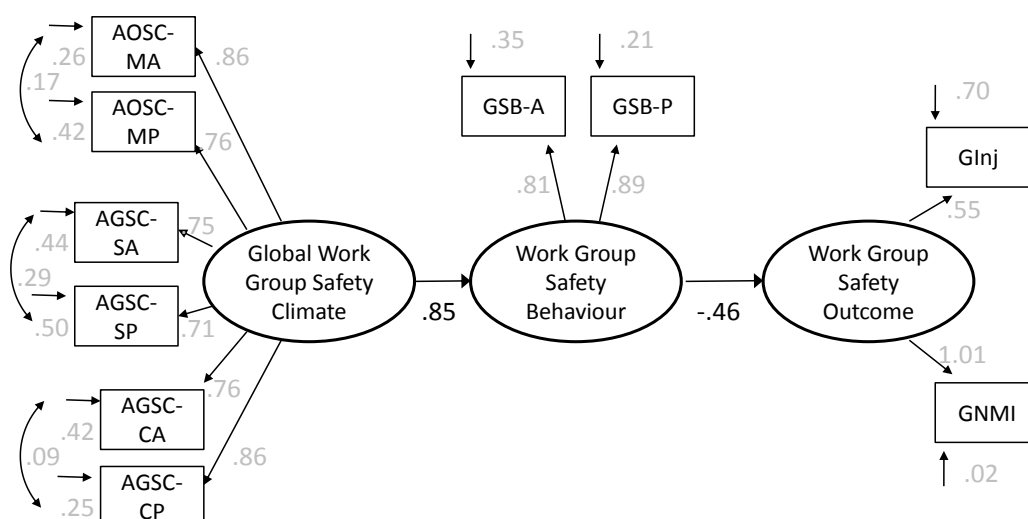


Figure 8.5 Standardised coefficients for the group-level mediation model of global safety climate, group safety behaviours and outcomes.

Note: AOSC-MA= Aggregated Organisation Safety Climate-Managers Active; AOSC-MP= Aggregated Organisation Safety Climate-Managers Proactive; AGSC-SA=Aggregated Group Safety Climate-Supervisors Active; AGSC-SP=Aggregated Group Safety Climate-Supervisors Proactive ; AGSC-CA= Aggregated Group Safety Climate- Coworkers Active; AGSC-CP= Aggregated Group Safety Climate- Coworkers Proactive; AGSB-A= Aggregated Safety Behaviours- Workers Active;

AGSB-P= Aggregated Safety Behaviours- Workers Proactive; GInj = Aggregation Injuries; GNMI = Aggregation Near Miss Incidents

For the final model the percentage of explained variance for Group Safety Behaviours was 72% and Group Safety Outcomes 21%. The moderate effect size observed for the prediction of Group Safety Outcomes using CSA group-level aggregation was consistent with the ILSA results in again being considerably larger than that observed when data was processed using the individual- level analysis. Full support was therefore found for both the mediation model proposed in Hypothesis 10 and for the stronger construct associations in group-level models proposed in Hypothesis 11. Evidence of stronger associations between constructs was again observed in both the bivariate correlations and parameter estimates obtained in the CSA model compared to individual- level analysis.

The different method of data aggregation did not substantially change the magnitude of effects compared to the results found when using the ILSA method. For the CSA method only a 2% increase in explained variance was noted for the group safety behaviours. Again the relatively large effect size achieved for the prediction of group safety behaviours reinforces current opinions that the safety performance of workers may be explained by the prevailing safety climate operating within organisations. It appears that while the strength of associations between constructs is improved when accounting for the nonindependence of data in organisational settings by conducting group-level analyses, the aggregation methodology applied does not appear to have a large impact on the results when a global conceptualisation of the constructs is being examined.

### **8.5. Incremental variance supplementary analysis**

To further test that co-worker commitment to safety can account for a significant proportion of the variance in safety outcomes beyond that already accounted for by management and supervisor subscales of safety climate a series of supplementary hierarchical multiple regression analyses (MRA) were undertaken. Four separate analyses for the individual - level, ILSA and CSA data were conducted using injuries, near miss incidents, and both active and proactive safety behaviours of individual workers as criterion variables. In summary, when injuries and near miss



incidents were used as criterion variables coworker safety climate did not account for a significant proportion of variance in outcomes beyond that already accounted for by management and supervisor safety climate. In contrast, when predicting workers' safety behaviours, coworker safety climate provided statistically significant incremental variance. The full results for the supplementary MRAs are reported in Appendix H.

## 8.6. Discussion

Two main objectives of my thesis were to investigate the relationship between employees' perceptions of workplace safety climate, workers' safety behaviours and safety outcomes such as injuries and incidents, and to examine potential differences in construct relations when individual and group-level data is assessed. In Section 8.2 the safety climate measures were operationalised and tested in a manner consistent with those studies categorised under the label *Global Safety Climate* in Christian et al.'s (2009) and Beus, Payne and Payne et al.'s (2010) meta- analyses. However in this instance safety climate items or subscales were not summated or averaged to form a global scale score, but rather safety climate subscales were used as separate indicators of a higher order global safety climate construct for the SEM analyses. Likewise individual safety behaviours were modelled as a composite of active and proactive behaviours, as were the retrospective injuries and incident data. My choice to run a global model for the prediction of safety outcomes was intended to ground my study in the extant literature.

Meta- analyses conducted by Clarke (2006), Christian et al. (2009) and Nahrgang et al. (2011) have identified that the relationship between safety climate and safety outcomes such as accidents and injuries operates indirectly through individual and group-level safety performance behaviours. As such I proposed that when safety climate was treated as a global construct the effects on safety outcomes would be fully mediated by individual safety performance. Whereas, results for the individual-level data set indicated that a direct relationships between global psychological safety climate and both individual safety behaviours and individual safety outcomes provided the best fit to the data, the full mediation model proposed in Hypothesis 10 was supported at the group-level of analysis. Furthermore in

support of Hypothesis 11, stronger overall construct relationships were identified in the group-level analyses compared to the individual-level analysis.

Inspection of the three proposed individual-level models indicated that in all cases the relationship between individual safety behaviours and safety outcomes was not significant. Furthermore, in the case of the full model, the positive direction of the association between ISB and ISO was contrary to prediction, going against general findings of negative correlations between behaviour and injuries. When the direct relationship between safety climate and outcomes was constrained, the parameter estimate for ISB to ISO reversed direction, indicating that rather than operating as a mediator, in this instance, ISB may be acting as a suppressor variable.

This effect was not noted in the group-level analysis, however, two potential reasons for such results relate to a possible pattern of high social desirability responses in some workers and differences in workers' willingness to report accidents and near misses. In some cases individuals who reported higher near miss and injury occurrences may also have been more likely to rate their own safety performance in a positive manner, but the safety climate of the work area less positively. This scenario fits with attribution theory premises that would see workers who had experienced negative safety events (high injury/incident statistics) diffusing personal responsibility from themselves (high safety behaviours ratings) and transferring causal responsibility to situational factors (low safety climate ratings). Such biased response patterns would potentially artificially inflate the safety behaviour measures and attenuate safety climate measures, thereby confounding the true climate-behaviour –injury association.

Alternatively, in organisations with stronger safety climates, the importance of being aware of and learning from near miss incidents injuries may have been enhanced. Accordingly workers in this environment may be more likely to recall and be willing to report near miss incidents and injuries. In these instances workers may have rated psychological safety climate as high, their own behaviours positively, but also report relatively higher incident and injury rates. However, in both scenarios, any disparity in individual workers' responses may have been diffused when data was collapsed to the group-level.

As stated above, the strength of relationship between constructs was generally stronger when assessed at the group-level, in particular in relation to the prediction of safety outcomes. As such my results are consistent with trends identified in the safety literature. To expand, the strength of relationship between global psychological safety climate and safety outcomes observed in my study are relatively consistent with the population estimates generated for both individual and group-level data in previous meta-analysis (Beus, Payne, et al., 2010; Christian et al., 2009). In line with my results, Beus and colleagues found small negative correlations between safety climate and retrospective injuries and relatively stronger medium negative correlations with organisational safety climate.

Christian et al. (2009) also identified a weak negative relationship between global psychological safety climate and workplace accidents when self-report data was used for the criterion measure, and slightly stronger negative correlations for aggregated organisational safety climate. Christian et al.'s results also indicated that both compliance and participative safety behaviours of workers had commensurate weak, negative relationships with safety outcomes, of a magnitude equivalent with safety climate. In contrast to Christian et al.'s results, an initial examination of bivariate correlations in my analysis showed far stronger relationships between the psychological safety climate variables and outcomes than between individual safety behaviours and outcomes, immediately flagging potential problems for a full mediation model.

In particular, proactive safety practices showed no significant correlations with either injuries or near miss incidents at the individual-level. However again this pattern was not found when group analysis was conducted. Indeed when group analysis was performed using CSA aggregation the relationship between individual performance and injuries, while still slightly weaker, was more aligned with safety climate-outcome associations. Bivariate correlations also showed that safety outcomes had slightly stronger (small to moderate) associations with active safety behaviours than proactive practices.

This trend was contrary to Clarke's (2006) results that showed participative safety practices had slightly stronger (though weak overall) associations with injuries than compliance behaviours. As stated above, this finding was not supported in my study for either the group or individual-level data. However, while Clarke's (2006) results were based on a very small sample, more recent meta-analytic results (Nahrgang et al., 2011) based on a marginally larger sample of studies identified weaker effects between participative safety practices and injuries than found for compliance behaviours. While Nahrgang et al. (2011) did not distinguish between data treatments used in the studies included in their meta-analysis, their composite measures of engagement/participative safety practices showed smaller initial correlations with outcomes than found for compliance behaviours. As such, participation was not included in the testing of their proposed JD-R safety model. In this model Nahrgang et al. maintained a direct pathway between safety climate and accidents/injuries, finding this direct relationship to be stronger than the link between compliance behaviours and safety outcomes, a finding consistent with results from my individual-level analysis.

While overall only 4.9% of the variance in safety outcomes was accounted for in the individual-level model, this small effect size for predicting individual safety outcomes is relatively consistent with past findings based on individual-level retrospective, self-report data (Christian et al., 2009). The increase in effect size in the group-level models is also reflected in the extant literature, however the magnitude of change observed in studies using self-report data by Christian et al. is less substantial than that observed in my results. Furthermore, supplementary MRA analyses indicated that although the four safety climate indicators in combination accounted for a statistically significant proportion of variance in injuries and near misses, the two coworker safety climate indicators did not account for a significant proportion of incremental variance in outcomes above that initially accounted for by management commitment to safety.

Nahrgang et al. (2011) also concluded that predictive relationships were stronger when adverse events were used as a criterion compared to accident and injury data. A stronger effect with near miss incidents was observed in the bivariate correlations and modelled effects for all three data treatments in my study. It is important to note

that the significant relationship between safety climate and individual safety outcomes in my study was driven largely by the stronger effects found for near miss incidents. My results therefore, add weight to Christian et al.'s recommendation that research focus shift to investigating accidents in which no injuries are incurred (i.e., near miss incidents) and micro-accidents (Zohar, 2000) (in which only minor injuries are incurred) as well as reportable injuries as defined by OSHA regulations. Furthermore, given the overall strength of associations observed in my study, the utility of both the recall-based minor injury and near miss incident measures is supported by my results.

In contrast to the small to moderate effects found for incident and injury outcomes, safety climate explained over 70% of the variance in individual safety behaviours in all models. Although an increase in variance (80%) in safety behaviours was observed in the ILSA model compared to the CSA model (72%), overall the large effect sizes observed for the prediction of safety performance reinforce current opinions that the safety behaviours of workers may be principally explained by safety climate (Nahrgang et al., 2011). Christian et al. (2009) found the population estimate for psychological safety climate and self-reported safety behaviours to be .47, representing around 22% of variance. Christian et al.'s results also indicated that larger associations were observed between safety climate and safety performance with group data (34%). This trend is commensurate with my results however effect sizes are of a small magnitude. Clarke (2006) also found moderate, positive correlations between safety climate and both dimensions of safety performance.

The relatively larger effects explained in my results are most likely linked to the expanded operationalisation of the safety climate construct. This is supported by the supplementary MRA analyses which found that on in both individual and group level data treatments coworker safety climate accounted for addition variance in workers safety active and proactive behaviours beyond that provided by existing measures of management and supervisor safety climate (i.e Active 30%; Proactive 45%), increasing variance accounted for up to a total of 60%. For example in the CSA data variance in workers active safety behaviours accounted for increased 26% with the addition coworker safety climate in the model. For workers proactive safety

behaviours incremental variance in the hierarchical MRA analysis rose 13% when coworker safety climate was included at step 2 of the model run.

In both the above mentioned meta-analyses (Christian et al., 2009; S. Clarke, 2006) global safety climate was generally composed of management practices and safety systems content. Nahrgang et al. (2011) also conceptualised safety climate as a largely management-level construct. When Nahrgang et al. assessed the relative importance of the predictors of individual safety performance they found that job resources (including both individual resources and supportive environments) accounted for 67% of workers' engagement in participative safety practices and 58% of compliance practices. These variance estimates are more commensurate with my study.

Interestingly, within Nahrgang et al.'s (2011) job resource predictor category, safety climate only accounted for 34% of the total  $R^2$  for compliance behaviours and 42% for proactive behaviours, bringing the proportion of variance in safety performance explained by safety climate back down to around 19% and 28% respectively. However, coworker and leader support contributed more than 45% of the remaining variance in safety behaviours. As I discussed in Section 4.3, the overlap between general support and safety-related practices in both the coworker and leadership dimensions of Nahrgang et al.'s study loosely equates these variables with the group safety climate dimensions of my safety climate construct. As such the larger proportion of explained variance in safety performance in my study is likely to be due to the incorporation of coworker, supervisor and management commitment to safety in my global psychological safety climate scale.

In sum, differences in model structures and strength of observed associations can emerge with the simple aggregation of data. This process of aggregation could therefore explain variations in results reported in meta-analyses investigating differences between conceptualisations of psychological and organisational climate that have previously been attributed to the data source issues (i.e., the use of prospective or retrospective data or archival compared to self-report data). Although meta-analytic evidence would support the use of objective, prospective injury data, if this is not plausible the use of minor injury and near miss data combined with group-

level of analysis will improve the likelihood of researchers' finding strong predictive relationships. Overall my results show that global safety climate is a strong predictor of individual safety behaviour. The conclusion to be drawn from these findings is that in work environments where safety is valued, workers are more likely to comply with policies and procedures and be more engaged in taking personal responsibility and using their initiative in safety-related situations. Furthermore, having a positive safety climate in an organisation is likely to result in a reduction in the number of safety-related incidents occurring and minor personal injuries experienced by workers. My results also provide some justification for the inclusion of coworker practices in an expanded work-level safety climate index, however the results for the next series of model testing will allow more concise examination of the relationships between safety climate and individual safety behaviours.

## **9. Work-level Model of Social Exchange and Safety Climate**

### **9.1. Introduction**

Having previously established the discriminant validity of the safety climate and social exchange scales in Chapter 7, a further objective of my thesis is to investigate how the quality of social exchanges occurring in the workplace influence safety climate and workers' safety performance. In this chapter I investigate the proximal and distal relationship between social exchange and safety climate dimensions (operationalised as separate lower-order constructs) and individual safety performance (operationalised as active and proactive safety behaviours). A level- of analysis approach is adopted to test Hypotheses 12, 13 and 14. Model testing will again be under taken using group-level data using both ILSA and CSA to test Hypothesis 15. Individual-level data treatment was undertaken and included as Appendix I, for comparison purposes in the discussion chapters.

### **9.2. Model Specification**

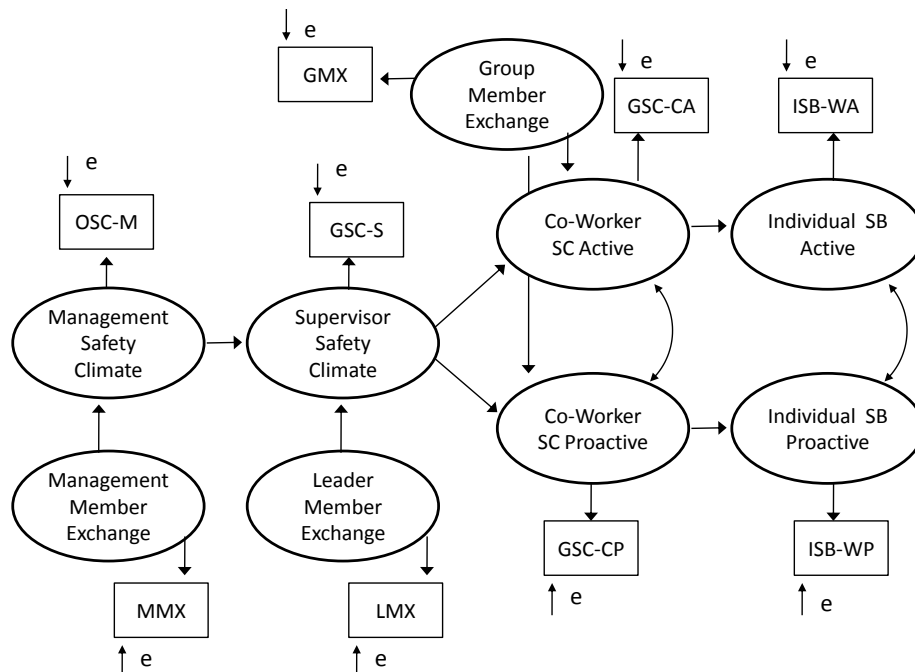
Hypothesis 12 predicts that in a stratified work-level model of safety climate coworker's commitment to safety will mediate the more distal influence of management and supervisor commitment to safety on workers safety behaviours. Hypothesis 13 further proposes the dimensions of climate for social exchange at distinct work-levels as antecedents of safety climate at the corresponding work-level such that:

- (d) High quality management-member social exchange supports front-line workers' positive perceptions of organisation level management safety climate.
- (e) High quality leaders-member social exchange supports front-line workers' positive perceptions of group level supervisor safety climate.
- (f) High quality management-member social exchange supports front-line workers' positive perceptions of group level co-worker active and proactive safety climate.

Furthermore, in Hypothesis 14 I propose that the positive impact of climate for social exchange on individual workers' safety behaviours will be best represented by a fully mediated model operating through the establishment of positive safety climate when compared to a direct or partially mediated model.

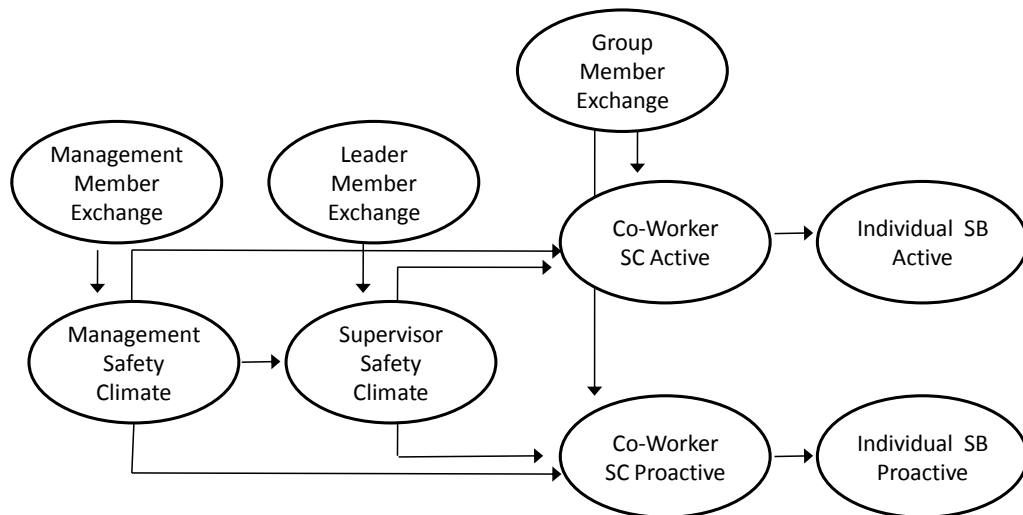


The above hypotheses are represented in the mediation model for the relationship between climate for social exchange, safety climate and safety behaviours as presented in Figure 9.1. In this model both exogenous and endogenous variables are represented by single observed variables with measurement error estimated. Additionally, the correlations between the active and proactive components of both GSC-C and ISB-W are recognised by freeing these parameters in model testing. The covariances between error terms for the three social exchange indicators were also included in the modelling. Diagrammatic representations are also provided for two alternative models, however for clarity, observed variables and measurement error are omitted. The partial mediation model (Figure 9.2) includes the direct effects of OSC-M on GSC-C active and proactive practices. The direct effects model includes the direct pathways between social exchange variables and individual safety behaviours (Figure 9.3).

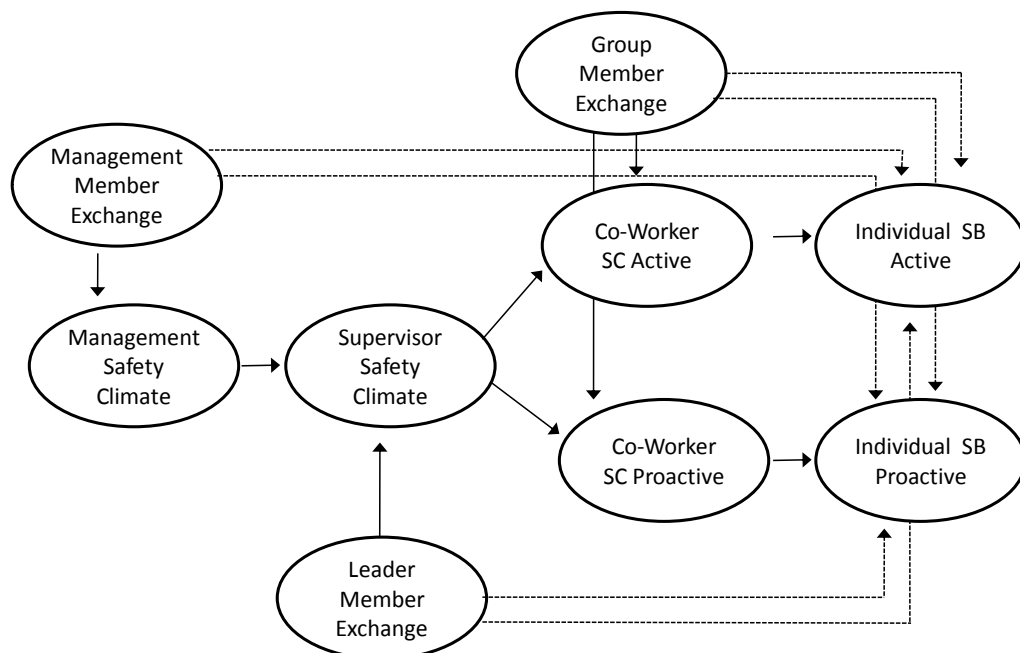


*Figure 9.1.* Mediation model for social exchange, safety climate dimensions and individual safety behaviours.

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; ISB-WA= Individual Safety Behaviours- Workers Active; ISB-WP= Individual Safety Behaviours- Workers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.



*Figure 9.2.* Partial mediation model for social exchange, safety climate dimensions and individual safety behaviours.



*Figure 9.3.* Direct social exchange effects model for safety climate dimensions and individual safety behaviours.

### 9.3. ILSA Group-level Analysis.

To test Hypotheses 12, 13 and 14 the models were tested using ILSA group-level data. An initial run of this series of SEM models included group-based estimates of measurement error; however these models failed to generate solutions. When measurement error was removed and covariances between the social exchange

variables were included, the path models generated solutions. Descriptive statistics, zero-order correlations for the aggregated scales used in the path analysis are provided in Table 9.1. For comparison purposes differences between correlations obtained using individual and group-level analysis are also provided.

Table 9.1 *Means, Standard Deviations and Zero-Order Correlations for ILSA Group Safety Behaviours, Safety Climate and Social Exchange Scales*

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1 AOSC-M	3.75	0.56		.00	.06	.03	.06	.19	.11	.05	.18
2 AMMX	3.42	0.68	.83**		.04	.04	.01	.08	.03	.00	.09
3 AGSC-S	3.76	0.54	.71**	.68**		.00	.01	.05	.07	.12	.18
4 ALMX	3.78	0.62	.51**	.60**	.78**		-.11	.02	.04	.05	.13
5 AGSC-CA	3.82	0.59	.55**	.51**	.53**	.25*		.06	.05	.09	.09
6 AGSC-CP	3.82	0.52	.72**	.62**	.62**	.43**	.76**		.01	.09	.14
7 AGMX	3.80	0.50	.42**	.40**	.37**	.37**	.64**	.57**		.15	.07
8 GSB-WA	4.14	0.47	.47**	.39**	.55**	.31**	.75**	.63**	.57**		.05
9 GSB-WP	4.02	0.48	.62**	.48**	.63**	.38**	.62**	.73**	.38**	.72*	

*Note.*  $N=77$ ; Difference between-group and individual- level correlations are represented above the diagonal. \* $p<.05$ , \*\* $p<.01$ : Note: AOSC-M= Aggregate Organisation Safety Climate-Managers; AGSC-S=Aggregate Group Safety Climate-Supervisors; AGSC-CA= Aggregate Group Safety Climate- Coworkers Active; AGSC-CP= Aggregate Group Safety Climate- Coworkers Proactive; GSB-WA= Group Safety Behaviours- Workers Active; GSB-WP= Group Safety Behaviours- Workers Proactive; AMMX= Aggregate Manager-Member Exchange; ALMX=Aggregate Leader-Member Exchange; AGMX=Aggregate Group Member Exchange.

Strong correlations between the safety climate variables and group active and proactive safety behaviours also provide initial support for Hypothesis 12.

Significant, positive bivariate correlations between the social exchange and safety climate variables also provide initial support for Hypothesis 13: that the quality of social exchanges amongst managers, supervisors and workers act as an antecedent for the development of positive group-level safety climate. Significant positive correlations between social exchange variables and group safety behaviours also offers initial support for the mediation model proposed in Hypothesis 14.

Overall the correlations observed using ILSA protocols are relatively consistent with those obtained using individual-level analysis, however in support of Hypothesis 15, slightly stronger correlations between variables are observed in the group analysis.

The exception to this trend was seen in the weaker correlation found between LMX and GSC-CA at the group-level (decrease from .36 to .25). Again comparatively weaker correlations were found between LMX and the active and proactive components of both Coworker Safety Climate and Group Safety Behaviours than for either MMX or GMX. The largest correlation increases were found for the associations between Management level Safety Climate and the proactive scales of both Coworker Safety Climate (.53 to .72) and Group Safety Behaviours (.44 to .62); and between Proactive Group Safety Behaviours and Supervisor Safety Climate (.45 to .63).

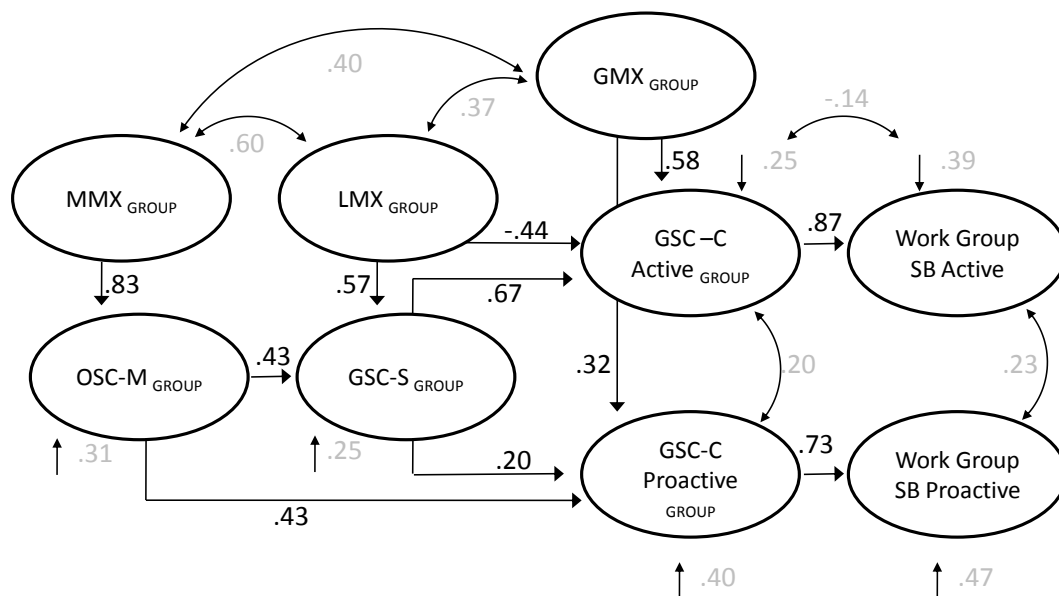
As shown in Table 9.2 the independence model was easily rejected but the hypothesised mediation model did not prove a good fit to the data.

Table 9.2 *Assessment of Fit and Model Differences for the Work-level Model of Social Exchange and Safety Climate (ILSA Group-level)*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
1.Independence	910.55***	36	-	-	-	-
2.Mediation	71.08***	22	.94	.92	.10	.16 (.11,.20)
3.Direct SX	62.30***	16	.95	.93	.09	.18 (.13,.23)
4.Partial Mediation	52.98***	20	.96	.94	.08	.14 (.09,.19)
5.Final Modified	26.56n.s	19	.99	.97	.06	.06 (.00,.13)
Difference ( $\Delta\chi^2$ ) #1-#2	839.47***	14				
Difference ( $\Delta\chi^2$ ) #2-#3	8.78n.s	6				
Difference ( $\Delta\chi^2$ ) #2-#4	18.10***	2				
Difference ( $\Delta\chi^2$ ) #4-#53	26.42***	1				

*Note.*  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p$ <.05, \*\* $p$ <.01, \*\*\* $p$ <.001

In contrast to the individual-level model solutions achieved with large sample SEM, the use of path analysis without modelled measurement error in this instance produced less than adequate fit in the initial runs. Inclusion of the direct effects between social exchange and group safety behaviours resulted in no improvement in fit statistics. In addition, no significant direct pathways between social exchange and safety behaviours variables were found. While the inclusion of the direct paths from AOSC-M to both active and proactive AGSC-C indicators improved fit, several indices remained less than optimal in this partial mediation model. Inspection of structural models for the partial mediation model and modification indices highlighted minor path changes that would substantially improve model fit. The standardised structural coefficients for the final model are presented in Figure 9.4.



*Figure 9.4.* Significant standardised coefficients for the group-level model of social exchange, safety climate and group safety behaviours.

Note: The Group subscript indicates that all variables are group level aggregates: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-C= Group Safety Climate- Coworkers; Work group SB-Active= Aggregate Individual Safety Behaviours- Workers Active; Work group SB-Proactive= Aggregate Individual Safety Behaviours- Workers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

The modified model including a path between ALMX and the active dimension of coworker safety climate and an error covariance between the active components of AGSC-C and Group safety behaviour was therefore tested. As the direct path between AOSC-M and AGSC-CA was not significant in the partial mediation model

this was also dropped from the final model. The modified model provided a theoretically justifiable solution with excellent fit. While guided by modification indices the changes imposed reflected the change in correlations identified at the bivariate level, especially in relation to the weaker correlation between ALMX and AGSC-CA and therefore warranted further investigation. Chi square difference tests indicated a significant improvement in model fit for the modified model over the partial mediation model.

### **9.3.1. Direct Effects**

Parameter estimates are presented in Table 9.3. In support of Hypothesis 13, examination of the unstandardised structural equations indicated significant positive relationships between climate for social exchange and safety climate indicators. Direct effects for the social exchange indicators on aggregate safety climate variables were largely consistent with previous results with the exception of the negative path between ALMX and the active dimension of AGSC-Coworkers. While the overall strength of associations between social exchange and safety climate were weaker this, may have been due to the error variance not being modelled.

A one point increase in a work group's ratings of management safety climate resulted in a significant 0.41 point increase in AGSC at the supervisory level. The inclusion of the direct pathway from AOSC-M to AGSC-CP was also significant. A one unit increase in AGSC-S resulted in a 0.72 unit increase in AGSC-C Active but only a 0.19 unit increase for AGSC-C Proactive ( $p < .05$ ) which can be explained by the inclusion of the direct effect of OSCM on the latter. In combination these results indicate that when using functional work-groups as the central level of analysis the perceived influences of management and supervisor commitment to safety directly impacts on the establishment of strong group-based safety norms represented by coworker safety climate. However in this instance the direct impact of AOSC-M manifests in the promotion of proactive group practices but not active safety practices. When aggregation of workers' perceptions of the quality of social exchanges is conducted the patterns of association with safety climate at the corresponding level of the organisational hierarchy are generally consistent with results achieved using individual-level analysis, supporting Hypotheses 13 and 14.

Table 9.3 *Parameter Estimates for the Work-level Model of Social Exchange and Safety Climate (ILSA Group-level)*

Path	Direct Effect			Indirect Effect		Total Effect	
	St	Unst	SE	Unst	SE	Unst	SE
<b>AMMX</b>							
→AOSC-M	0.83	0.68*** (0.58,0.79)	.054			0.68***	.05
→AGSC-S				0.28***	.05	0.28***	.05
→AGSC-CA				0.20***	.05	0.20***	.05
→AGSC-CP				0.32***	.05	0.32***	.05
→GSB-WA				0.14***	.03	0.14***	.03
→GSB-WP				0.22***	.04	0.22***	.04
<b>ALMX</b>							
→AGSC-S	0.57	0.50*** (0.38,0.61)	.059			0.50***	.06
→AGSC-CA	-0.44	-0.41** (-0.58,-0.23)	.089	0.36***	.07	-0.05n.s	.08
→AGSC-CP				0.09*	.05	0.09*	.05
→GSB-WA				-0.03n.s	.05	-0.03n.s	.05
→GSB-WP				0.06n.s	.03	0.06n.s	.03
<b>AGMX</b>							
→AGSC-CA	0.58	0.68*** (0.51,0.85)	.088			0.68***	.09
→AGSC-CP	0.32	0.33*** (0.17,0.49)	.081			0.33***	.08
→GSB-WA				0.46***	.07	0.46***	.07
→GSB-WP				0.22***	.06	0.22***	.06
<b>AOSC-M</b>							
→AGSC-S	0.43	0.41*** (0.28,0.54)	.065			0.41***	.07
→AGSC-CA				0.29***	.07	0.29***	.07
→AGSC-CP	0.43	0.39*** (0.23,0.55)	.081	0.08n.s	.04	0.47***	.07
→GSB-WA				0.20***	.05	0.20***	.05
→GSB-WP				0.32***	.06	0.32***	.06
<b>AGSC-S</b>							
→AGSC-CA	0.67	0.72*** (0.50,0.94)	.11			0.72***	.11
→AGSC-CP	0.20	0.19* (0.01,0.37)	.094			0.19*	.09
→GSB-WA				0.49***	.08	0.49***	.08
→GSB-WP				0.13*	.07	0.13*	.07
<b>AGSC-CA</b>							
→GSB-WA	0.87	0.68*** (0.54,0.82)	.073			0.68***	.07
<b>AGSC-CP</b>							
→GSB-WP	0.73	0.68*** (0.54,0.82)	.072			0.689***	.07

Note. N=77; St= Standardised; Unst= Unstandardised; Estimate 95% confidence interval in parenthesis, SE=Standard Error, \* $p<.05$ , \*\* $p<.01$ , \*\*\*  $p<.001$ ; AOSC-M= Aggregate Organisation Safety Climate-Managers; AGSC-S=Aggregate Group Safety Climate-Supervisors; AGSC-CA= Aggregate Group Safety Climate- Coworkers Active; AGSC-CP= Aggregate Group Safety Climate- Coworkers Proactive; GSB-WA= Group Safety Behaviours- Workers Active; GSB-WP= Group Safety Behaviours- Workers Proactive; AMMX= Aggregate Manager-Member Exchange; ALMX=Aggregate Leader-Member Exchange; AGMX=Aggregate Group Member Exchange.

Results show that high quality social exchanges are linked to high safety climate ratings in all but the association between ALMX and AGSC-CA. Contrary to expectation, modelling this pathway showed a significant negative relationship indicating that work-groups with lower ratings of the quality of supervisor-member social exchange also report relatively higher ratings of the compliance-based aspects of coworker safety climate. This may be linked to the interpretation that supervisors with more authoritarian leadership styles (i.e., lower LMX scores) may focus on ensuring workers' compliance.

### 9.3.2. Indirect and Total Effects

In relation to the indirect impact of social exchange variables on group-level safety climate the indirect pathways from AMMX and ALMX to the two Coworker climate dimensions were statistically significant, ranging from 0.09 to 0.36. However, while the total effects of AMMX on Coworker Safety Climate may be interpreted as small to medium, the total effects of ALMX on Coworker Safety Climate are trivial. Small to medium indirect effects were also observed for the influence of AMMX and AGMX on both Active and Proactive Group safety behaviours. Again the total effects of ALMX on Active and Proactive GSB scales were not significant.

Unstandardised coefficients also indicated that the indirect pathways from AOSC-M to GSB-W were statistically significant for both active and proactive dimensions. The indirect relationship between AOSC-M and the active subscale of AGSC-C was also significant. While the indirect relationship between AOSC-M and AGSC-CP was not significant the total effects for this pathway were significant. Furthermore, the positive associations between GSC-S and group safety behaviours were fully mediated by the corresponding coworker safety climate dimensions.

To determine the practical significance of the ILSA findings, disturbance terms were assessed. In the final model the percentage of explained variance for all variables are considered large effects. Results indicated that 51% of variance in Active Work-group Safety Behaviours and 53% of Proactive safety practices may be explained by our understanding of the facet-specific safety climate and foundation social exchange climates operating within the organisation. Reduced form equations provided alternate estimates of 23% and 27%.



When examining the hierarchical relationships, the most distal dimension of AMMX has a major impact on management's commitment to safety, explaining 69% of the variance in AOSC-M. The influence of both AOSC-M and LMX in combination accounted for 75% of the variance in GSC-Supervisors. When accounting for the variance in both the active and proactive GSC-C scales slightly different predictive equations are derived, however in both cases nearly two thirds of variance can be accounted for (Active= 61%; Proactive 60%).

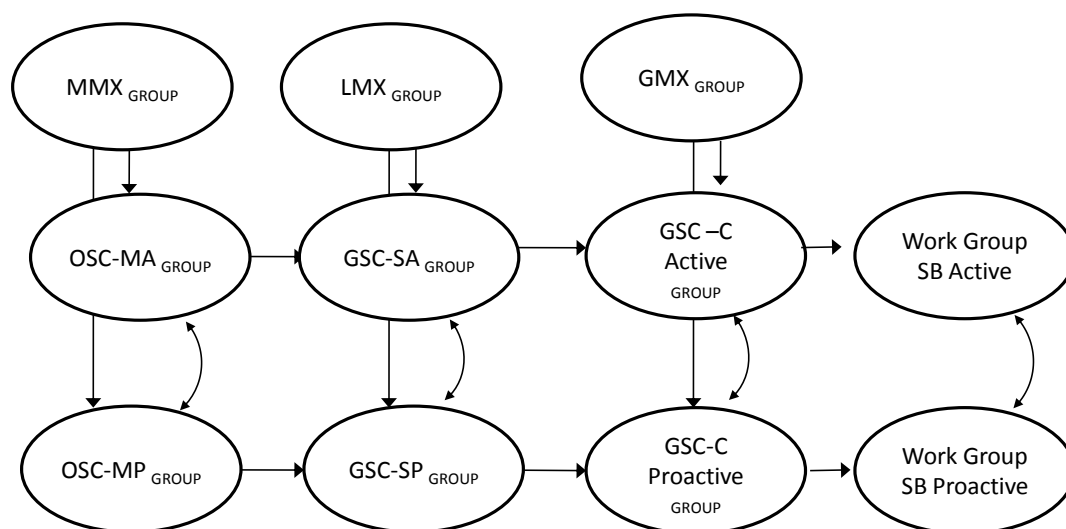
These results indicate that while the patterns of association found using individual-level and ILSA derived group-level analysis are generally consistent, the previously obtained individual-level findings that the benefits of high quality social exchanges manifest most strongly in the formation and maintenance of compliance-based group norms is less evident in the group-level results. This result may be partially due to the modelling of upper level management direct influences on proactive group safety practices and proximal impact of supervisor-member exchanges on active group safety practices. In this instance it appears that management safety practices and social exchange relations with workers has a relatively stronger positive influence on workers' engagement in proactive safety behaviours than compliance. Furthermore work-groups that rate their supervisors more highly on the LMX scale also report relatively fewer active safety practices amongst their coworkers. However, when a stronger safety priority of supervisors is factored in this effect is mitigated.

Overall the results support the proposal that establishing high quality social interactions amongst workers as a foundation climate operating across levels of the organisation will assist in the promotion of positive organisation and group-level safety climates and group safety performance. Given the strength of the bivariate correlations and parameter estimates, partial support is found for Hypothesis 15.

#### **9.4. CSA Group-level Analysis**

On the basis of results for group-level EFA reported in Section 7.8 the management and supervisor safety climate scales were split into active and proactive dimensions for this series of group-level model testing. Figure 9.5 shows the hypothesised

construct relationships. Two additional models specifying the direct influence of social exchange on safety behaviours, and the cross effects of active and proactive safety climate dimensions were also tested. As depicted, the covariances between active and proactive dimensions of safety climate and work-group safety behaviours are specified in the modelling. Error terms were calculated and included in the model specification.



*Figure 9.5.* Hypothesised CSA group-level model of the predictive relationship between social exchange, safety climate and group safety behaviours.

All scales represented with a GROUP subscript are derived using CSA aggregation methods including OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange. Work Group Safety Behaviours- Active and Proactive are derived by direct aggregation of Individual Safety Behaviours of Workers using the ILSA approach.

Descriptive statistics, zero-order correlations and group-based alpha coefficients for the aggregated scales, are provided in Table 9.4. In support of Hypothesis 13 large positive correlations I found for all hierarchically aligned social exchange and safety climate variables. Additionally, significant moderate to large positive correlations between social exchange and safety climate variables and group safety behaviours offers initial support for the mediation model proposed in Hypotheses 12 and 14. Overall the pattern of correlations observed using both CSA and ILSA protocols are consistent. In support of Hypothesis 15 stronger correlations between variables were observed in both forms of group analysis than in the individual-level analysis.

However, the splitting of management and supervisor levels of safety climate into their active and proactive dimensions allows further investigation of the subtle differences in construct relations.

Table 9.4 *Means, Standard Deviations and Zero-Order Correlations for CSA Group Safety Behaviours, Safety Climate and Social Exchange Scales*

Variable	1	2	3	4	5	6	7	8	9	10	11
1 AOSC-MA	<b>.92</b>										
2 AOSC-MP	.82**	<b>.94</b>									
3 AMMX	.84**	.74**	<b>.96</b>								
4 AGSC-SA	.73**	.61**	.69**	<b>.92</b>							
5 AGSC-SP	.67**	.61**	.59**	.82**	<b>.93</b>						
6 ALMX	.56**	.39**	.57**	.73**	.72**	<b>.96</b>					
7 AGSC-CA	.62**	.50**	.55**	.53**	.50**	.28*	<b>.93</b>				
8 AGSC-CP	.73**	.67**	.63**	.59**	.60**	.43**	.76**	<b>.91</b>			
9 AGMX	.48**	.35**	.41**	.41**	.26*	.36**	.64**	.56**	<b>.91</b>		
10 GSB-WA	.50**	.42**	.41**	.57**	.50**	.32**	.72**	.65**	.57**		
11 GSB-WP	.60**	.54**	.46**	.50**	.63**	.36**	.62**	.72**	.38**	.72**	
Mean	3.60	3.86	3.43	3.64	3.82	3.78	3.82	3.80	3.80	4.14	4.02
SD	0.60	0.56	0.66	0.63	0.54	0.60	0.56	0.54	0.50	0.47	0.48

*Note.*  $N=77$  CSA group alpha coefficients are represented in bold on the diagonal. \* $p<.05$ , \*\* $p<.01$ : AOSC-MA= Aggregate Organisation Safety Climate-Managers Active; AOSC-MP= Aggregate Organisation Safety Climate-Managers Proactive; AGSC-SA=Aggregate Group Safety Climate-Supervisors Active; AGSC-SP=Aggregate Group Safety Climate-Supervisors Proactive; AGSC-CA= Aggregate Group Safety Climate- Coworkers Active; AGSC-CP= Aggregate Group Safety Climate-Coworkers Proactive; GSB-WA= Group Safety Behaviours- Workers Active; GSB-WP= Group Safety Behaviours- Workers Proactive; AMMX= Aggregate Manager-Member Exchange; ALMX=Aggregate Leader-Member Exchange; AGMX=Aggregate Group Member Exchange.

Of note is the trend for the perceived active and proactive safety practices of agents at higher levels of the organisation (i.e., manager and supervisor safety climate) to align more strongly with the corresponding active or proactive behaviours of workers. At the bivariate level, the strong correlations observed between AGSC-SA and AGSC-CP, and AOSC-MA with the proactive scales of both AGSC-C and group safety behaviours are notable exceptions to this trend. Again comparatively weaker correlations were found between ALMX and the active and proactive components of both GSC-C and G than for either AMMX or AGMX. A relatively weaker correlation was again observed between LMX and GSC-CA at the group-level.

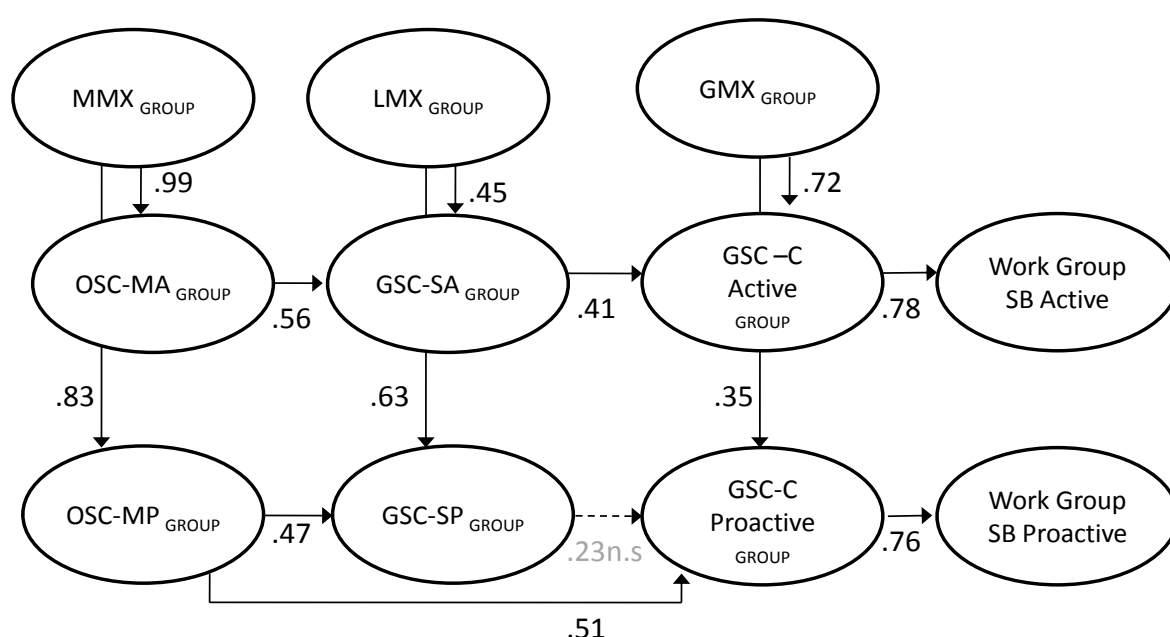
The group-level SEM with modelled error produced less than adequate fit in the initial runs with two of the three theoretical models failing to produce solutions. The first of these models also specified the direct paths between social exchange and safety behaviours. The second alternative model included the additional active-proactive safety climate cross effects. The failure of these models may be linked to the addition of too many pathways given the small sample size. However, running the full mediation model did not prove problematic. Examination of the modification indices in the mediation model recommended the inclusion of a direct path from AOSC-MP to AGSC-CP and several error covariances. As shown in Table 9.5 the independence model was easily rejected and the hypothesised mediation model proved only a fair fit to the data.

Table 9.5 *Assessment of Fit and Model Differences for the Work-level Model of Social Exchange and Safety Climate (CSA Group-level)*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	< .08	< .10
1.Independence	1424.84***	55	-	-	-	-
2.Mediation	101.64***	36	.95	.93	.06	.12 (.09,.16)
3.Part Mediation	90.75***	35	.96	.94	.05	.12 (.08,.16)
4.Part Mediation& Error	72.03***	34	.97	.95	.05	.10 (.05,.14)
5.Final Model	51.87*	32	.99	.96	.05	.07 (.00,.11)
Difference ( $\Delta\chi^2$ ) #1-#2	1323.2***	19				
Difference ( $\Delta\chi^2$ ) #2-#3	10.89***	1				
Difference ( $\Delta\chi^2$ ) #3-#4	18.72***	1				
Difference ( $\Delta\chi^2$ ) #4-#5	20.16***	1				

*Note.*  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

The standardised structural coefficients for the final model are represented in Figure 9.6 and the full measurement model is included in Appendix J. Chi square difference tests indicated a significant improvement in model fit for the final model which was found to provide a theoretically justifiable solution with excellent fit. As found for the ILAS derived model partial support of Hypothesis 12 was again found using the CSA derived indicators. However, the splitting of AOSC-M and AGSC-S into active and proactive dimensions served to clarify how the chain of psycho-social influence on safety operates down the organisational hierarchy.



*Figure 9.6.* Significant standardised coefficients for the CSA derived group-level model of social exchange, safety climate and group safety behaviours.

All scales represented with a GROUP subscript are derived using CSA aggregation methods including OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-CA= Group Safety Climate- Coworkers Active; GSC-CP= Group Safety Climate- Coworkers Proactive; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange. Work Group Safety Behaviours- Active and Proactive are derived by direct aggregation of Individual Safety Behaviours of Workers using the ILSA approach.

#### 9.4.1. Direct and Indirect Effects for Social Exchange

Parameter estimates for the group-level direct and indirect pathways between Social Exchange constructs, the dimensions of Safety Climate and aggregated Group Safety Behaviours for the final model are presented in Tables 9.6 and 9.7.

Table 9.6 *Parameter Estimates for Social Exchange effects in the Work-level Model of Social Exchange and Safety Climate (CSA Group-level)*

Path	Direct Effect			Indirect Effect		Total Effect	
	St	Unst	SE	Unst	SE	Unst	SE
<b>AMMX</b>							
→AOSC-MA	0.99	0.88*** (0.75,1.01)	.067			0.88***	.07
→AOSC-MP	0.83	0.68*** (0.53,0.83)	.076			0.68***	.08
→AGSC-SA				0.51***	.09	0.51***	.09
→AGSC-SP				0.30***	.07	0.30***	.07
→AGSC-CA				0.18**	.06	0.18**	.06
→AGSC-CP				0.40***	.08	0.40***	.08
→GSB-WA				0.13**	.04	0.13**	.04
→GSB-WP				0.29***	.06	0.29***	.06
<b>ALMX</b>							
→AGSC-SA	0.45	0.46*** (0.26,0.66)	.10			0.46***	.10
→AGSC-SP	0.63	0.55*** (0.38,0.71)	.085			0.55***	.08
→AGSC-CA				0.17**	.05	0.17**	.05
→AGSC-CP				0.13n.s	.07	0.13n.s	.07
→GSB-WA				0.12**	.04	0.12**	.04
→GSB-WP				0.09n.s	.05	0.09n.s	.05
<b>AGMX</b>							
→AGSC-CA	0.72	0.85*** (0.56,1.13)	.15			0.85***	.15
→AGSC-CP	0.35	0.38** (0.14,0.63)	.12			0.38**	.12
→GSB-WA				0.59***	.11	0.59***	.11
→GSB-WP				0.28**	.09	0.28**	.09

*Note.* St= Standardised; Unst= Unstandardised; Estimate 95% confidence interval in parenthesis, SE=Standard Error, \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$ ; AOSC-MA= Aggregate Organisation Safety Climate-Managers Active; AOSC-MP= Aggregate Organisation Safety Climate-Managers Proactive; AGSC-SA=Aggregate Group Safety Climate-Supervisors Active; AGSC-SP=Aggregate Group Safety Climate-Supervisors Proactive; AGSC-CA= Aggregate Group Safety Climate- Coworkers Active; AGSC-CP= Aggregate Group Safety Climate- Coworkers Proactive; GSB-WA= Group Safety Behaviours- Workers Active; GSB-WP= Group Safety Behaviours- Workers Proactive; AMMX= Aggregate Manager-Member Exchange; ALMX=Aggregate Leader-Member Exchange; AGMX=Aggregate Group Member Exchange.

Examination of the unstandardised structural equations for the final model indicated significant positive relationships between AMMX and both Active and Proactive AOSC-M. The direct paths between ALMX and both AGSC-SA and AGSC-SP were also significant. Positive relationships were also observed between AGMX and both AGSC-CA and AGSC-CP when ALMX and AMMX were controlled. The modelling of direct effects for the social exchange indicators across work-levels

showed that the quality of social exchanges experienced within work-groups has a different pattern of association with workers' perceptions of active and proactive safety climate. The effects overall were medium to large, with the strongest associations being observed between both AMMX and the active dimension AOSC-M; and AGMX with the active dimension of coworker safety climate. In contrast, the relatively weakest associations were observed for group- member social exchange and proactive group safety climate-coworker and leader-member exchange with the proactive dimension of supervisor safety climate.

In relation to the indirect impact of social exchange variables on group-level safety climate the indirect pathways from AMMX to the four Supervisor and Coworker climate dimensions were statistically significant. The indirect effects of AMMX on Group Safety Behaviour were slightly weaker for the active dimension than for the proactive subscale. While the indirect effects of ALMX on Coworker Safety Climate may be considered small, the path to GSC-CA was significant. This pattern of association was replicated with the small indirect effects found between ALMX and both group safety behaviour subscales. Medium to large indirect effects were also observed for the influence of AGMX on both Active and Proactive Group safety behaviours.

Overall these results show a relatively consistent pattern of association between constructs when CSA aggregation is applied compared to ILAS or individual-level analysis. However, the separation of management and supervisor safety climate into active and proactive components allows more concise examination of how the quality of social exchanges occurring within work-groups are differentially associated with the perceived level of specific compliance or participative safety practices taking place.

#### **9.4.2. Direct and Indirect Effects for Safety Climate**

In relation to the safety climate measures a one point increase in work-group ratings of active management safety practices resulted in a significant 0.58 point increase in their ratings of active safety climate at the supervisory level. The respective increase in the proactive domain was marginally less at 0.44 scale points. Moving down the

organisational hierarchy, a one unit increase in AGSC-SA resulted in a 0.36 unit increase in Coworker Active Climate. While the direct path between AGSC-SP and AGSC-CP was significant in the full mediation model, when the path between AOSCMP and AGSC-CP was included, this mediation pathway was no longer significant. However, the nonsignificant AGSC-SP to AGSC-CP pathway was retained in the final model as fit indices were reduced when it was dropped from the model. In line with previous results strong, positive associations were found between coworker climate and group safety behaviours.

Table 9.7 *Parameter Estimates for Safety Climate effects in the Work-level Model of Social Exchange and Safety Climate (CSA Group-level)*

Path	Direct Effect			Indirect Effect		Total Effect	
	St	Unst	SE	Unst	SE	Unst	SE
<b>AOSC-MA</b>							
→AGSC-SA	0.56	0.58*** (0.37,0.78)	.10			0.58***	.10
→AGSC-CA				0.21**	.07	0.21**	.07
→GSB-WA				0.15**	.05	0.15**	.05
<b>AOSC-MP</b>							
→AGSC-SP	0.47	0.44*** (0.25,0.62)	.09			0.44***	.09
→AGSC-CP	0.51	0.48*** (0.21,0.75)	.14	0.10n.s	.06	0.58***	.11
→GSB-WP				0.42***	.08	0.42***	.08
<b>AGSC-SA</b>							
→AGSC-CA	0.41	0.36*** (0.19,0.53)	.09			0.36***	.09
→GSB-WA				0.25***	.06	0.25***	.06
<b>AGSC-SP</b>							
→AGSC-CP	0.23	0.23n.s (-0.02,0.49)	.13			0.23n.s	.13
→GSB-WP				0.17n.s	.10	0.17n.s	.10
<b>AGSC-CA</b>							
→GSB-WA	0.78	0.70*** (0.54,0.86)	.08			0.70***	.09
<b>AGSC-CP</b>							
→GSB-WP	0.76	0.73*** (0.55,0.91)	.09			0.73***	.09

*Note.* N=77; St= Standardised; Unst= Unstandardised; Estimate 95% confidence interval in parenthesis, SE=Standard Error, \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$  AOSC-MA= Aggregate Organisation Safety Climate-Managers Active; AOSC-MP= Aggregate Organisation Safety Climate-Managers Proactive; AGSC-SA=Aggregate Group Safety Climate-Supervisors Active; AGSC-SP=Aggregate Group Safety Climate-Supervisors Proactive; AGSC-CA= Aggregate Group Safety Climate-Coworkers Active; AGSC-CP= Aggregate Group Safety Climate- Coworkers Proactive; GSB-WA= Group Safety Behaviours- Workers Active; GSB-WP= Group Safety Behaviours- Workers Proactive.



The unstandardised coefficients for the final model indicated that the indirect relationships between the active dimensions of AOSC-M and AGSC-C represented a small but significant effect. Due to the specification of the direct effects between the proactive subscales of AOSC-M and AGSC-C the indirect relationships was not significant, however the total effects for this pathway were significant. The indirect pathways from the active and proactive AOSC-M dimensions to the corresponding GSB-W scales were both statistically significant. The positive associations between AGSC-SA and Active Group Safety Behaviours were fully mediated by the corresponding coworker safety climate dimensions however the indirect effects of AGSC-SP on Proactive GSB was not significant.

To determine the practical significance of the CSA findings, disturbance terms from the structural equations for the endogenous variables in the model were assessed. In the final model the percentage of explained variance for all variables are considered large effects. Results indicated that 61% of variance in Active Work-group Safety Behaviours and 58% of Proactive safety practices (51% and 40% respectively based on reduced form equations) may be explained by our understanding of the facet-specific safety climate and foundation social exchange climates operating within the organisation. The effect size for the active safety behaviour dimension is less than that observed in the individual- level model, however in all other instances the proportion of variance in safety climate that is explained by the model is greater using the CSA method than the ILAS or individual- level approach, supporting Hypothesis 15.

Furthermore, our understanding of how the processes of social exchange and safety climate impact on individuals' safety behaviours is enhanced by splitting the more distal safety climate constructs into active and proactive dimensions. Working down the organisational hierarchy, workers' ratings of the quality of social exchanges managers engage in with their subordinates was found to be strongly aligned with workers' perceptions of management's commitment to safety. This effect was most pronounced for the active dimension of management safety climate where AMMX explained 97% of the variance. In comparison, 69% of variance in the Proactive subscale was explained.

The influence of ALMX and both active and proactive aspects of AOSC-M in combination accounted for 83% and 93% of the variance in AGSC-SA and AGSC-SP respectively. When accounting for the variance in both the active and proactive AGSC-C subscales slightly different predictive equations were derived, however in both cases over 80% of variance can be accounted for (Active= 87%; Proactive 82%). These effects are substantially stronger than observed with the alternate methodologies applying the single construct operationalisation of management and supervisor safety climate. The separation of management and supervisor safety climate scales into active and proactive dimensions allowed a clearer picture of the chain of psycho-social influence to emerge.

## **9.5. Discussion**

My overall objective of this chapter was to investigate how the climate for social exchange influences safety climate and workers' active and proactive safety performance. By using a level-of-analysis approach rather than global treatment of constructs in this set of analyses, it was possible to see the differential impact that social exchange and safety climate dimensions have on workers' safety behaviours. The use of the multilevel approach to construct operationalisation and data treatment constitutes one of the major theoretical contributions of this thesis.

### **9.5.1. Climate for Social Exchange**

Hypotheses 13 and 14 proposed that high quality social exchanges would support positive perceptions of safety climate at the corresponding work-level and that the impact of social exchange climate on safety behaviours would be fully mediated by positive safety climates within the organisational hierarchy. Research to date has found evidence of the safety benefits to be gained from organisations providing supportive environments (Nahrgang et al., 2011), however the main theoretical and empirical focus has been on leadership style and generic organisational support. The importance of worker inter-relationships in predictive safety models has also been implied in a recent meta-analysis by the strong associations found between individual safety behaviours and both internal group processes (Christian et al., 2009) and coworker support (Nahrgang et al.). However, the issue of poor construct distinction between safety climate, leadership and coworker support scales has been raised as a concern. To minimise this potential confound, I adopted a levels-of-analysis

approach, as recommended by Zohar (2010), in which social exchange and safety climate constructs were separated into well-defined work-level dimensions.

Results for all three analyses of the full social exchange model indicate that workers' perceptions of the quality of social exchanges occurring at each level of the organisational hierarchy are closely and positively associated with their perception of safety climate at the corresponding level. Furthermore, the distal influences of management and supervisor workplace social exchanges and their perceived commitment to safety were found to indirectly impact individual safety behaviours through the establishment of strong group safety norms represented by coworker safety climate. As such both Hypotheses 12 and 14 were supported.

The initial examination of the zero-order correlations for individual and both group level analytic treatments showed a pattern of strong to moderate positive correlations between safety climate, social exchange and individual safety behaviours offering initial support for the full mediation model between social exchange and safety behaviours. In particular, strong associations were observed between social exchange and safety climate variables at the same work-level; the largest of these associations being at the management level. This strong correlation may be due to workers adopting an overall heuristic to gauge the positive or negative performance of their managers across the range of social exchange and safety climate items. Indeed the trend for the magnitude of effects for the social exchange -safety climate relationship to diminish down the organisational hierarchy indicates that workers are more capable of differentiating between social interaction referents and safety commitment referents when rating more physically and functionally proximal organisational agents such as coworkers and their immediate supervisors than managers who have a more distal relationship.

Of note were the relatively weaker associations observed between group- member exchange and both active and proactive coworker safety behaviours. When comparing across methodologies the relationship trends between social exchange and safety climate were largely replicated when utilising the individual- level analysis and ILSA approach, with slightly weaker correlations being observed in the ILSA

model. In particular, aggregating the data to the group-level resulted in a substantial attenuation of the pathway between-group member social exchange and coworker proactive practices. In contrast, no reduction was observed with the active subscale. For the CSA model the relatively weaker association between-group social exchange and the proactive coworker safety climate dimension was replicated, however the relationship with the active subscale was substantially increased compared to the parameter estimate obtained for this pathway in either the individual or ILSA models.

Of particular interest in the CSA model was the pattern of social exchange -safety climate associations across the organisational work-levels. The separation of the management and supervisor safety climate scales into active and proactive dimensions in the CSA model showed a degree of differentiation in the relationships observed with the social exchange antecedents. For example, at the management level, MMX was most closely associated with active management practices (97% of variance explained) compared to proactive climate (69%). In contrast, at the group-level LMX was more strongly associated with the proactive dimension of supervisory safety climate than with supervisor active safety practices. When considered in combination with the validation results reported in Chapter 7 these differential associations indicated that front-line workers clearly distinguished between safety and relationship-related climate referents as proposed by Zohar and Luria (2005).

As no previous research has examined climate for social exchange in a safety context applying the collective group referent used here, replication of my results is required to ascertain the generalisability of the relationships observed. Furthermore, in making comparison with the extant literature below it is important to note that general organisational climate and the foundation climate for social exchange described in this thesis are not theoretically the same. Instead the climate for social exchange may be considered as only one facet within the broader conceptualisation of organisational climate as defined by James and colleagues (L. A. James & James, 1989; Jones & James, 1979). As described in Chapter 2, general organisational climate includes components such as leader support and facilitation, autonomy and

workgroup cooperation; therefore it is plausible to argue that constructs represented in the climate for social exchange fit within the scope of general organisational climate.

That being established, my results are consistent with Neal et al.'s (2000) proposal that general organisational climates not only predict facet-specific climates but that the facet-specific climate mediates the influence of more general climates on outcomes relevant to the domain of enquiry. The strength of the associations observed in my research are generally stronger than past findings investigating general organisation climate as a context for safety climate development (DeJoy et al., 2004; see Larsson et al., 2008; Neal et al., 2000; Silva et al., 2004; Wallace et al., 2006). In a hospital setting, Neal and colleagues showed that the relationship between general organisational climate and individual safety behaviours was fully mediated by safety climate (Neal et al., 2000). However, as Neal et al. operationalised general and safety climate as individual-level constructs the magnitude of the strong, positive relationship ( $r = 0.52$ ) they found between organisational climate and safety climate should be compared against the range of social exchange - safety climate correlations reported for my individual-level model ( $r$  values ranged from 0.56 - 0.83), all of which were stronger than Neal et al.'s result.

Silva and colleagues (2004) also found that general climate explained 52% of the variance in safety climate. When compared against the effect sizes found for organisation-level management safety climate and group-level supervisor safety climate using the ILSA and CSA models, the results of my study again show stronger effects. In this instance the magnitude of effects observed in my research indicates that climate for social exchange provides a viable measure of a foundation climate influential in the safety domain.

Hofmann and Morgeson (1999) have described how social exchange theory provides a conceptual framework to explore key aspects of organisational behaviour in a safety context. They showed that both perceived organisational support and LMX had significant associations with safety communication and that LMX also showed

significant associations with commitment. Hofmann and Morgeson concluded that the more proximal exchange relationship with direct supervisors was more critical in fostering better safety communication, commitment to safety and fewer injuries in group leaders than more distal organisational support. Even though they collected data from supervisor and group leader dyads, rather than front-line workers, the replication of stronger bivariate correlations between more proximal social exchange relations and safety climates in my study indicates that the social exchange relationship with safety variables appear consistent across samples.

A comparison of effect sizes for social exchange can be made with Wallace et al.'s (2006) study examining the mediated relationship between foundation climates, safety climate and accidents. As part of their model, Wallace et al. examined the association between organisational support (using a generic organisation referent) and supervisor safety climate at the group-level of analysis. While I did not model this cross level association, a comparison of Wallace et al.'s group-level correlations against my ILSA results showed that the bivariate associations between MMX and group-level supervisor safety climate were considerably stronger in my study (ILSA  $r=.68$  compared to  $r=.48$ ). This difference may simply be an artefact of the sample populations; however an alternative explanation for these results may be that the alignment of climate constructs within work-levels optimises the magnitude of associations observed. Additionally, in my study the use of a specific management referent and collective focus on the group rather than the individual in all climate scales may have contributed to the stronger associations.

In my initial review of the social exchange and safety literature, I identified that two key issues required greater attention. These were the need to ensure construct distinction between safety-specific climates and foundation climates associated with leadership or social support and the importance of distinguishing between organisational referents in climate inventories. I have argued that without an explicit focal referent, that allows the clear differentiation of item content tapping social support and the safety practices of the different agents across the organisational hierarchy, the precision of safety climate survey instruments is likely to be compromised and the interplay between constructs potentially confounded. The

strength of associations found in my study offer some support to the validity of this argument, however further replication of study protocols is required to assess if the results are an artifact of the sample.

Furthermore, by comparing results obtained using individual and group-level data, I have been able to show that while the pattern and strength of relationships are relatively robust across statistical treatments, subtle differences emerge when the nonindependence of organisational data is recognised and group-level analysis undertaken. For example, for the individual-level model, management safety climate was shown to have both a direct and indirect influence on the active and proactive aspects of group-level coworker safety climate. Using the ILSA approach the direct influence of management safety climate was shown to impact proactive group practices but not active safety practices. When the CSA approach was applied management's engagement in proactive safety practices was shown to directly influence proactive normative safety practices (overriding the direct influence of supervisors).

Additionally, when workers' perceptions of the quality of social exchanges were modelled using the CSA methodology, the patterns of association with safety climate at the corresponding level of the organisational hierarchy were shown to be stronger than those observed in the two alternate data treatments. Also, the unexpected negative association between LMX and active coworker safety climate observed in the ILSA analysis was not replicated when the CSA approach was used. In the CSA model the indirect effects of group based leader-member exchange showed a small but significant positive relationship with coworkers' active safety practices and a nonsignificant positive relationship with the proactive subscale. These disparities indicate that the nature of the safety climate – social exchange relationship at the supervisor level may be more complex than previously considered. For example, it may be that some supervisors who are rated by workers as having relatively lower LMX scores (perhaps having a more authoritarian style of leadership) are still successful in establishing a positive workgroup safety climate, in particular in terms of worker compliance.

Overall my results support the proposal that establishing high quality social interactions amongst workers as a foundation climate operating across levels of the organisation will assist in the promotion of positive organisation and group-level safety climates.

### **9.5.2. Safety Climate and Safety Behaviours**

Within the broader scope of the multilevel social exchange safety model, it was also possible to test the hypothesis that the differential influence of safety climate on individual safety behaviours would be best represented by a fully mediated model operating through the active and proactive safety commitment of coworkers (Hypothesis 12). My results indicated that a partial mediation model, including the direct influences of more distal organisation-level management safety climate on coworker safety climate dimensions, provided the best fit to the data, with only minor variations across the three analysis methodologies. While the hypothesised full mediation model proposed in Hypothesis 12 was not supported, the partial mediation model including the direct influences of management safety commitment on proactive coworker safety climate in the ILSA and CSA models, and both active and proactive coworker climate in the individual-level modelling, is theoretically justifiable.

To summarise the pattern of within construct safety climate associations found in my study, the most distal dimension of safety climate, associated with management commitment to safety, was found to have a major impact on supervisory safety practices. The influence of both management and supervisor climate dimensions had strong associations with both the active and proactive subscale of coworker climate. While all three analytic treatments produced generally consistent results, overall the CSA model, distinguishing between active and proactive dimensions of management and supervisor safety climate, provided the clearest picture of the chain of influence impacting on workers' safety behaviours.

When individual-level modelling was undertaken, safety climate and social exchange accounted for a greater percentage of variance in active safety behaviours (82%) than proactive behaviours (53%). Furthermore, my individual-level results conflict with past meta-analytic results (Christian et al., 2009; S. Clarke, 2006; Nahrgang et al.)



that have found safety climate to have a stronger relationship with workers' participative safety behaviours than compliance. The magnitude of these associations and the increased relationship between safety climate and active safety practices of workers is most likely associated with the expansion of the safety climate construct to include coworker commitment to safety, but may also be linked to response biases in the data.

To expand, in the two group-level analyses, the explained variance in the active safety performance dimension was substantially reduced (Individual- level =82%, ILSA=51%: CSA= 61%), however the same degree of attenuation was not found for the proactive subscale (Individual- level =53%, ILSA=61%: CSA= 58%). As argued previously, employee ratings on the active safety behaviour scale are likely to be the most susceptible to social desirability responses. The subsequent aggregation of data to the group-level may reduce the impact of such cases either intentionally through the averaging of responses across the group or inadvertently through the omission of anomalous data from the analysis (i.e., workers who were the only respondents for their work group).

Despite this statistical aberration the magnitude of effects between the group safety climate and both active and proactive safety performance were still substantially higher than organisational safety climate correlations previously reported in meta-analyses (Christian et al., 2009) or observed more recently in Jiang et al.'s study (2010). In addition, the explained variance in workers' active and proactive safety practices was more modest when using the individual-level modelling and ILSA approach compared to the CSA analysis. I argue that this was due to the separation of management and supervisor safety climate into active and proactive dimensions allowing the linkages between aligned safety practices at the different organisational work-levels to be modelled more effectively. For example, a worker's willingness to follow rules such as wearing protective safety equipment (workers' active safety practices) is likely to be strongly associated with the provision of correct equipment and monitoring of rule compliance (management and supervisory active safety climate) when their coworkers are also complying with the procedure (coworker active safety climate). Likewise the uptake and engagement in safety training by

workers (proactive safety practice) is likely to be strongly associated with workers' perceptions of the provision of quality training programs by management (proactive management safety climate).

In terms of the different patterns of association anticipated to occur between safety climate and the two safety behaviour scales, when comparing results for the individual-level and ILSA models it appears that the active safety behaviours of workers are more closely linked to the normative practices of coworkers than workers' proactive practices. However the extent of this differentiation is reduced in the CSA model where the link between the group norm and safety performance of individuals is equally strong for both active and proactive practices.

My results are therefore generally consistent with Jiang et al.'s (2010) findings as they also reported correlations of similar magnitude between workers' perceptions of their colleagues' safety knowledge and behaviour, and self-reported compliance and participative safety practices. In addition, Jiang et al. also identified stronger correlations between workers' safety performance and safety norms compared to management safety climate; however the overall effects were far weaker than those found in my study. Jiang et al. found that unit-level safety climate moderated the influence of group norms on safety behaviours such that both compliance and participative worker practices were strongest in work-groups with both high management commitment to safety and positive safety norms. As the main focus of Jiang et al.'s study was on the role coworkers' normative safety behaviour plays in workplace safety, the similarities observed between their and my results reinforce the importance of establishing positive group safety norms in both Chinese and Australian workplaces.

While the impact of coworkers' normative behaviours on an individual's intentions and performance has been well established in the Theory of Planned Behaviour literature (Ajzen, 1991), only recently has a TPB model been applied in the safety domain (Fogarty & Shaw, 2010). Fogarty and Shaw found that group safety norms mediated the link between management safety attitudes, workers' intentions to violate procedures and self-reported violations. These outcome measures can be conceptualised as the opposite of safety compliance practices used in my research.

The similar pattern of associations found in my study and Fogarty and Shaw's results provides evidence that the relationships investigated are robust whether measuring outcomes negatively as violations or positively as safety compliance.

A key finding of my study is therefore the important role coworker commitment to safety plays in the workplace. My results indicate that the distal influences of management and supervisor commitment to safety exert their influence on individual workers' safety behaviours indirectly through the establishment of strong group safety norms represented by coworker safety climate. This effect was sustained across data treatments and was supported by supplemental analysis which showed that coworker commitment to safety accounted for additional variance in worker's safety behaviours when the influence of management and supervisor commitment to safety was controlled for. Indeed a main objective of this research was to investigate the relationships between the work-level based safety climate dimensions, with the intention of advancing our understanding of how the separate dimensions of safety climate impact on each other and individual workers' safety behaviours.

While little research to date has examined the interrelations between safety climate dimensions, Tomás et al. (1999) found significant relationships between safety climate (representing mainly management actions and safety goals), supervisors' safety responses and coworkers' safety responses. Their modelling did not support the direct impact of safety climate on coworkers' safety response. Instead they identified significant direct paths between supervisor safety responses and workers' safety compliance behaviours. In contrast to Tomás et al.'s findings, the inclusion of the direct pathways between supervisor safety climate and workers' safety performance were not supported in my modelling. However, my results do indicate the importance of both the direct and indirect influence of management and supervisor safety climate on coworker safety norms and show how both distal climate dimensions indirectly impact on active and proactive safety performance. To clarify further, I found stronger total effects for the relationship between management safety climate and proactive worker behaviours than for active behaviours. In contrast, my results also indicate that the relationship between supervisor climate and workers' active safety performance is stronger than for

proactive practices. Again, the nature of these relationships was most clearly defined using the CSA methodology in which supervisor and management safety climate was separated into active and proactive subscales, supporting the greater utility of this approach to group-level analysis.

In sum, these results have both theoretical and practical implications in that they reinforce the long established notion in the extant literature and with safety practitioners that managers and supervisors play a key role in workplace safety, while expanding our understanding to show that this influence manifests through the establishment of positive coworker safety norms in the workplace. When reviewing the safety literature, it was apparent that research to date has focused on investigating the more formal influences of management and supervisors on safety, to the neglect of the influences exerted by coworkers. My results add weight to the argument that establishing a positive safety climate across all the levels of the organisation is instrumental in both reinforcing the importance of rule compliance and encouraging workers to engage in more proactive safety activities. While supervisors play a particularly vital role in encouraging, and ensuring workers comply with, safety procedures, it appears that higher-level management commitment to safety has a more telling role in fostering worker engagement in proactive safety practices. Importantly, establishing high quality social exchange interactions amongst employees at all levels of the organisation will assist in the promotion of positive organisation and group-level safety climates.

The process undertaken in my thesis highlights the efficacy of using CSA aggregation when functional work-groups are the central level of analysis. The variation in factor structures and subsequent SEM results found using the various methodologies justify Shannon and Norman's (2009) concerns regarding the need for researchers to account for the nonindependence of data in their samples when deriving factor structures as well as when modelling predictive relationships. While the issue of using correct measurement metrics for scale development at aggregate levels of analysis is far from simple, one theoretical implication of my thesis is that not applying the appropriate ILSA or CSA techniques for each construct as recommended by Peterson and Castro (2006) may be detrimental to the results achieved.

In sum my results add weight to Zohar's (2008, 2010) recent recommendations that researchers should seek to understand the patterns of relationships between general and facet-specific climates across the organisational hierarchy. As no studies examining with the relationships between foundation climates, facet-specific safety climate and safety outcomes have investigated the three dimensions of social exchange, as undertaken in my thesis, my results contribute to the extant literature by advancing our understanding of how supportive environments promote safety in the workplace.

## 10. Overall Discussion

### 10.1. Introduction

Accidents and injuries in organisations continue to be a major concern to all vested parties, as researchers and safety practitioners strive to identify ways to minimise their occurrence. One avenue of investigation has identified safety climate as a lead indicator of an organisation's safety standing. The general aim of my research was to examine the relationships between key organisational predictors of employee safety outcomes by developing and testing a multilevel model of safety climate and social exchange using both individual and group-levels of analysis. Specifically the objectives of my research were:

- To develop a measure of safety climate, using a level-of -analysis approach that incorporates the active and proactive safety practices of organisational agents.
- To examine organisational differences in safety climate profiles representing climate level, strength and variability.
- To investigate how the relationship between employee perceptions of management, supervisor and work-group commitment to safety (i.e., levels of safety climate) influence individual employees' safety performance and safety outcomes (e.g., injuries, near misses and micro-accidents).
- To investigate how the climate for social exchange, including the management, supervisory and coworker social exchanges, influences perceived safety climate level and workers' safety performance.
- To examine potential differences in the hypothesised construct structures and relationships for the multilevel model of safety climate when analysed at the individual and group-level.

In this chapter I discuss the key findings of my study. I also identify methodological strengths and limitations of the research in terms of the conceptual framework for organisational safety research described in Chapter 1, which guided my research. Theoretical and practical implications are described and three ideas presented for future research to lead on from my findings that address the themes identified in the safety research framework.

## **10.2. Key Findings**

### **10.2.1. Validation of scales**

The first phase of my research focused on validating scales incorporated in the proposed multilevel operationalisation of safety climate. While determining the content range and dimensionality of safety climate has long been acknowledged as a problematic issue in the safety literature (Beus, Payne, et al., 2010; Guldenmund, 2000), in line with Zohar's (2010) recommendations I adopted a stratified approach to construct development using clearly defined organisational referents to improve the alignment of item content within and across organisation-levels. By adding coworker safety practices to Zohar and Luria's existing organisational and group-level operationalisation of safety climate many of the dimensions previously identified as components of safety climate (e.g., reporting, monitoring, procedures, safety awareness, training, communication, role of safety reps, coworker support) were incorporated at the appropriate level of analysis ensuring functional relevance to the work-level concerned .

The pattern and strength of associations observed in both exploratory and confirmatory factor analyses supported the validity of a three-level model of safety climate, distinguishing between management, supervisor and coworker commitment to safety. A two-factor structure representing the active and proactive safety practices of coworkers was supported when tested using both individual and group-level factor analyses. Different factor solutions emerged for the more distal management and supervisor safety climate dimensions, with a two-factor solution representing active and proactive safety practices for each scale only emerging when tested at the group-level. My results support the utility of adopting a level-of-analysis approach in the operationalisation of the safety climate construct.

Furthermore, expanding the level-of-analysis approach facilitated the operationalisation of climate for social exchange as a potential antecedent of safety climate. As Zohar and Luria (2005) have argued that constructs that fuse leadership style and safety priorities are problematic, by using clearly defined referents it was possible to ensure the discriminant validity between relation-based and safety focused constructs in a rigorous and theoretically meaningful manner. The factor

validation of the three proposed social exchange scales, tapping workers' social exchanges with management, supervisors and coworkers, showed that all scales had a one-dimensional structure. Importantly the use of a collective referent shift to the group, rather than on individual dyadic social exchanges and more specific management referents in the leader scales, did not compromise the psychometric properties of these scales. These changes facilitated the treatment of all three social exchange constructs as dimensions of a foundation climate for social exchange. A further key finding was that the fully stratified work-level model of social exchange and safety climate provided a superior fit compared to the global construct domain model, offering support for the use of first order safety climate and social exchange variables in predictive models.

In addition the splitting of safety performance into active and proactive dimensions and establishing the discriminant validity between coworker safety climate and workers' self-reported safety behaviours offered the opportunity to examine safety performance (one of the core constructs used in safety research) in a more critical manner. In particular my results showed how attribution and social desirability response biases differentially impact on the two dimensions of self-report safety behaviours. In particular the active dimension of workers' safety performance incorporating typically "within job role" safety expectancies, is more likely to be subject to response biases than the proactive dimension incorporating "beyond job role" or safety citizenship expectancies (Hofmann et al., 2003).

### **10.2.2. Global Safety Climate and Outcomes**

While establishing the validity of scales used in research is paramount, Zohar (2010) recently called for safety research to shift its focus away from definitional issues to functional processes and explanatory models using a level-of-analysis approach. Consistent with this, the second phase of my research modelled the association between safety climate, individual safety behaviours and safety outcomes within the broader social context of the organisation using both individual-level and group-level analysis. To replicate the general trend within safety research, I first modelled the safety climate -safety outcomes relationship using a global conceptualisation of safety climate. This analysis allowed direct comparisons with existing studies, which



subsequently allowed me to conclude that the addition of coworker safety climate added to the predictive utility of the construct.

My results for the individual-level data analysis indicated that a direct relationship between global psychological safety climate and both safety behaviours and outcomes provided the best fit to the data. In contrast the proposed full mediation model was supported at the group-level of analysis. A strong relationship between global safety climate and safety behaviours was observed across all models. The substantial increases in effect sizes compared to results reported in meta-analyses (Christian et al., 2009; S. Clarke, 2006) supported the predictive utility of the global safety climate construct when active and proactive coworker safety practices were added. Overall stronger construct relationships were identified in the group-level analyses compared to the individual- level analyses.

The small effect size observed when predicting individual safety outcomes was relatively consistent with past findings based on individual- level retrospective, self-report data (Christian et al., 2009). However the increased effect size in my group-level results was greater than those observed for group-level studies using self-report injury data. These relatively larger effects may be attributed to the inclusion of coworker safety climate in the global construct and also the use of minor injuries and near miss incidents as safety outcomes. Indeed the use of these two safety outcome indices proved to be very effective with the greater range and variability in the measures adding support to the utility of the data collection method and retrospective time span for incident recall adopted in my research.

In combination the key findings from this chapter led me to conclude that group-level analysis offers the best opportunity to track the relationship between safety climate and safety outcomes. While strong direct associations exist between safety climate, workers' safety behaviours and workers' self-reported injuries and incidents when the influence of reporting biases in workers' safety behaviours are controlled in group-level analysis it is clear that a mediation model provides the best description of the nature of the safety climate- outcomes relationship.

### **10.2.3. Climates for Social Exchange and Safety**

Having established the predictive validity of the global model of safety climate my next objective was to investigate the patterns of interaction between the dimensions of safety climate and their potential antecedents. To date, empirical findings have indicated that the general organisational climate provides the context in which more specific facet climates, such as safety climate, emerge (Nahrgang et al., 2011; Neal et al., 2000). Whereas the foundation climates so far examined in the safety literature have represented a variety of contextual workplace dimensions, my results showed strong direct links between dimensions of climate for social exchange and safety climate operationalised at the same hierarchical level of the organisation, and indirect links with workers' safety behaviours. The relationships between constructs were relatively robust across the different analytic treatments, with the exception that the strength of effects were generally attenuated when using individual- level data.

When group-level analysis, using the CSA approach to data aggregation, was conducted the modelling of direct effects for the social exchange indicators across work-levels showed that the quality of social exchanges experienced within work-groups has a differential pattern of association with workers' perceptions of active and proactive safety climate. The splitting of management and supervisor safety climate measures into active and proactive dimensions served to clarify how the chain of psycho-social influence on safety operates down the organisational hierarchy. As such my results indicated that in addition to differences in results occurring due to the level of analysis selected, applying different aggregation methodologies can also significantly influence findings. In particular, potentially important construct relationships may have been overlooked if the nested nature of organisational data was not taken into consideration.

A key finding of my study is that establishing high quality social interactions amongst workers as a foundation climate operating across levels of the organisation will assist in the promotion of positive organisation and group-level safety climates. This finding is complimented by the evidence provided that while managers and supervisors' commitment to safety play a key role in workplace safety, their influence on individual workers' safety performance can be reinforced or diluted by the prevailing safety practices of coworkers. Again while these relationships are

robust across the methodologies applied when group-level analysis using CSA derived construct are used the clearest and most theoretically justifiable representation of construct structures and relationships is produced.

In combination my findings add empirical support to Zohar's (2010) integrated model of safety climate and outcomes in which the process of *sense-making* is shown to provide a foundation for a modified version of the safety pyramid. In Zohar's multilevel model the social and cognitive exchanges between leaders and workers play a crucial role in the formation of climate perceptions. Safety climate in turn guides workers' behaviours which underlie the occurrence of safety incidents and injuries. In linking foundation climates, safety climate, individual workers' behaviours, safety incidents and injuries as illustrated in Figure 10.1 my research provides empirical evidence to support Zohar's safety pyramid.

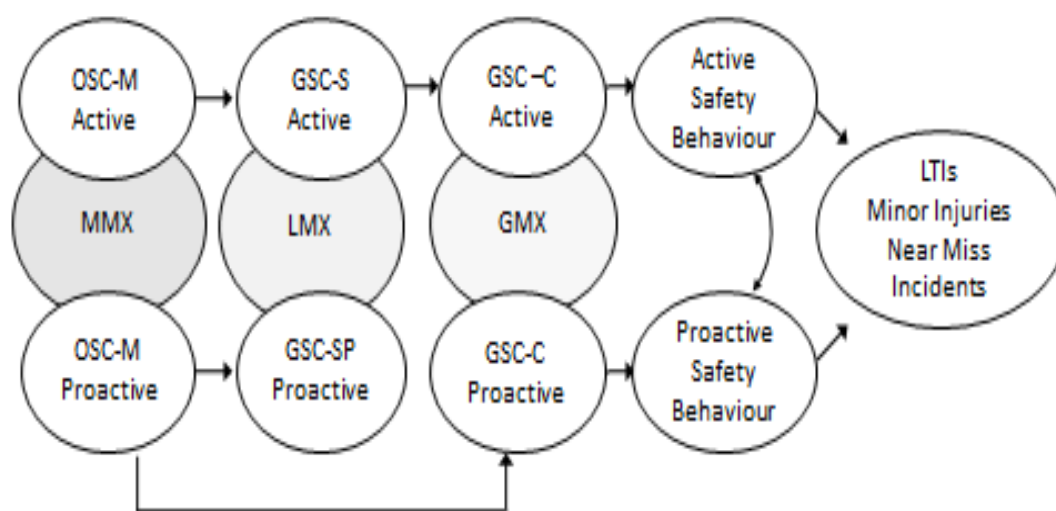


Figure 10.1. Work-level model of foundation and safety climate

Note: OSC-M= Organisation Safety Climate-Managers; GSC-S=Group Safety Climate-Supervisors; GSC-C= Group Safety Climate- Coworkers; MMX= Manager-Member Exchange; LMX=Leader-Member Exchange; GMX=Group Member Exchange.

However I would argue that if a metaphor for safety is to be applied, a safety iceberg is a more accurate representation of the nature of organisation safety; with injuries and accidents comprising the highly visible tip of the iceberg and prevailing safety environment forming the larger, yet unseen underlying structure that ultimately has

the potential to cause the most damage. The broader organisational climate, and in particular supportive social environment, then forms the ocean in which the safety iceberg is sustained. My results indicate that to reduce the size of the tip of the iceberg, modifying the environment in which it exists may provide the greatest opportunity to achieve pervasive change.

The following sections examine the methodological limitations and strengths of my research and directions for future research. When discussing strengths and limitations the theoretical and practical implications are incorporated where applicable.

### **10.3. Research Methodology Limitations**

The findings of my study should be interpreted with an awareness of the following limitations.

#### **10.3.1. Common method variance**

A general concern in psychological research is the use of self-report measures which may introduce systematic bias to the data (Campbell, 1982). Spector (1986) also suggested that common method variance associated with a reliance on one form of response format can artificially inflate correlations between constructs.

Consequently a possible limitation in this study was the use of a self-report questionnaire with a standard response scale for all climate scales. However, support for the validity of self-report instruments has also been offered (Conway & Lance, 2010; Howard, 1994; Reio, 2010; Spector, 1994). Spector argued that when employed within an appropriate design, surveys provide important and relatively effective measurement tools. Conway and Lance (2010) also indicated that while misconceptions about the nature and the impact of common method bias abound, use of self-report data can be justified if researchers provide:

- (a) an argument for why self-reports are appropriate;
- (b) construct validity evidence;
- (c) [evidence of a ] lack of overlap in items for different constructs, and
- (d) evidence that authors took proactive design steps to mitigate threats of method effects (p.325).

In light of Conway and Lance's (2010) statements, I would argue that the self-report instruments used in my thesis are clearly appropriate as the focus of study is obtaining individual workers' perceptions of the state of safety in their organisation. Furthermore construct validity evidence has been provided and efforts to minimise item overlap and improve construct discriminant validity in all instruments have been described at length in the methodology section.

### **10.3.2. Cross-sectional data**

A further common limitation of research within the broader field of psychology is the use of cross-sectional data. Cross-sectional designs do not permit conclusions to be made regarding causal relations between constructs. While structural equation modelling techniques allow a more stringent investigation of the direction of the relationships between constructs (Bollen, 1989), longitudinal designs need to be employed to infer causal relationships. As such, while the mediation models proposed were successfully tested in this study, for any causal conclusions to be drawn regarding the temporal sequencing of the constructs, longitudinal studies would need to be undertaken.

The issue of temporal sequencing is especially pertinent with regard to clarifying the causal relationships between safety climate and workplace injuries. The issue of reverse causation continues to be an area of debate in the safety literature (Beus, Payne, et al., 2010; S. Clarke, 2006). On the basis of their meta-analysis Beus, Payne, et al. argued that "injuries were more predictive of organisational safety climate than safety climate was predictive of injuries...and that the injury → safety climate relationship is stronger for organisational climate than psychological climate"(Beus, Payne, et al., p. 713), however they acknowledged that the magnitude of the temporal ordering effect was weak. Beus, Payne et al.'s conclusions are based on the results of cross-sectional studies using retrospective injury data rather than on truly longitudinal data as would have to be the case for the prospective injury data. As such, scope remains for future studies to undertake longitudinal research to explore these important causal relationships.

However longitudinal designs are not without their own methodological issues in organisational research. In particular employee attrition, and both theoretical and logistical difficulties associated with the timing of collecting prospective injury data (whether subjective or objective) from participant companies, is often problematic. Too short a time interval between data collect points may compromise effect sizes by restricting the range of injury and incident responses, whereas too long an interval may result in greater employee attrition and contextual changes due to organisational growth or regression. For example, in my study the consistent, and in some instances rapid, turnover of both front-line and management employees meant that in two of the largest companies key management personnel who had negotiated the contracts for prospective data collection, had been head-hunted to different organisation prior to the follow-up collection date. The new management team recognised that many of the employees who had potentially participated in the research were no longer employed; placing the viability of conducting the second data collection and validity of objective team injury data provided in question. A further complication was experienced when a major and protracted power supply issue was experienced across industry sectors, resulting in several participant companies standing down or retrenching workers, which had the potential to massively inflate attrition and fundamentally affect employees' responses across data collection periods. In sum, both cross-sectional and longitudinal designs have limitations; and while every attempt to obtain longitudinal data was made in the data collection phase of my research the use of a cross-sectional data is ultimately justifiable.

### **10.3.3. Analysis**

The choice to conduct my analyses on both individual and group-level data is a strength of my thesis, however the use of traditional structural equation modeling using the aggregated group data as the base unit rather than more sophisticated Multilevel Structural Equations Modelling (ML-SEM: Mehta & Neale, 2005) or Multilevel Modeling (MLM) may be considered a methodological limitation. The direct aggregation of individual-level data to the group-level and subsequent analysis at this level can result in interpretation and statistical errors (Tabachnick & Fidell, 2007). However, the decision to use SEM for both individual and group data was based largely on my intention to make direct comparisons of models obtained across levels of analysis.

Additionally, large samples are typically required for both MLM and ML-SEM procedures, however when using MLM techniques the sampling criteria are more flexible (Kreft & De Leeuw, 1998). For example in MLM a trade-off exists between the number of groups and number of members in each group. To have adequate power of .90, to detect cross-level interactions, a sample of 150 groups with five people per group is required; or 30 groups with 30 people per group. For the detection of main effects models the sample size is argued to be slightly less (Hofmann, 1997; Kreft & De Leeuw, 1998). As a form of restricted CFA, ML-SEM has equivalent sample size requirements. However, as the data is nested, the sample size is again linked to the number of clusters ( $n$ ) rather than the total number of participants ( $N$ ). As such, the minimum number of work-groups required for either analysis was approximately 150.

While my sample was not adequate to support these methodological options the utilisation of ML-SEM and MLM in future research will extend the rigour of existing safety literature in line with current methodological recommendations (Chan, 1998; Kozlowski & Klein, 2000; Mehta & Neale, 2005). However, in practical terms, the likelihood of studies continuing to report individual-level results is high given that the data collection procedure and data analysis required for multilevel analysis are more complex and challenging.

#### **10.3.4. Sample Size**

In terms of the individual-level SEM analyses undertaken the employee sample was adequate in terms of size and representativeness of the participant organisations on characteristics such as gender, age, job types and tenure. A limitation in my study was the relatively small sample size for the group-level analysis. Although data loss due to the inclusion criteria set for the group analysis (i.e., having at least two valid responses from group members) did not appear to affect the representativeness of the sample, it did result in a less than adequate sample size for the group-level analysis.

In multilevel research the target units for grouping participant data should reflect the conceptual models being tested and subsequently the sampling strategy undertaken

should be directed by this hierarchical structure (Kreft & De Leeuw, 1998). In the case of my research, sampling strategies were undertaken to ensure adequate numbers of functional work-groups (coworker and supervisor group-level constructs) and departments/worksites (higher level management constructs) in the total sample.

As the focus of the highest grouping unit directly targeted in my model was management at the department level, to truly apply the multilevel approach, the sample size and data decomposition should have been based on the number of organisations/departments/ worksites represented rather than on the number of work-groups in the sample. While every effort was exerted to obtain a sample that would provide adequate numbers of groups within departments, this goal was not ultimately achieved. However when tests for aggregation were conducted at both the organisation and work-group levels results indicated that even for the organisation-level construct (OSC-M) the work-group provided a more appropriate level of aggregation. As the referent used in the management scales directed workers' to consider management practices at the departmental/site level further testing at this level may show strong within-group homogeneity and between department variability.

Hofmann and Morgeson (1999) discussed two potential analytical issues relating to the use of small samples for SEM. These were the potential bias in, and significance of, the maximum likelihood parameter estimates derived, and also the potential attenuation of overall assessment of fit. They provided evidence that in samples as small as 50 neither the accuracy of parameter estimates (Anderson & Gerbing, 1988) or fit indices (Bentler & Bonnett, 1980; Bentler & Chou, 1987) would be adversely affected. As my group sample was larger than both this theoretical cut off and the group-level sample used by Hofmann and Morgeson, my sample can be considered adequate, if not optimal. Given the lack of statistical power available in the group-level analysis, the significance of results and magnitude of the fit statistics testify to the strength of associations observed.

While it appears that the use of group methodologies enhances the relationships between constructs, one alternative explanation must be considered. That is, when creating the group data set the decision was made to exclude groups with only one



valid response. This decision had a direct impact on further reducing the sample size and may have introduced a systematic bias to the sample. For example, excluded groups potentially had poorer response rates than the retained groups, or had adequate response rates but were of smaller size. Included work-groups, with multiple respondents may therefore have a greater degree of group cohesion or a more positive interest in workplace safety than is generally found in the organisations.

The issue of potential biases due to inclusion criteria is also a concern in relation to the use of ICCs or  $R_{wg}$  statistics to exclude groups from analyses. Groups with poor ICCs and low  $R_{wg}$  are usually removed from analysis due to the definitional inference that respondents within these group do not exhibit an adequate degree of shared perceptions. However a potential issue with this approach is that while groups with large within-group variability may have weaker safety climates this does not equate to no climate. If groups with weak climates are subsequently removed from the analysis you immediately reduce power in the analysis and potentially lose variance and contextual variability amongst the data. This is particularly relevant if the analysis undertaken is seeking to investigate the antecedents of climate strength. I therefore would argue to retain all functional work-groups but report agreement statistics to appreciate the nature and continuity of group coherence in the sample.

#### **10.3.5. Response Rates**

The smaller than expected sample was largely due to two issues concerning the economic and employment conditions in the region over the data collection period. The first involves the dropout of several committed organisations and work sites from the project due to unforeseen economic circumstances (e.g., A corporate take-over at the proposed time of data collection in one instance and the extended shut down of production sites and long-term stand down of workers in the midst of data collection due to a major loss of power supply to industries in the region, as discussed in section 10.3.2).

Poor response rates in several participant organisations also contributed to the sample shortfall. In particular, the lowest response rates were found for contracting

companies operating in the resource and mining industries. At the time of data collection, labour supply issues and high levels of job transience associated with an economic boom were affecting industries across the region and in particular those operating in the resource sector. This trend was reflected in the high representation of newer and younger workers in the sample and also shows in the discrepancy between company tenure and industry experience as highly prized experienced workers were able to freely migrate to higher paying jobs.

Low response rates in these organisations were also potentially linked to their remote location and the fly-in-fly-out nature of work in these sectors. Whilst concerted efforts were made to inform employees of the project, distribution of questionnaires to workers in these two sectors was generally undertaken by company personnel rather than the researcher which may have resulted in concerns regarding the confidentiality of information.

Notwithstanding these limitations, the present study demonstrated several strengths which helped it contribute to the literature.

#### **10.4. Research Methodology Strengths**

With regard to the framework of my thesis, a high degree of consideration was given to exploring the multidimensional nature of safety in a way that reflects conceptually the multilevel structure of organisations.

##### **10.4.1. Sample Heterogeneity**

A strength of this study relates to the sampling strategy applied to facilitate data aggregation. Theme five of the research framework outlined in Chapter 1 focused on safety in terms of two aspects of organisational fit: the congruence of the organisation with its external environment (how the safety performance of an organisation compares to others) and the congruence within the organisation (how individuals and groups differ within the organisation). Conducting inter and intra organisational research provides an opportunity to identify similarities and differences in safety-related antecedents and outcome variables across and within industries.

To facilitate external fit analysis, consideration was given to recruiting a variety of organisations from different industry groups including the resource, transport, construction and manufacturing sectors. To facilitate examination of internal fit functional work-teams and departments were clearly identified in the data collection process. This process resulted in greater heterogeneity in the sample population than is usually observed in safety climate research. Previous studies have utilised restricted samples from a limited number of organisational settings. In contrast, participants in this study included employees representing multiple job types from organisations of differing size, purpose and structure.

The diverse nature of this sample allowed greater scope for making context specific interpretations of results as shown in the presentation of organisation safety climate profiles. Additionally, Cook, Cambell and Paracchoi (1990) have emphasised that the external validity of a concept cannot be derived from a single study but from a body of research in diverse settings. Therefore, the contribution of these findings to the extant literature pertaining to climates for social exchange and safety, serve to enhance the external validity of the constructs.

#### **10.4.2. Group Identification**

During the data collection process care was taken to identify and access group structures that aligned with the work-level model proposed. To ensure respondents directed their perceptual evaluations to organisational agents associated with their specific work group, explicit focal referents were applied in the questionnaire. This process was applied to reduce the degree of ambiguity often found in organisational surveys and is considered a strength of my study. However, a supplementary analysis undertaken indicated that workers' perceptions of the size of their functional work-group showed no correlation with the actual group size as prescribed in organisational records. That is, from a subjective, individual perspective and an objective, organizational perspective team composition was shown to differ, with workers generally underestimating their group size.

While it is expected that individuals are likely to base their perceptual evaluations of the work-group on a limited number of significant coworkers, the differences

observed indicate that what and who constitutes a functional work-group is more complex than expected. For example, who respondents are including and excluding may depend on physical or functional proximity. Alternatively larger group sizes could lead to more ingroup-outgroup distinction which may have implications for the climate strength of the group. Consequently the potential impact on research findings requires further investigation.

The inference that workers are potentially basing their group climate perceptions on smaller groupings than are structurally defined has practical implications for group based research. For example, when developing climate surveys consideration should be given to identifying what constitutes each workers' functional work-group. Asking respondents questions about their work-group size and structure prior to completing the climate items may prime workers to consider their work-group in a more objective manner.

#### **10.4.3. Psychological and Organisational Safety Climate**

In accordance with the multilevel theme of my thesis framework, my intention in this study was to analyse explanatory models linking social exchange, safety climate and safety outcomes using both individual and group-level data. This methodological approach was intended to facilitate more rigorous examination of the potential difference in construct associations obtained when different methodologies are used.

Although the majority of safety research continues to utilise individual-level data to examine the relationships between global psychological safety climate (PSC) and outcomes, far fewer studies have used aggregated group or organisational-level data to investigate organisation safety climate (OSC) either as a global or multidimensional construct using appropriate collective referents. Despite meta-analyses consistently reporting different effect sizes in studies examining psychological and organisational safety climate, it remains unclear whether this effect has been due to design, data source or level-of-analysis issues. Acknowledging the limitation that my study uses retrospective, subjective injury data collected at one time period; one of the strengths of my study lies in the opportunity provided to

make a direct comparison across data treatment methodologies without the potential confounding issues associated with data sources or design.

As an integral part of my thesis, my results draw attention to the theoretical importance of understanding organisations in terms of the multilevel nature of their internal contexts. I have also attempted to show the utility of climate indices derived when using group-level approaches including climate level, strength and variability as potential diagnostic tools for safety practitioners and managers. While recognising the scope of my study is limited, my results contribute to our understanding of construct structures and relationships in models of safety climate by investigating both Psychological and Organisational Safety Climate analysed at both the individual and group-level.

#### **10.4.4. Minor Injuries and Near Miss Incidents**

As longitudinal, objective injury statistics were not ultimately made available due to major changes and disruptions in employment circumstances in the participant companies following the main data collection, the use of self-reported injuries and near miss occurrences were the only viable source of safety outcome data. Clarke (2006) found that studies using retrospective injury data produced weaker associations than studies using prospective data. To optimise construct relations they therefore recommended the use of prospective safety outcome measures. As such the use of retrospective data in my study was a potential limitation.

However the studies in Clarke's (2006) meta-analysis that used prospective data generally obtained this data from more objective sources, such as company OHS medical records. All-but-one of the prospective studies also used group-level analysis. In Chapter 3 I argued that the overlap between data source, level of analysis and design make generalisations relating to the utility of retrospective and prospective data and inferences regarding the temporal ordering of injuries as an antecedent of safety climate rather than as an outcome (Beus, Payne, et al., 2010) less justifiable.

My results for both individual-level and group-level analysis indicate that the relationship between safety climate and retrospective injury and near miss data is stronger when group-level data is used. In light of this finding it is likely that Clarke's (2006) results are partially an artefact of the level of analysis applied rather than the type of injury data obtained. Given the results of my study, while the use of self-report, retrospective data may not allow researchers to make causal inferences, this form of data is both expedient and valid.

Additionally, the strength of the safety outcome effects observed indicates that the use of a more comprehensive protocol to obtain LTI, minor injuries and near miss frequency data was justified. In particular, my results showed that far stronger effects were found for the relationship observed with near miss incidents compared to those with minor injuries. This finding fits with the established understanding that injuries are less common than accidents (Christian et al., 2009) and as such the latter potentially offers greater response range. Overall my results support Christian et al.'s call for future research to look more closely at higher frequency safety outcomes such as micro accidents (Zohar, 2000) and shows that near miss incidents may yet prove an even more useful indicator of safety outcomes.

In terms of the practical implications for researchers, my results showed that the simple aggregation of data to the group-level enhances the magnitude of the relationship between the constructs improving the likelihood of achieving significant results in the analysis. As such, despite potential drawbacks in reduced effects sizes that could realistically be expected when using retrospective, self-report injury data, the utility of this information source, especially when including near miss data, should not be dismissed but rather considered as an underestimate of effects when analysed at the individual- level.

#### **10.4.5. Active and Proactive Dimensions of Safety Behaviour**

In relation to workers' safety behaviours, adopting a dimensional approach involved operationalising and analysing both active and proactive safety behaviours as separate aspects of safety performance. As the majority of empirical safety studies have gauged safety performance in terms of safety compliance, with few studies having examined both active and proactive behaviours concurrently (Christian et al.,

2009; S. Clarke, 2006) the use of both measures is a strength of my study and contributes to the broader understanding of workers' safety practices.

Furthermore, a simple shift of referent from self to coworkers expedites the change from an individual-level construct to an emergent group climate indicator. My results also showed that while active and proactive dimensions of workers' safety behaviours scale are strongly correlated, different patterns of associations are found between each dimension of safety performance and both antecedents such as safety climate and injury outcome.

One additional point of theoretical interest was the weak association between safety behaviours and safety outcomes observed in the individual-level analysis. This finding was interpreted in terms of the workers' self-report ratings of safety behaviours being susceptible to social desirability response. However, the impact of this effect was shown to be mitigated when the scale was aggregated to the group-level. Importantly when active and proactive safety was modelled separately it appeared that the response biases were more apparent in the active safety behaviours subscale than proactive subscale.

While a close association was observed between the individual safety behaviour scales and coworker safety climate scales the influence of self-report biases appeared to be reduced in the climate scales. As such, for both practical purposes (i.e, when reporting safety benchmark or diagnostic information to organisations), and research purposes, the coworker safety climate scale may ultimately provide a more accurate reflection of the normative safety performance of front-line employees.

#### **10.4.6. Work-level Model of Safety Climate**

In line with Zohar's (2010) recommendations, I have argued that the differentiation of organisation and group-level dimensions of safety climate should provide greater theoretical clarity and analytic utility. Furthermore, I proposed the inclusion of coworker commitment to safety as a group-level dimension of safety climate. My

results have supported the key role coworkers play in the establishment of normative safety practices.

The modification of Zohar and Luria's (2005) model of safety climate to include coworker safety practices constitutes one of the major strengths of my thesis. It contributes to the safety literature by expanding the content domain of the construct in line with established definitions (Zohar, 2003, 2008, 2010; Zohar & Luria, 2005). In Beus, Payne et al.'s (2010) terms, the inclusion of group-level coworker safety practices rectifies the content deficiency prevalent in many scales without increasing construct contamination that occurs when including workers' personal attitudes to safety in climate scales.

Importantly, as my results show, the work-level model of safety climate allows researchers the opportunity to analyse and report results for either a global or dimensional operationalisation of safety climate. Indeed the organisation of item content according to work-level functionality facilitates the inclusion of global safety climate in more complex structural models. In line with recommendations that three indicators constitute the optimal number of manifest variables per construct in confirmatory analysis (Little et al., 1999), the parcelling of the safety climate scales into their theoretically derived domains reduces item diversity to a level at which the construct representation will most likely be accurate at the higher order of analysis, while improving the power of the overall structural analysis and retaining broader domain relevance at the item level.

In addition, the treatment of safety climate as a lower-order multidimensional construct representing key macro and micro dimensions adopts the approach recommended by Guldenmund (2007) and Zohar (2010). The separation of safety climate dimensions at hierarchical levels importantly allows researchers to tease out variations in the chain of psycho-social influence (Oliver et al., 2002). Furthermore my results showed that using the CSA approach to data aggregation provided a different factor solution for the management and supervisor safety climate scales. These structures provided a more theoretically sound and interpretatively useful tool and ultimately resulted in stronger effects and clarified construct relations. While not widely adopted in the safety literature, on the basis of my findings I would argue that



respecting the nonindependence of data at the factor examination phase appears to be a well-conceived recommendation (Peterson & Castro, 2006; Shannon & Norman, 2009). The identification of both active and proactive safety climate subscales at the three work-levels using the CSA approach to scale formation therefore constitutes one of the major strengths of my research.

By modelling active and proactive safety behaviours as separate facets across work-levels, my intention was to move beyond the typical compliance driven approaches to safety to a participative, core value approach. In a core value approach, personnel at all levels of the organisation are encouraged to take ownership of safety issues and be proactive in “doing the right thing”(O'Toole, 2002, p.233). However in terms of the practical implications for safety practitioners, managers and workers, it is important to establish that endorsing a proactive safety focus does not overshadow the significance of understanding and/or promoting compliance behaviours in organisations, but rather builds upon this solid base. The separation of active and proactive practices across work-levels in the CSA model showed a clearer picture of how supervisors and managers influence coworkers' active and proactive practices in different ways. This finding has strong practical implications for management in terms of both understanding the processes in operation and also in helping guide strategies for change.

In sum, the inclusion of safety-specific content in scales organised around the safety practices of agents traversing the organisational hierarchy acknowledges both the multidimensional and multilevel nature of safety climate. Furthermore, the inclusion of domain-aligned safety content, with more clearly defined referents, offers opportunities for researchers and safety practitioners to track areas of strength and weakness in the chain of safety activity, identify incongruent practices across work-levels and identify tensions in safety priorities between organisational agents. Of particular importance was the inclusion of the coworker safety climate scale as an indicator of group safety norms. Given the greater potential for positive bias in individual performance scores I would argue that a more accurate picture of group-level worker safety performance may be gauged from the ratings of coworker actions than aggregated personal performance scores.

#### **10.4.7. Climate for Social Exchange**

My research investigated the utility of social-exchange theory as a common theoretical basis for understanding the lateral and vertical workplace interactions operating within organisations. Importantly I operationalised social exchange as a foundation climate supporting the development of the more facet-specific safety climate. The incorrect use of referent levels in aggregated data has been identified as a problem in multilevel studies (Chan, 1998). Furthermore, imprecise specification of management levels (Flin, 2003) and generic organisation referents can create an unnecessary degree of ambiguity in questionnaires. In my study attention was paid to the use of specific target referents (coworker, direct supervisor and sectional management) in the generation of survey items. Also, a focus on the collective referent (i.e., the group) was used for the climate indicators. As such the social exchange variables had a collective rather than dyadic focus.

As social exchange was conceptualised as an emergent collective construct it was important to establish if workers would differentiate between their own dyadic social exchanges and group-based exchanges. Although a direct comparison between existing social exchange scales and my modified scales was not conducted, my results support the use of the group referent in the social exchange scales. The stronger correlations observed between the social exchange and safety climate variables than with individual worker performance support the appropriate application of the group-based referents for the social exchange variables. However, without also obtaining direct referent data for the social exchange variables to ascertain if workers were making intuitive social comparisons in shifting to a collective referent, it was not possible to determine if this is indeed the case.

Research has identified that the social comparisons workers make with other workers can also have an influence on workplace outcomes (Vidyarthi, Liden, Anand, Erdogan, & Ghosh, 2010). For example, when workers compared the quality of their own relationships with leaders (LMX) and those they perceive their leaders to be having with other workers (LMX social comparison) job performance and

citizenship behaviours were impacted (Vidyarthi et al., 2010) above the impact of the LMX relationship itself. Vidyarthi et al. concluded that when employees interpret their LMX relations with their supervisor as more constructive relative to other workers in their group then their performance may be optimised. Correspondingly, negative comparison may result in reduced performance even if the LMX relationship is itself perceived as positive.

Likewise, negative effects on both team performance and positive affect have been observed when managers and team members disagree about the level of organisational support provided to workers (Bashshur, Hernandez, & Gonzalez-Roma, 2011); with negative consequences being most evident when managers perceive support to be greater than team members. Research on social comparison (or perceptual distance) relating to either social exchange or safety climate perceptions has yet to be conducted in the safety domain, offering scope for future research in this area to provide greater insights into safety practices.

In line with past research my results highlight the important role having quality social exchanges amongst employees plays in the formation of workers' perceptions and the establishment of normative safety performance standards (Chiaburu & Harrison, 2008). While replication of results is required, the use of appropriate collective referents is a further strength of my thesis as it extends the methodological rigour of existing climate literature in line with Chan's (1998) recommendations. Overall my results supported the utility of a work-level model of safety that incorporates the climate for social exchange as a foundation for the emergence of facet-specific safety climate and therefore goes some way towards filling the theoretical gaps in the existing safety literature, exposed by Zohar. While Nahrgang et al. (2011) have argued that a supportive environment is critical to workplace safety, our understanding of what constitutes such an environment is still developing.

### **10.5. Practical Implications**

My findings indicate that if organisations are interested in encouraging workers to be more proactive in their approach to safety (i.e., by using their initiative in safety-related situations, forwarding ideas and concerns about safety and generally engaging

in constructive safety-related discussion with fellow workers and supervisor) higher level management has a direct role to play in this process. In sum, managers need to be more proactive in ensuring they use all the information available to improve existing policies, invest time and money in quality training, provide detailed and relevant safety information to workers, make every effort to raise the profile of safety and be seen to be continually trying to improve safety levels in the organisation. In contrast top managers have a less direct role to play in maintaining safety compliance norms as responsibility for workers' active safety practices is better handled at the supervisory level where monitoring behaviours and reinforcing procedures has a more direct impact on workers' active safety practices.

In addition, it is important for managers and supervisors to understand that the safety norms of the group, represented by established coworker practices, are likely to strongly influence individual safety behaviour. Therefore, to improve safety in the workplace, efforts should be exerted by managers and supervisors towards understanding the informal pressures exerted by key stakeholders within work-groups with the intention of directing all workers towards positive safety standards. When specific safety training needs are established, work-group based safety training and inclusive briefing sessions where consistent messages can be delivered to all group members may offer the best opportunities for improving the safety environment.

At a practical level, creating level-adjusted safety climate subscales when providing organisational diagnostic feedback provides safety researchers, practitioners and managers the opportunity to make linkages between the provision and uptake of safety services and track breakdowns in safety practices and communications. For example, workers may perceive that managers provide adequate safety training options but that coworkers are unwilling to engage in the training opportunities. This tells a very different story from a situation in which workers' perceive the safety training opportunities to be limited but in general are willing to get involved in the programs offered. The same form of interpretive utility applies to other processes such as communication, incident reporting, risk, manpower planning, monitoring and procedures (Guldenmund, 2007).

Furthermore, separating workers' safety behaviours and safety climate into two distinct dimensions representing active and proactive safety practices is likely to produce a clearer picture of the current focus of safety within an organisation. This should allow safety practitioners to better monitor changes that occur as organisations build upon establishing basic compliance practices to focus more on prioritising personal ownership of safety as a generic value across all levels of the organisation. As this shift occurs proactive behaviours, previously considered discretionary, are more likely to be deemed nondiscretionary by both workers and their managers.

Finally, the most potentially important practical implication of my results is that establishing high quality social interactions amongst employees at all levels of the organisation will assist in the promotion of positive organisation and group-level safety climates. In particular, improving the quality of internal group social exchanges between workers, coworkers and supervisors is likely to manifest most strongly in the formation and maintenance of compliance based group norms. In contrast, improved social exchanges with higher level management are more likely to facilitate greater worker engagement in proactive safety practices. Furthermore, it is important for managers and supervisors to understand that the proximal influence of group interactions and coworker commitment to safety are likely to reinforce or mitigate the influence of their own safety priorities. That is to say, the impact of more distal supervisory and management safety and leadership practices on individual workers' safety activities is largely dependent on the group priority for safety and strength of group consensus to this goal.

It is vitally important for managers to understand that workers' perceptions of the quality of workplace social support and the relationships they have with their managers and supervisor are closely aligned with their perceptions of those same leaders' commitment to safety. Consequently, as Nahrgang et al. (2011) have inferred, the social support environment is likely to be just as important in promoting safety in the workplace as the safety priorities and procedures forwarded by management.

In practical terms this means that if managers wish to encourage workers to become more engaged in workplace safety it is imperative they are honest and transparent in their dealings with workers. Likewise, if managers want workers to use their initiative in safety-related situations it is important for managers to show that they have a sound understanding of workers' job needs and problems and can appreciate and take into consideration the specific circumstances impacting on workers when inevitably mistakes are made. Finally, when workers see that managers are making effective decisions and can trust that management actions are in the best interest of both workers and the organisation, they are more likely to reciprocate by taking greater personal responsibility for safety in their immediate environment. In sum when workers perceive that managers have a genuine concern for their welfare they are likely to respond by not only personally doing the right thing but encouraging others to do so as well.

#### **10.6. Future Directions**

Having discussed the strengths and limitations of my thesis and offered practical and theoretical implications based on the interpretation of my findings the following ideas focus on future directions for research based on gaps in the research framework present in Chapter 1. In terms of my overarching research framework Bennett et al.'s (2003) sixth theme relates to researchers having an awareness of the core tensions involved in maintaining optimal safety within an organisation. This relates to the degree of organisational alignment of *adaptive tensions* in terms of three main dimensions: stability versus chaos; coherence versus diversity and a slack versus tight fit. Safety climate indicators, such as climate strength and variability, go some way towards assessing the level of deviance and consensus amongst individuals and work-groups. While I have briefly touched on these indices in my description of organisational profiles, a major gap in my thesis was not investigating climate strength as a focal construct in the explanatory models, either in terms of its impact on outcomes or to examine social exchange relations as an antecedent of climate strength.

Furthermore, as my research focused solely on front-line workers perceptions of social exchange and safety climate dimensions a gap in my research is the neglect of

managers' and supervisors' viewpoints. Indeed the alignment across work-levels of climate measures, tapping into the core tensions or perceptual distance between employees and their managers, may provide an additional index of organisational safety climate. These ideas for future research are developed in the following section.

#### **10.6.1. Climate Strength as a Focal Index**

While my research focused on the relationship between social exchange and level of safety climate, as has typically been done in the leadership-safety literature (e.g. S. Clarke & Ward, 2006; Crichton, 2005; Kelloway et al., 2006; Martinez-Córcoles et al., 2011; Wu et al., 2008; Zohar & Tenne-Gazit, 2008) an important alternate avenue of investigation is to examine how climate for social exchange relates to climate strength. According to Chan's typology of compositional models when using consensus composition model approaches, as applied in this thesis, within-group variance is treated as error variance. In such models, if the criteria for aggregation are not met in a particular work unit, there is assumed to be a lack of agreement within the group and any information from that unit is not considered uniform enough to represent a climate per se. These data may then be excluded from further analysis or alternatively overall aggregation not supported. While consensus models are the most commonly applied in safety climate research, potentially the exclusion of data representing weaker climate perceptions within groups may in fact lead to biased findings, as only those units with relatively strong climates are retained for examination.

However when dispersion composition models are applied, climate strength becomes a highly useful focal index. For example it may be used as a group or organisation-level descriptive statistic in combination with climate level as used in this study: as a predictor variable, a control variable, or as an outcome in its own right.

In the dispersion approach, a unit with poor internal consensus remains a valid source of information; being viewed as having a weak climate (a potentially meaningful point of differentiation from other units), rather than having no climate. For example, using the within-group homogeneity statistic as their index of climate strength, Luria (2008) identified that both transformational leadership style and positive group interactions predict safety climate strength in military units. Pousette,

Larsson and Törner (2008) tested the theory that as safety climate represents “a property of a social unit” (p.403), the level of agreement in responses (climate strength) would be higher for safety climate factors, than for measures of individual safety attitudes; such as safety knowledge and motivation. They found support for their hypothesis using ICCs as an index of climate strength.

In contrast, Zohar and Luria (2005) used standard deviations to measure organisational and group climate strength and found that increases in organisational safety climate strength were associated with reduced lower level, between-group variability and increased group-level safety climate strength. Following Zohar and Luria’s lead Beus, Payne, et al. (2010) also used standard deviation scores to index climate strength and identified a curvilinear relationship between organisational tenure and safety climate strength, with longer tenure being related to stronger climate.

As these few studies testify, further research is required to uncover the antecedents and outcomes of climate strength. Having operationalised the work-level model of safety climate one obvious antecedent candidate is the quality of social exchange. Following Luria (2008) and Zohar and Luria’s (2005) lead, it would further our understanding of the social exchange -safety climate relationship to investigate if the climate for social exchange at different work-levels predicts not only climate level as found in my study but also climate strength.

In sum, while indices of climate perceptions have expanded to include the examination of group consensus amongst workers and dispersion of their responses across organisations, scope remains for future research examine climate strength as focal construct in safety climate studies. Furthermore, while a growing interest in issues concerning group consensus in safety climate research has been shown, the examination of potential differences in perceptions of safety climate between workers, supervisors and managers has attracted less attention. Several approaches may be taken to explore potential work-level differences including: examining differences in how managers, supervisors and workers conceptualise the construct; assessing organisation-wide hierarchical differences on aggregated safety climate



ratings; and investigating within-group manager and worker alignment as described in the following sections.

### **10.6.2. Work-level Differences in Safety Climate**

#### ***10.6.2.1. Factor structure stability***

As safety climate research has typically focused on workers' perceptions of safety climate at an individual-level of analysis, research investigating potential differences in how workers and managers conceptualise the construct has been relatively sparse. However, in line with generic climate research trends within the broader organisational literature (Glick, 1985; Hackman, 2003), the need to understand factor structure and consistency across respondent groups and identify differences in climate levels across work units is gaining more research attention.

When comparing constructs across work-levels an important first step is to check the continuity of factor structures. To date few studies (Harvey, Bolman, & Gregory, 1999; Harvey et al., 2002; McDonald, Corrigan, Daly, & Cromie, 2000) have examined whether employees across work-levels conceptualise safety climate in a similar way. Harvey, Bolan and Gregory concluded "that the basic conceptualisations of safety differ between management and employees, and potentially from plant to plant" (1998, p.11). In particular they identified differences in both factor solutions obtained for safety culture items for managers and workers and relative mean scores across the identified factors.

Of the few studies that have assessed work-level differences in the safety domain, the practice of not examining factor structures for different work-levels has been commonplace, with researchers generally collapsing information across work-levels for factor examination before assessing mean differences in work-level categories as supplementary analyses. However, in defence of this practice, few studies have had the sample sizes required at each work-level (especially managers and supervisors) to support factor analysis as best practice would prescribe. Therefore, further research is recommended to ascertain if safety climate factor structures are stable across work-levels.

### ***10.6.2.2. Safety Climate Alignment***

Furthermore, the few studies that have reported work-level differences using a mean difference approach (S Clarke, 1999; S. Clarke, 2004; Mearns, Flin, Gordon, & Fleming, 1998; Prussia, Brown, & Willis, 2003) have all used individual-level data. To date no safety climate research has taken into consideration group-level effects (i.e., differences between workers, their supervisors and managers in each work team) such has been applied when deriving *team-leader perceptual distance* (Gibson, Cooper, & Conger, 2009) in organisational research.

Scope therefore exists for the investigation of work-level similarities and differences in line with Zohar's (2010) recommendation for using group-level data as the base unit of analysis. That is, by looking more closely at what managers, supervisors and workers in any work unit report that they do, compared to what others in their work unit perceive them doing, we may enhance our understanding of the overall and unit-level alignment of safety climate. The triangulation of employee perceptions within the work-group would also help resolve any issues of common method variance as the group-level data would be obtained from different sources.

Team-leader perceptual distance (Gibson et al., 2009), represents the difference between team member ratings and their managers' ratings of key organisational climate measures. Recent studies have identified that differences in climate for organisational support (Bashshur et al., 2011), goal accomplishment and constructive conflict (Gibson et al., 2009) can impact on team performance, such that greater differences between stakeholders is associated with reduced performance. However, no studies have examined the issue of differences in climate conceptualisation or perceptions across work-levels in the safety domain in this manner.

One pattern-level characteristic, proposed by Zohar (2010), which may influence employees' perceptions of safety climate, is the alignment between espoused and enacted safety priorities, which can be interpreted as the congruence between an organisational agent's words and actions. If a lack of alignment between the formally stated policies and procedures and the explicit actions of company agents is observed by workers it would be expected that the level of safety climate would be compromised. For example, a high degree of alignment between espoused policy

and enacted safety practices would demand that managers and/or supervisors not only talk the safety talk, but walk the safety walk.

As safety climate is considered as a social construct (Rochlin, 1999), attention is focused on the employees' consensual interpretation of the enforced policies and enacted practices, rather than on the espoused set of formal policies or procedures in and of themselves (Zohar, 2003). However, while obtaining subjective measures of the enforced safety policies and enacted practices of organisational agents is the purpose of safety climate questionnaires, options to capture espoused policies and practices other than objective evaluations of policy documents and procedural manuals are limited. One option I wish to propose for future research is based on the correspondence between workers' perception of organisational agents' safety practices (for managers and supervisors) and those same agents' self-ratings.

As illustrated in Figure 10.2, at the work-unit level, safety climate alignment would represent the difference between what a supervisor or manager acknowledges doing and what workers in their unit perceive them as doing. While a highly subjective measure, in view of self-protection biases, we would expect leaders to report a relatively high level of compliance with company policy, and therefore the disparity between ratings to represent a meaningful incongruence between policy and practice. Such a measure would extend the utility of work-level differences in safety climate in a manner consistent with team-member perceptual distance (Gibson et al., 2009) currently being used in climate research. Furthermore it would potentially provide a new focal safety climate construct for descriptive and predictive purposes.

To determine if, and to what degree, systematic biases are operating across work-levels of the organisation, a 360 degree reporting structure would be required in questionnaire development. When utilised in the research design, small response differences would indicate greater alignment of opinions across work-levels (i.e., less team-leader perceptual distance), stronger cohesion and overall a stronger safety climate. Alternatively large differences in opinions would be indicative of a weaker overall safety climate.

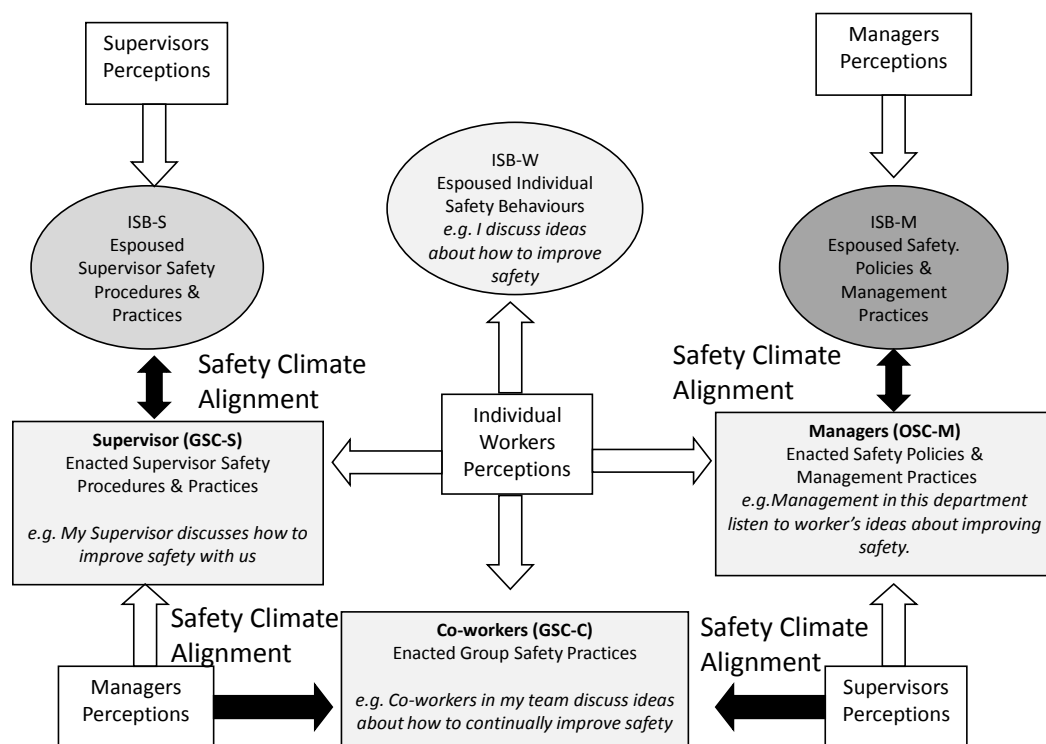


Figure 10.2. Alignment for group and organisational level espoused and enacted safety climate measures.

Note: OSC-M= Organisation Safety Climate-Managers; ISB-M= Individual Safety Behaviours - Managers; GSC-S=Group Safety Climate-Supervisors; ISB-S= Individual Safety Behaviours - Supervisors; GSC-C= Group Safety Climate- Coworkers; ISB-W= Individual Safety Behaviours-Workers

A recommendation for future research is therefore to examine similarities and differences in safety climate dimensions across organisational work-levels by using both individual-level data and group-level data collected from front-line workers, their supervisors and managers. I propose that the measurement of climate strength and variability at the group, department or organisational level as described by Zohar and Luria (2005) could be further enhanced by the measurement of an additional climate indicator, tapping the alignment of management', supervisors' and workers' perceptions of safety climate. The triangulation of data from different organisational sources would provide opportunities to compare and expand the safety literature in a manner not previously undertaken.

### **10.7. Conclusion**

My investigation of how workers' perceptions of the safety commitment of managers, supervisors and coworkers combine to influence individual workers' active and proactive safety behaviours and outcomes such as minor injuries and near miss incidents within the broader workplace environment of social relations goes some way towards answering Zohar's (2010) recent call for safety research to shift its focus away from definitional issues to functional processes and explanatory models using a level-of-analysis approach. My research adopted a multilevel analytical approach that acknowledged the nested nature of individuals within organisational settings and allowed the examination of the differing levels and the relative strengths of foundation and safety-specific climate indicators within and between employee groups. Importantly, my results indicate that the use of near miss incident information provides a valid safety outcome measure with greater response range and variability than generally observed in accident and injury data.

By undertaking two separate series of analyses utilising a global and a dimensional conceptualisation of safety climate I have established the predictive utility of the proposed work-level model of safety climate in a variety of statistical and theoretical applications. In line with past research in the field my results indicate that as a global construct safety climate is a strong predictor of both individual safety behaviours and safety outcomes. However, when separating out the safety climate dimensions a clearer picture of the nature and strength of associations between constructs emerges.

In particular my findings indicate that differences in construct factor structures and the strength of observed associations in structural models can emerge with the simple aggregation of data. While the results of my individual-level analysis generally supported the hypothesised construct relationships for both the global and dimensional models of safety climate tested, in all instances the group-level analysis provided stronger and more interpretable findings.

In sum, my findings add weight to the argument that establishing a supportive working environment in which employees engage in quality social exchanges and

safety is prioritised across all the levels of the organisation is instrumental in reinforcing both the importance of rule compliance and encouraging workers to engage in more proactive safety activities. My findings support the important role that managers and supervisors play in promoting a positive safety environment, however they also indicated that coworker interactions and safety practices also play a crucial role in consolidating both compliance and proactive safety norms.

My results showed that when undertaking safety climate research the choice of methodology used is likely to influence findings and must be taken into consideration at the earliest stages of project development. While the pattern of modelled associations between climate for social exchange, safety climate, worker behaviours and safety outcomes were found to be relatively robust whether individual or group-level analysis are undertaken, the aggregation of data is likely to facilitate stronger effects. However these results require further replication. My concluding recommendation is that while using the group as the unit of analysis can be both logistically and statistically more demanding the benefits to safety researchers warrants the effort required to collect the larger samples needed. Such efforts and application will ultimately improve the theoretical rigour of findings within the safety literature.

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## Appendix A: Sample Questionnaire

### Safety Climate Survey

#### *Information about this survey.*

The survey you are asked to complete provides you the opportunity to share your views on a range of work-related safety issues. Your participation in this survey will allow researchers the opportunity to investigate how employees' perceptions of the safety climate in their company influence workers' safety behaviour and injury rates. Management at [this organisation] support the project and agree that all information provided will be **anonymous** and **confidential**.

The survey takes approximately **20 minutes** to complete. Questions in the survey ask about different aspects of safety in your job, including your own approach to safety and your opinions about the safety behaviours of management, supervisors and other workers in your organisation. There are no trick questions. If some of the questions appear repetitive, this is to ensure that we have adequately obtained your viewpoint.

All responses will be treated in the **strictest confidence**. Your name is not required on the survey. Other possible identifying details such as age, gender, tenure and job type are asked to allow statistical analysis of specific research questions. However, only averaged and general feedback will be provided to management, ensuring no individual can be directly or indirectly identified. Management at [this organisation] agree to have no access to completed questionnaires or individual responses.

The questionnaire has two identifying codes on it. One is to allow your information to be matched with your work team, including your direct supervisor. This code has been applied by the researcher and is not known to the company. The second is your personal code, which will be used to match your information when safety surveys are conducted in the future.

Your participation in the study is **voluntary** and your decision to participate or withdraw from this research may be done freely at any time. By completing the survey you indicate that you have understood what the research involves and have consented to take part. Once you have completed the survey please seal it in the **reply paid** envelope provided and mail it directly to Curtin University.

The survey has been designed as part of a Doctoral project, supervised through the School of Psychology at Curtin University of Technology. Approval for the study has been given by the Curtin University Human Research Ethics Committee and only the researcher and her immediate supervisors will have access to the completed questionnaires.

If at any time you have any queries or concerns regarding the survey, please contact the researcher, Fiona Geddes on (08) 93817098 or email [fionageddes@westnet.com.au](mailto:fionageddes@westnet.com.au). Professor Clare Pollock may also be contact at Curtin University on (08) 9266 7279. If needed, verification of ethics approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth 6845 or by telephoning (08) 92662784.

Thank you for your participation.

**Please Remember**

**All responses are strictly CONFIDENTIAL  
DO NOT print your name on the survey**

**PLEASE TURN OVER TO BEGIN**

## Part A

The following section asks you to consider a series of statements about “Top level management” in your [department/site/organisation]. Please rate your level of agreement with each statement by circling your answers on the scales provided.

		Completely Disagree	Moderately Disagree	Undecided	Moderately Agree	Completely Agree
Top Management in this [department/site/company]...		Agreement				
1	Reacts quickly to solve the problem when told about safety hazards	1	2	3	4	5
2	Insists on thorough and regular safety audits and inspections	1	2	3	4	5
3	Tries to continually improve safety levels in each department	1	2	3	4	5
4	Provides all the equipment needed to do the job safely	1	2	3	4	5
5	Is strict about working safely when work falls behind schedule	1	2	3	4	5
6	Quickly corrects any safety hazards (even if it's costly)	1	2	3	4	5
7	Provides detailed safety reports to workers (e.g. injuries, near accidents)	1	2	3	4	5
8	Considers a person's safety behaviour when promoting people-rewards safe working	1	2	3	4	5
9	Requires each manager to help improve safety in their department	1	2	3	4	5
10	Invests a lot of time and money in safety training for workers	1	2	3	4	5
11	Uses any available information to improve existing safety rules	1	2	3	4	5
12	Listens carefully to worker's ideas about improving safety	1	2	3	4	5
13	Considers safety when setting production speed and schedules	1	2	3	4	5
14	Provides workers with a lot of information on safety issues	1	2	3	4	5
15	Regularly holds safety-awareness events (e.g. presentation ceremonies)	1	2	3	4	5
16	Gives safety personnel the power they need to do their job	1	2	3	4	5
17	Emphasize the importance of reporting all safety accidents and near misses	1	2	3	4	5
18	Are honest and “up front” in their dealings with employees	1	2	3	4	5
19	Understand employees' job problems and needs	1	2	3	4	5
20	Recognise the contributions of employees	1	2	3	4	5
21	Can be trusted to do what is best for employees	1	2	3	4	5
22	Take personal responsibility for their mistakes	1	2	3	4	5
23	Make decisions that employees feel confident to defend to other workers	1	2	3	4	5
24	Have effective working relationships with employees in this organisation	1	2	3	4	5
25	Show genuine concern for the welfare of employees	1	2	3	4	5

Please indicate which of the behaviours by management listed above do you consider to be;

- 1) the most important to ensuring a high level of safety in your organisation
- 2) the areas that require most improvement

You may list more than one item for each heading

	Item Numbers					
	1st	2nd	3rd	4th	5th	6th
Importance						
Improvement						



**Part B**

The following section asks you to consider a series of statements about the behaviours of your direct supervisor. Please rate your level of agreement with each statement by circling your answers on the scales provided.

		Completely Disagree	Moderately Disagree	Undecided	Moderately Agree	Completely Agree
	My direct Supervisor...	Agreement				
26	Makes sure we receive all the equipment needed to do the job safely	1	2	3	4	5
27	Frequently checks to see if we are all obeying safety rules	1	2	3	4	5
28	Discusses how to improve safety with us	1	2	3	4	5
29	Uses explanations (not just compliance) to get us to act safely	1	2	3	4	5
30	Emphasises safety procedures when we are working under pressure	1	2	3	4	5
31	Frequently tells us about the hazards in our work	1	2	3	4	5
32	Refuses to ignore safety rules when work falls behind schedule	1	2	3	4	5
33	Is strict about working safely when we are tired or stressed	1	2	3	4	5
34	Reminds workers who need reminders to work safely	1	2	3	4	5
35	Makes sure we follow all the safety rules (not just the most important ones)	1	2	3	4	5
36	Insists that we obey safety rules when fixing equipment or machines	1	2	3	4	5
37	Says a "good word" to workers who pay special attention to safety	1	2	3	4	5
38	Is strict about safety at the end of the shift, when we want to go home	1	2	3	4	5
39	Spends time helping us learn to see problems before they arise	1	2	3	4	5
40	Frequently talks about safety issues throughout the work week	1	2	3	4	5
41	Insists we wear our protective equipment even if it is uncomfortable	1	2	3	4	5
42	Encourages workers to report all safety accidents and near misses	1	2	3	4	5
43	Lets all members of the team know where they stand with him/her	1	2	3	4	5
44	Understands our teams job problems and needs	1	2	3	4	5
45	Recognises the potential of all employees in our work group	1	2	3	4	5
46	Uses his/her available power to solve our work related problems	1	2	3	4	5
47	Would "bail out" team members at his/her own expense if they really need it?	1	2	3	4	5
48	Makes decisions that team members would defend and justify to other workers	1	2	3	4	5
49	Has effective working relationships with employees in our work group	1	2	3	4	5
50	Has a genuine concern for the welfare of employees in our work group	1	2	3	4	5

Please indicate which of the behaviours by your supervisor listed above do you consider to be;

- 1) the most important to ensuring a high level of safety in your organisation
- 2) the areas that require most improvement

You may list more than one item for each heading

	Item Numbers					
	1st	2nd	3rd	4th	5th	6th
Importance						
Improvement						

## Part C

The following section asks you to consider a series of statements about the behaviours of your fellow workers. Please rate your level of agreement with each statement by circling your answers on the scales provided.

Co-workers in my team...

	Completely Disagree	Moderately Disagree	Undecided	Moderately Agree	Completely Agree
	Agreement				
51 Refuse to ignore safety rules when work falls behind schedule	1	2	3	4	5
52 Always wear protective equipment even if it is uncomfortable	1	2	3	4	5
53 Are prepared to question co-workers who are not following safety rules	1	2	3	4	5
54 Monitor each other when tired or stressed to ensure no-one is working unsafely	1	2	3	4	5
55 Look out for each other's personal safety	1	2	3	4	5
56 Follow correct safety procedures when using equipment	1	2	3	4	5
57 Co-operate with supervisors to develop better safety practices	1	2	3	4	5
58 Use their initiative to help solve safety related problems	1	2	3	4	5
59 Get involved in the safety training programs provide by management	1	2	3	4	5
60 Make suggestions on how to improve job safety	1	2	3	4	5
61 Share information about safety hazards with supervisors and each other	1	2	3	4	5
62 Keep themselves informed about safety related issue	1	2	3	4	5
63 Discuss ideas about how to continually improve safety	1	2	3	4	5
64 Speak highly of those workers who pay special attention to safety	1	2	3	4	5
65 Report all safety related accidents and near misses as soon as they occur	1	2	3	4	5
66 Express opinions on safety matters even if others disagree	1	2	3	4	5
67 "Cover up" for one another when safety rules are not followed	1	2	3	4	5
68 Let each other know where they stand	1	2	3	4	5
69 Understand each other's job problems and needs	1	2	3	4	5
70 Respect each other's capabilities	1	2	3	4	5
71 Help each other solve work related problems	1	2	3	4	5
72 "Bail each other out" at their own expense when someone really needs it	1	2	3	4	5
73 Have confidence in each other's decisions such that they defend them to others	1	2	3	4	5
74 Have effective working relationships with each other	1	2	3	4	5
75 Show a genuine concern for each other's welfare	1	2	3	4	5

Please indicate which of the behaviours by your co-workers listed above do you consider to be;

- 1) the most important to ensuring a high level of safety in your organisation
- 2) the areas that require most improvement

You may list more than one item for each heading

	Item Numbers					
	1st	2nd	3rd	4th	5th	6th
Importance						
Improvement						

<b>Part D</b>		Completely Disagree	Moderately Disagree	Undecided	Moderately Agree	Completely Agree
The following section asks you to consider a series of statements about your own behaviours. Please rate your level of agreement with each statement by circling your answers on the scales provided.		Agreement				
I...						
76	Refuse to ignore safety rules when work falls behind schedule	1	2	3	4	5
77	Always wear protective equipment even if it is uncomfortable	1	2	3	4	5
78	Am prepared to question co-workers who are not following safety rules	1	2	3	4	5
79	Monitor myself when I am tired or stressed to ensure I am working unsafely	1	2	3	4	5
80	Look out for my co-workers personal safety	1	2	3	4	5
81	Follow correct safety procedures when using equipment	1	2	3	4	5
82	Co-operate with my supervisor to develop better safety practices	1	2	3	4	5
83	Use my initiative to help solve safety related problems	1	2	3	4	5
84	Get involved in the safety training programs provide by management	1	2	3	4	5
85	Make suggestions on how to improve job safety	1	2	3	4	5
86	Share information about safety hazards with supervisors and co-workers	1	2	3	4	5
87	Keep informed about safety related issue	1	2	3	4	5
88	Discuss ideas about how to continually improve safety	1	2	3	4	5
89	Speak highly of co-workers who pay special attention to safety	1	2	3	4	5
90	Report all safety related accidents and near misses as soon as they occur	1	2	3	4	5
91	Express my opinion on safety matters even if others disagree	1	2	3	4	5
92	"Cover up" for co-workers when safety rules are not followed	1	2	3	4	5

<b>Part E</b> In this section you are asked to record as accurately as possible the <b>number of times</b> you have experienced the following types of injuries in the <b>last 6 months</b> . Please record the number of injuries experienced for all three levels of severity:			
Types of Injuries	Minor (Requiring company first aid)	Lost-time Injury (Inability to work one full shift / day or more after injury )	Near Miss (Almost sustained an injury)
<i>e.g. Bruises &amp; Crushing</i>	5	0	2
Fractures & Dislocations			
Sprains & Strains (including Back injuries)			
Bruises & Crushing			
Superficial wounds (Scratches and abrasions)			
Open wounds (Cuts, lacerations & punctures)			
Burns & Scalds			
Eye Injuries			
Concussions & other head injuries			

**Part F****Background Questions**

The following questions are very important for properly analysing and understanding the information once it has been combined together. Please be assured that **all responses will be kept strictly confidential by the principal researcher at Curtin University.**

Please complete the following details by entering or circling the appropriate response:

93	Your year of birth	(year)	19__ __
94	Your gender	1 Male 2 Female	
95	What year did you first start with this Company?	(year)	__ __ __ __
96	What year did you start your current job?	(year)	__ __ __ __
97	What is the highest educational level you attained?	1 Primary 2 Secondary Yrs 8-10 3 Secondary Yrs 11-12 4 Certificate TAFE/College	5 Apprentice/Trade 6 University degree 7 Masters/PHD 8 Other
98	What type of job do you currently perform?	Job Title	__ __ __ __ __ __ __ __ __ __
99	How would you rate the likelihood of you being injured in your job?	1 2 3 4 5 6 7 8 9 10 Very low Very high	
100	How would you rate the relative hazard level in your job?	1 2 3 4 5 6 7 8 9 10 Very low Very high	
101	What is your job category?	1 Full-time 2 Part-time	3 Casual 4 Contractor
102	What location do you currently work from?	Site	__ __ __ __ __ __ __ __ __ __
103	How many years of experience do you have in this industry?	Years	__ __
104	How many people are in your work team?	Team	__ __ __
	To retain your anonymity we would ask you to create a personal code which will allow us to match your information in future surveys.		<i>Eg Smith 7<sup>th</sup> Oct 1956 = S M I O 7</i>
105	The code is made by combining the first 3 letters of your mother's maiden name and the day of the month on which you were born.	Your Code	__ __ __ __ __

Now that you have finished, please go back and check to see that you have answered all the questions. Then seal your questionnaire in the reply-paid envelope and post it directly to Curtin University.

**Remember all information is confidential**  
**Please return your completed survey as soon as possible. Thank you**  
**for your participation - your opinion is important to us.**

## Appendix B: Climate for Social Exchange Scale Modifications

The following three tables show the comparative wording and item inclusion for original and modified social exchange scales.

Table A1 *Leader-Member Exchange Scale Adaptation*

Original LMX 7*	Modified LMX
To what extent;	My direct supervisor;
Do you know where you stand with your supervisor or (know how satisfied/dissatisfied your supervisor is with you	Lets all members of the team know where they stand with him/her
Does your supervisor understand your job problems and needs	Understands our teams job problems and needs
Do you feel your supervisor recognises your potential	Recognises the potential of all employees in our work group
Would your supervisor be personally inclined to use their available power to solve problems in your work	Uses his/her available power to solve our work related problems
Can you count on him/her to “bail you out” at his/her expense when you really need it?	Would “bail out” team members at his/her own expense if they really need it?
Do you have confidence in your supervisors decisions such that you would defend and justify them even if they were not present to do so	Makes decisions that team members would defend and justify to other workers
How effective would you characterise your working relationship with your supervisor.	Has effective working relationships with employees in our work group
	Has a genuine concern for the welfare of employees in our work group

Note \* Graen & Uhl-Bien (1995) as used by Hofmann & Morgeson (1999)

Table B2. *Manager-Member Exchange Scale Adaptation*

Short version POS*	Modified MMX
To what extent does /is;	Top Management in this department/site;
The organisation strongly considers my goals and values	Are honest and “up front” in their dealings with employees
Help available from the organisation when I have a problem	Understand employees’ job problems and needs
The organisation is willing to help me when I need a special favours	Recognise the contributions of employees
The organisation takes pride in my accomplishments at work	Can be trusted to do what is best for employees
The organisation value my contribution to its wellbeing	Take personal responsibility for their mistakes
The organisation tries to make my job as interesting as possible	Make decisions that employees feel confident to defend to other workers
The organisation cares about my opinions	Have effective working relationships with employees in this organisation/work team
The organisation really cares about my well-being	Show genuine concern for the welfare of employees
The organisation cares about my general satisfaction at work	

Note \* 9 items from short version POS (Eisenberger et al., 1986) used by Hofmann & Morgenson (1999). Negative worded items are omitted.

Table B3. *Group-Member Exchange Scale Adaptation*

TMX*	Modified GMX
	Coworkers in my team:
Do other members of your team usually let you know when you do something that makes their jobs easier (or harder)? (Reciprocal)	Let each other know where they stand
How well do other members of your team understand your problems and needs?	Understand each other's job problems and needs
How well do other members of your team recognise your potential?	Respect each other's capabilities
In busy situations, how often do other team members ask you to help out? (Reciprocal)	Help each other solve work related problems
How flexible are you about switching job responsibilities to make things easier for other team members?	"Bail each other out" at their own expense when someone really needs it
How willing are you to help finish work that has been assigned to others? (Reciprocal)	Have confidence in each other's decisions such that they defend them to others
How often do you make suggestions about better work methods to other team members?	Have effective working relationships with each other
	Show a genuine concern for each other's welfare

Note \* 7 items from TMX (Seers et al., 1995) Reciprocally worded items indicated but not included.

## Appendix C: Sample Prior-Notification Sheet

### Employee Survey

A doctoral research student from Curtin University of Technology has approached *Organisation* to conduct a study investigating how the commitment of management, supervisors and workers to safety influences safety outcomes such as accident and injury rates in our organisation.

*Organisation* recognises our community responsibility to contribute to ongoing research and believes the study is worthy of our support.

Participation simply involves you filling in a short questionnaire, which should take around 20 minutes. As participation is voluntary, you are under no obligation to complete the survey.

It is important for you to understand that while *Organisation* is committed to ensuring the needs and concerns of its staff are identified, and where appropriate, acted on, your responses in this study will be completely confidential. You are not required to provide your name on the survey, ensuring all responses are anonymous.

A reply paid envelop, to return completed surveys directly to Curtin University, will be provided to ensure that no one at *Organisation* will know who has or has not completed a questionnaire. All information will be independently analysed by the researcher at Curtin University of Technology.

It has also been agreed that feedback from the survey will be provided in a final summary of average or grouped responses and *Organisation* will not have access to ANY responses you make as an individual.

The survey is intended to provide valuable information to help us understand the safety climate in our organisation. It also offers you the opportunity to share your views on a range of safety-related issues. The more responses received the more valid the findings will be.

Your contribution to this research is important and will be greatly appreciated.

The survey will be distributed on *Date next week* . Please return your completed survey by *Date next two weeks*.

If you have any queries about the survey please feel welcome to contact *Organisation Representative* or the researchers directly on the numbers listed below.

Thank you for your consideration of this request.

#### Organisational Rep Details

Position

Contact

Fiona Geddes  
B Science (Psychology)  
(08)9381 7098  
[fionageddes@westnet.com.au](mailto:fionageddes@westnet.com.au)

Associate Professor Clare Pollock  
School of Psychology  
Curtin University of Technology  
(08) 92667279

Approval for this study has been given by the Curtin University Human Research Ethics Committee. If needed, verification of ethics approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth 6845 or by telephoning (XX) XXXXXXXX. You may also contact Professor Jan Piek (XX) XXXXXXXX, as an independent representative of Curtin University of Technology.



## Appendix D: Sample Feedback Agreement

### Research Data Feedback Agreement

This agreement is between the researcher, a Doctoral student from the School of Psychology at Curtin University of Technology, and the management of *Organisation*.

- It is agreed that the following may be provided to management and employees at *Organisation*:
  1. An executive summary of the study's findings and conclusions.
  2. A report detailing data averages, frequencies and distribution statistics for each of the variables in the study. To safeguard against possible indirect identification of employees these will be provided in collapsed demographic categories.
- It is agreed that the above be provided on or before *Date*.
- It is agreed that the student facilitates a survey feedback session to management, supervisors and selected staff representatives on or before *Date*.

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Fiona Geddes  
PHD Candidate  
Curtin University

Date

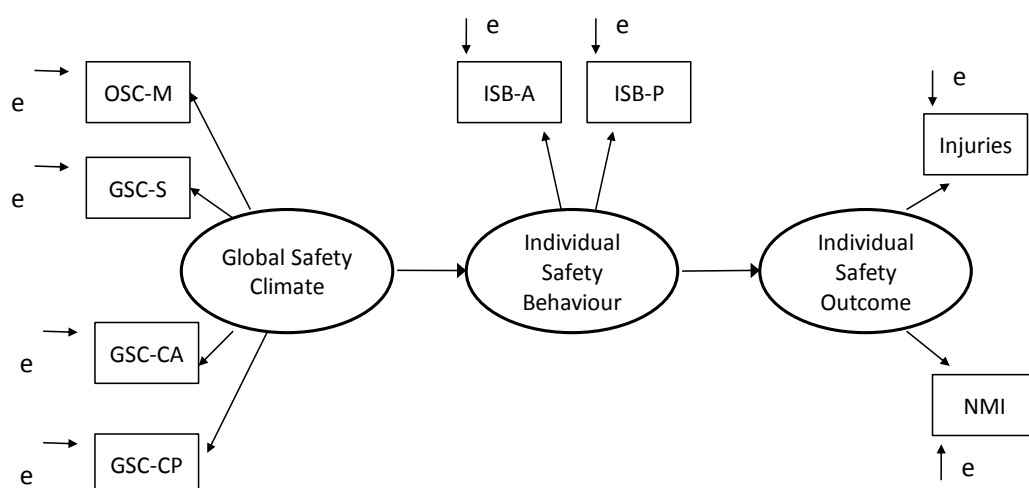
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Organisational Rep  
Position  
Company

Date

### Appendix E: Individual-Level Analysis and Scale Distributions

Hypothesis 10 proposed that the influence of global safety climate on self-reported safety outcomes will operate through the individual safety behaviours of workers. Figure E.1 depicts the hypothesised mediation model. Two alternative models are also tested: the full model, specifying both direct and indirect effects between safety climate and safety outcomes; and the direct model in which safety climate is hypothesised to directly influence both individual safety behaviours and injuries and incidents. In all the SEM analyses, maximum likelihood estimation was applied and the hypothesised models were compared for fit against the theoretical model for the null hypothesis (Sobel & Bohrnstedt, 1985). To comply with recommendations regarding the evaluation of nested models (Bentler & Bonnett, 1980; Hair et al., 2006; Kline, 2005) multiple fit indices were used.



*Figure E.1.* Mediation model of the predictive relationship between global safety climate, individual safety behaviours and safety outcomes.

The individual-level models were tested on the total sample. Only cases with valid data on all safety climate, individual safety behaviours and both injury and incident data were included in the analysis ( $N=318$ ). Twenty two cases (6%) had missing

data for one or more variables and one case with extreme injury data was removed. Table E.1 shows the descriptive statistics, scale reliabilities and zero order correlations for the safety climate, individual safety behaviours and injury and incident variables. Bivariate correlations amongst the safety climate dimensions ranged from .49 to .70. The highest correlation was observed between the two GSC-C active and proactive subscales. Of note is the pattern of bivariate correlations observed for both the injury and near miss incident data. While significant negative correlations are found between the safety climate and safety outcome data, the bivariate correlations between individual safety behaviours and both outcomes are weaker than anticipated.

Table E.1 *Means, Standard Deviations and Zero-Order Correlations for Individual-level Safety Climate, Safety Behaviour and Safety Outcomes.*

Variable	Mean	SD	Items	$\alpha$	1	2	3	4	5	6	7
1 OSC-M	3.79	0.78	17	.95							
2 GSC-S	3.78	0.82	17	.96	.67**						
3GSC-CA	3.82	0.82	6	.88	.49**	.52**					
4 GSC-CP	3.85	0.77	6	.90	.53**	.57**	.70**				
5 ISB-WA	4.19	0.67	12	.83	.43**	.43**	.66**	.54**			
6 ISB-WP	4.06	0.72	12	.87	.44**	.46**	.51**	.59*	.67**		
7LogINJ	0.197	0.33			-.20**	-.13*	-.12*	-.12*	-.08	.02	
8 LogINC	0.184	0.40			-.18**	-.12*	-.13*	-.10	-.14*	-.08	.45**

Note. N=318;  $\alpha$  = Cronbach's Alpha; \* $p < .05$ , \*\* $p < .01$ ,

Model fit statistics and results of the chi-square difference tests undertaken are displayed in Table E.2. The independence model was easily rejected. Assessment of fit indices for the full model indicated that this model provided a reasonable fit to the data. However, inspection of modification indices indicated that the addition of an error covariance between OSC-M and GSC-S would substantially improve fit. All models were therefore rerun with the error covariance between OSC-M and GSC-S freed. Fit indices for the full model with freed error covariance indicated that this model provided a good fit. The mediation model and equivalent direct path model (proposing no direct effects between individual behaviours and safety outcomes) provided an equally good fit, with neither model showing substantial improvement over the full model.

With fit equivalence across models, attention is turned to the structural coefficients for the SEM, as reported in Table E.3. Examination of the structural equations showed the standardised parameter estimate between GSC and ISB was statistically significant in all models indicating that ratings of safety climate are a strong positive predictor of individuals' self-reported safety behaviours. The direct pathway from safety climate to safety outcomes was statistically significant in both the full model and direct pathway model indicating that positive perceptions of safety climate are associated with lower rates of self-reported injury and incidents.

Table E.2 *Assessment of Fit and Model Differences for Predictive Models of Global Safety Climate, Safety Behaviour and Safety Outcomes*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
Independence (#1)	1587.04***	28	-	-	-	-
Full (#2)	115.05***	17	.94	.93	.05	.13 (.11,.16)
Fullwith error (#3)	59.75***	16	.97	.96	.04	.09 (.07,.12)
Mediation with error (#4)	63.00***	17	.97	.96	.05	.09 (.07,.11)
Direct with error (#5)	60.94***	17	.97	.96	.04	.09 (.06,.11)
Difference ( $\Delta\chi^2$ ) #1-#5	1526.1***	11				
Difference ( $\Delta\chi^2$ ) #2-#3	55.3***	1				
Difference ( $\Delta\chi^2$ ) #3-#4	3.25	1				
Difference ( $\Delta\chi^2$ ) #3-#4	1.19	1				

Note.  $N=318$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

In both the full and mediation models the direct pathway between individual safety behaviours and outcomes failed to reach statistical significance, curtailing the possibility of ISB acting as a mediator. Furthermore the positive direction of the association between ISB and ISO found in the full model is contrary to prediction (0.28,  $Z=1.47$ ,  $p>.05$ ). When the direct relationship between safety climate and outcomes was constrained in the mediation model the parameter estimate for ISB to ISO reversed direction (-0.17,  $Z= -1.40$ ) indicating that rather than operating as a mediator, in this instance, ISB may be acting as a suppressor variable. Finally the indirect effects of safety climate on safety outcomes were not significant.

Table E.3 *Parameter Estimates for Models Predicting Safety Outcomes*

Path	Full Model			Mediated Model			Direct Model		
	St	Unst	SE	St	Unst	SE	St	Unst	SE
Direct Effect									
GSC→ISB	0.84	0.98*** (0.79,1.17)	.097	0.84	1.00*** (0.80,1.19)	.099	0.84	0.99*** (0.80,1.18)	.098
ISB→ISO	0.28	0.13ns (-0.04,0.31)	.089	-0.17	-0.05ns (-0.12,0.02)	.036			
GSC→ISO	-0.45	-0.25* (-0.45,-0.04)	0.11				-0.22	-0.10* (-0.18,-0.02)	.042
Indirect Effect									
GSC→ISO	0.24	0.13ns	0.09	-0.14	-0.05ns	.040			
Total Effects									
GSC→ISO	-0.21	-0.12**	.042						

*Note.*  $N=318$ ; GSC= Global Safety Climate, ISB= Individual Safety behaviour, ISO= Individual safety Outcome; St= Standardised; Unst = Unstandardised; Estimate 95% confidence interval in parenthesis, SE=Standard Error, \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

The different total effects of global safety climate on individual injuries and incidents provided in the *Ksi* matrix are reported in Table E.4. Results indicate a marginally stronger predictive relationship between the rate of near miss incident reporting and safety climate than between climate and injuries. To determine the practical significance of the findings, disturbance terms for the endogenous variables in the model were assessed. The percentage of explained variance for ISB was 70% and for safety outcomes 4.9% in the direct model. While the effect size for predicting

safety outcomes is small, the large effect size for ISB reinforces current opinions that the safety behaviours of individual workers may be explained by safety climate.

Table E.4 *Total Effects for Global Safety Climate Predicting Safety Outcomes*

Total Effects	ISB		ISO	
	Active	Proactive	Injuries	Incidents
GSC				
Unst	1.00***	1.00***	-0.05	-0.11*
SE	.10	.11	.04	.04

Note. GSC= Global Safety Climate, ISB= Individual Safety behaviour, Incidents= Near Miss Incidents; Unst= Unstandardised; SE=Standard Error, \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

When considered in combination, the results for the individual-level analyses support the notion that a direct relationship exists between safety climate and safety outcomes such as injuries and near miss incidents, rather than a mediated relationship through individual safety behaviours. The full mediation model proposed in Hypothesis 10 was therefore not supported. Standardised structural coefficients for the final direct effects model are presented in Figure 8.2. Also reported are the error terms and modelled error covariance between GSC-S and OSC-M.

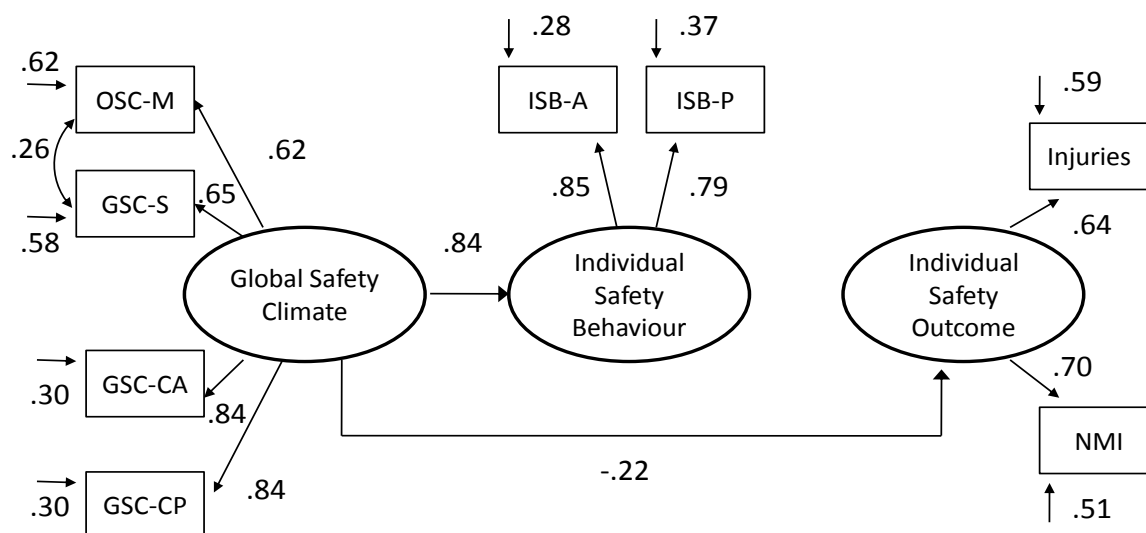
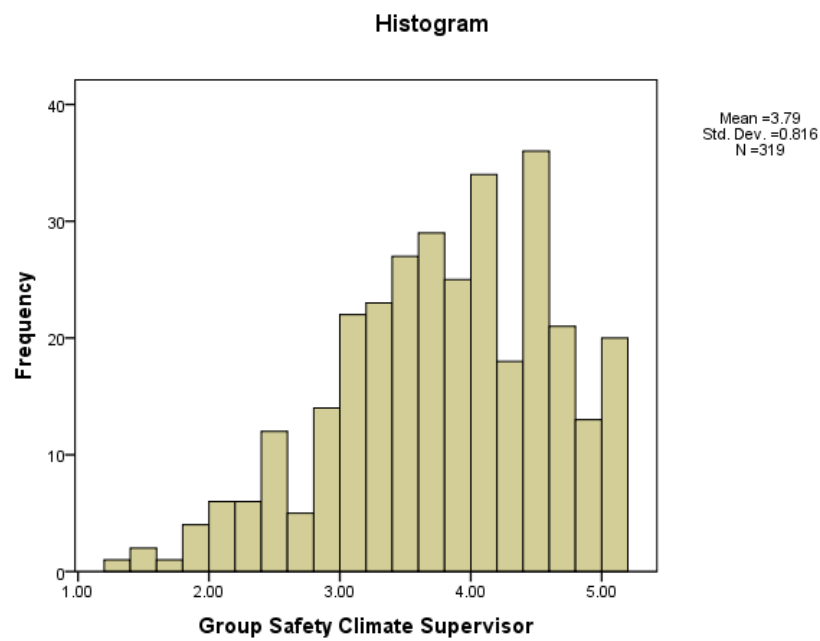
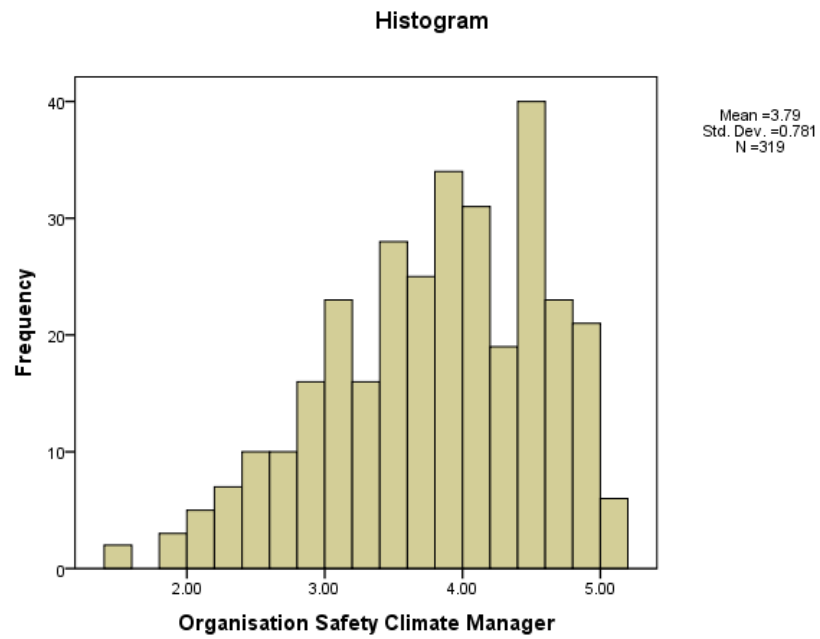
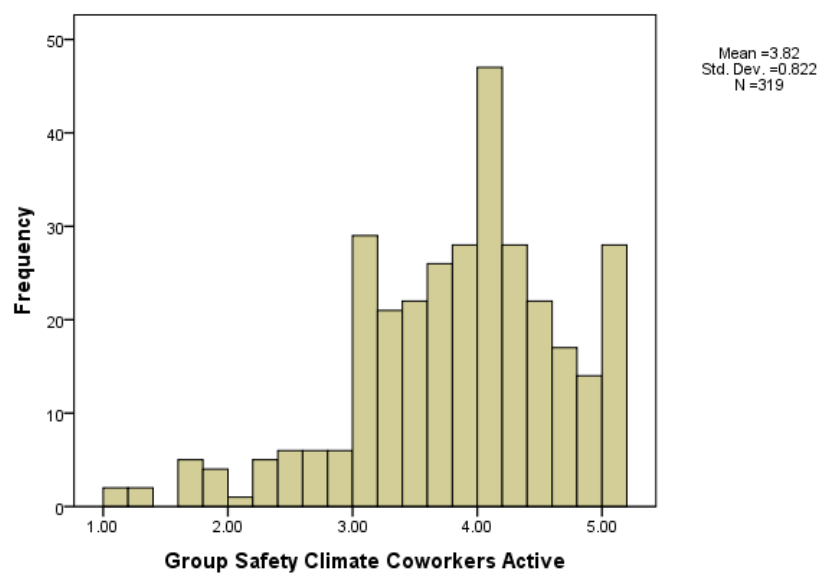


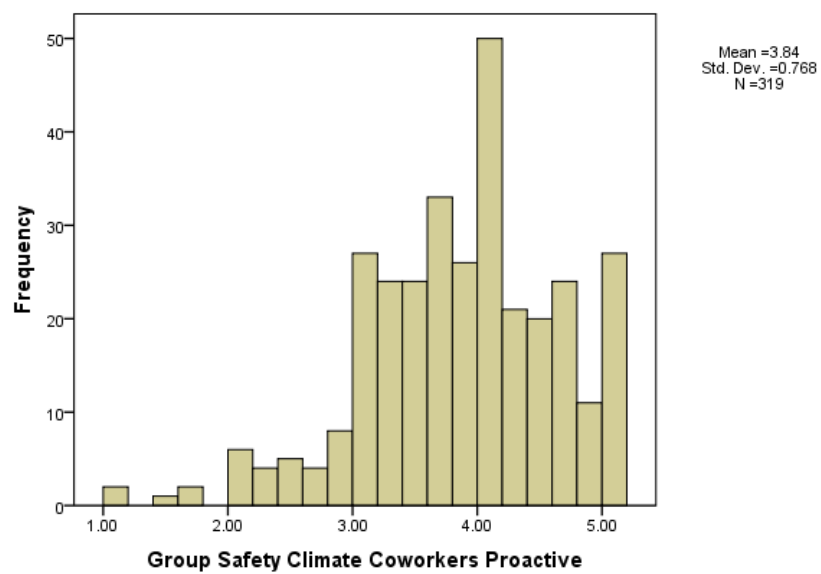
Figure E.2. Direct model with significant standardised coefficients for global safety climate, individual safety behaviours and safety outcomes.



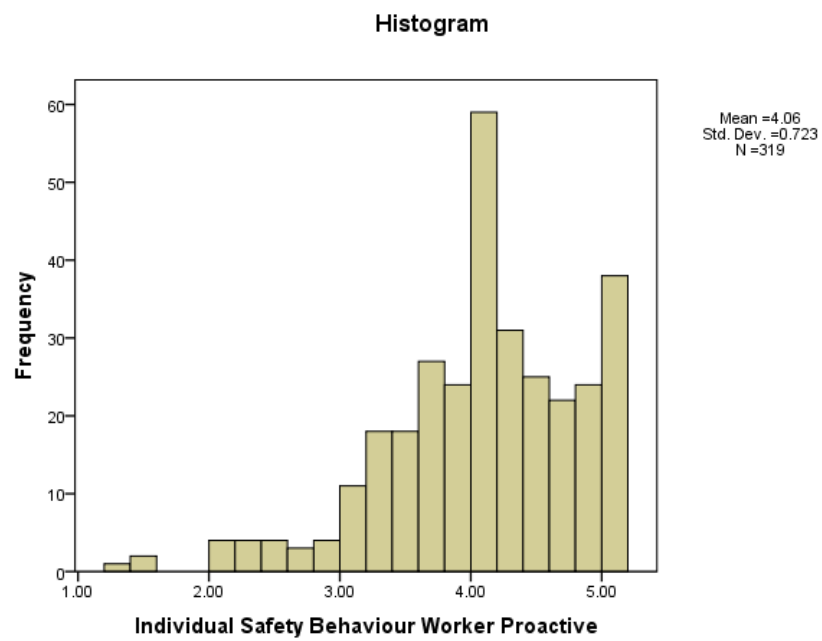
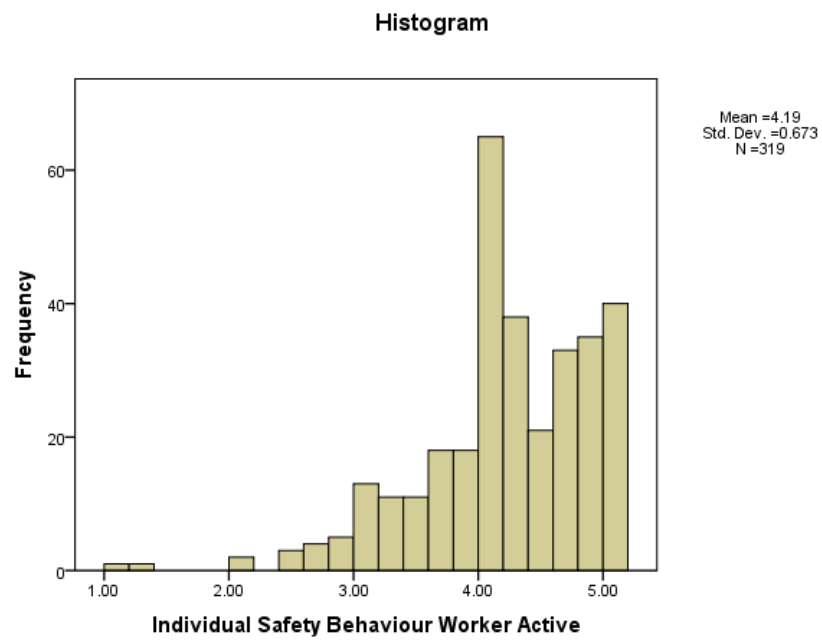
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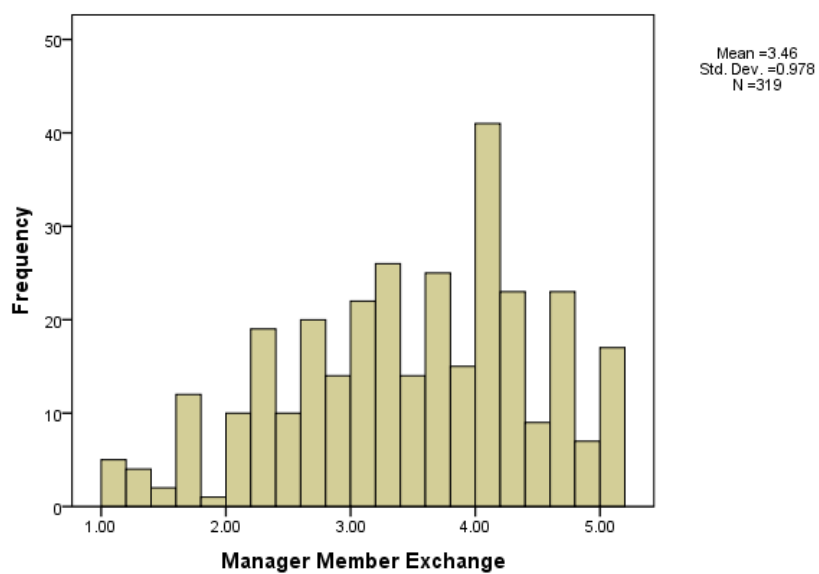
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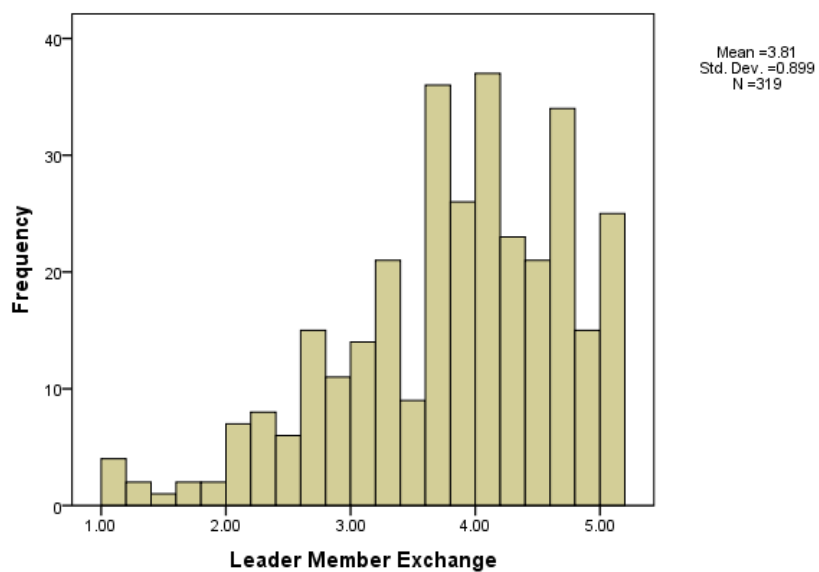


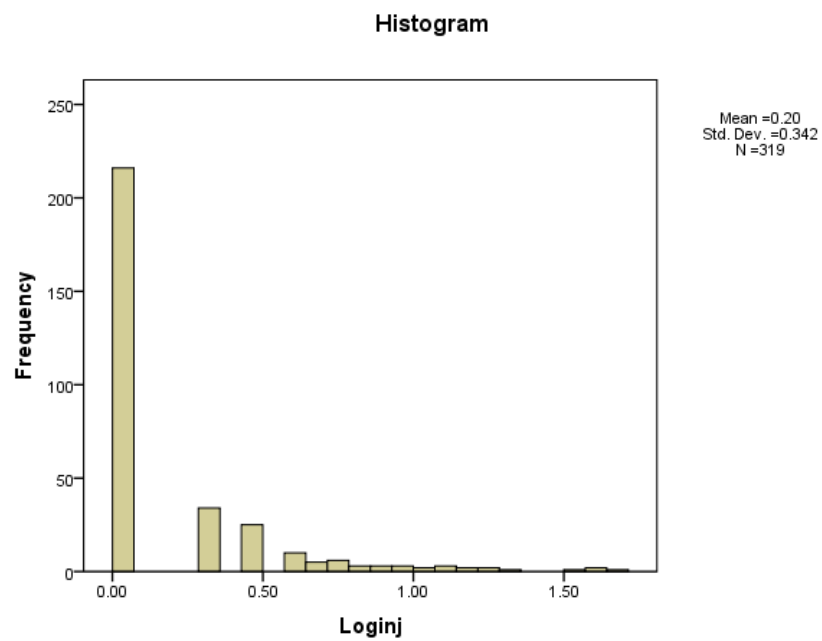
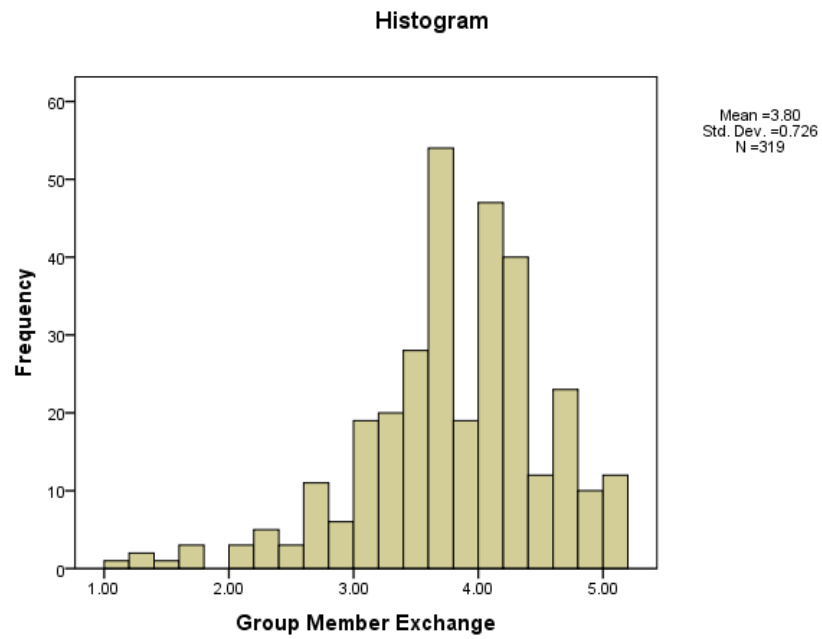


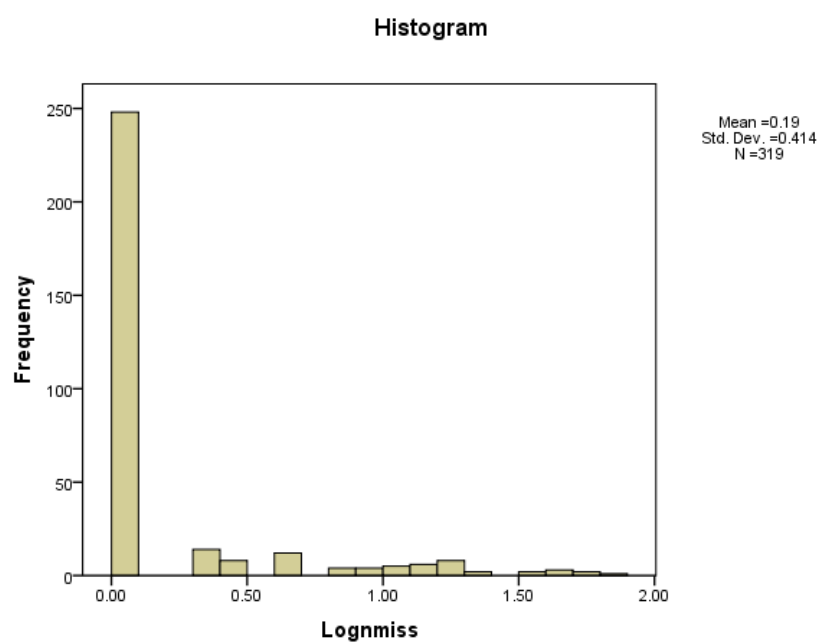
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## Appendix F: ICC Calculations for CSA Aggregation

Table F.1. CSA aggregation ICC and ANOVA results for Coworker Safety Climate and Social Exchange Scales Items.

Item	ICC	ANOVA
1 Refuse to ignore safety rules when work falls behind schedule	0.04	$F(79,297)=1.23, p=.128$
2 Always wear protective equipment even if it is uncomfortable	0.27	$F(79,297)=2.38, p<.001$
3 Are prepared to question co-workers who are not following safety rules	0.11	$F(79,297)=1.48, p=.014$
4 Monitor each other when tired or stressed	0.11	$F(79,297)=1.45, p=.020$
5 Look out for each other's personal safety	0.15	$F(79,297)=1.71, p=.001$
6 Follow correct safety procedures when using equipment	0.13	$F(79,297)=1.52, p=.009$
7 Co-operate with supervisors to develop better safety practices	0.11	$F(79,297)=1.63, p=.003$
8 Use their initiative to help solve safety related problems	0.07	$F(79,297)=1.44, p=.020$
9 Get involved in the safety training programs provide	0.20	$F(79,297)=1.92, p<.001$
10 Make suggestions on how to improve job safety	0.06	$F(96,297)=1.33, p=.056$
11 Share information about safety hazards with supervisors and each other	0.05	$F(79,297)=1.18, p=.179$
12 Keep themselves informed about safety related issue	0.09	$F(79,297)=1.29, p=.079$
13 Discuss ideas about how to continually improve safety	0.11	$F(79,297)=1.46, p=.017$
14 Speak highly of those workers who pay special attention to safety	0.08	$F(79,297)=1.28, p=.083$
15 Report all safety related accidents and near misses as soon as they occur	0.02	$F(79,297)=1.13, p=.245$
16 Express opinions on safety matters even if others disagree	0.14	$F(79,297)=1.63, p=.003$
17 Cover up for one another when safety rules are not followed		Not included
18 Let each other know where they stand	*	$F(79,297)=0.91, p=.692$
19 Understand each other's job problems and needs	0.08	$F(79,297)=1.44, p=.020$
20 Respect each other's capabilities	0.04	$F(79,297)=1.20, p=.156$
21 Help each other solve work related problems	0.04	$F(79,297)=1.32, p=.060$
22 Bail each other out at their own expense when someone really needs it	0.06	$F(79,297)=1.38, p=.035$
23 Have confidence in each other's decisions such that they defend them to others	0.07	$F(79,297)=1.40, p=.031$
24 Have effective working relationships with each other	0.11	$F(79,297)=1.62, p=.003$
25 Show a genuine concern for each other's welfare	0.11	$F(79,297)=1.50, p=.011$

Note. \* An ICC value could not be computed for this item. The following warning produced-The final Hessian matrix is not positive definite although all convergence criteria are satisfied.

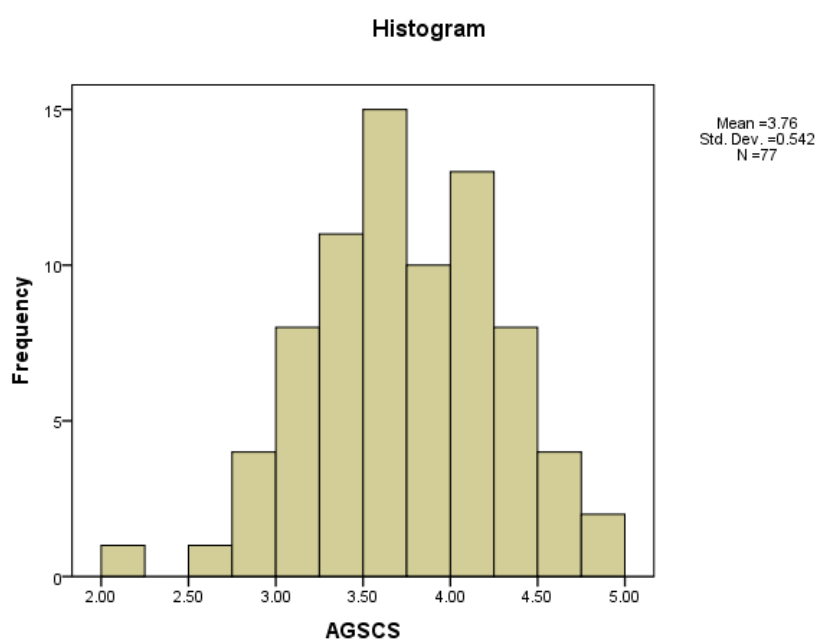
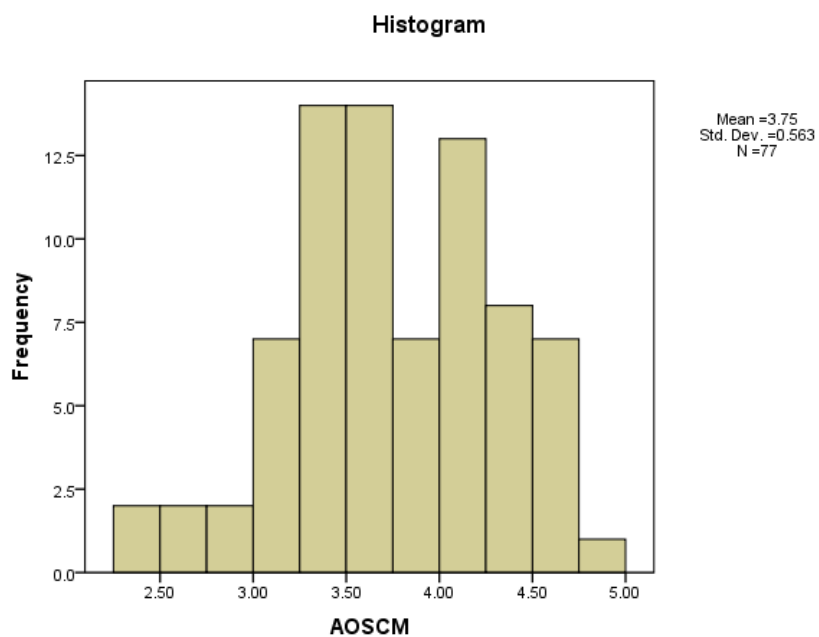
Table F.2. CSA aggregation ICC and ANOVA results for Supervisor Safety Climate and Social Exchange Scales Items.

Item	ICC	ANOVA
1 Makes sure we receive all the equipment needed to do the job safely	0.14	$F(79,302)=1.63, p=.003$
2 Checks to see if we are all obeying safety rules	0.15	$F(79,302)=1.59, p=.004$
3 Discusses how to improve safety	0.11	$F(79,302)=1.43, p=.021$
4 Uses explanations (not just compliance) to get us to act safely	0.15	$F(79,302)=1.59, p=.005$
5 Emphasises safety procedures when we are working under pressure	0.10	$F(79,302)=1.33, p=.053$
6 Frequently tells us about the hazards	0.09	$F(79,302)=1.31, p=.065$
7 Refuses to ignore safety rules when work falls behind schedule	0.15	$F(79,302)=1.64, p=.003$
8 Is strict about working safely when we are tired or stressed	0.17	$F(79,302)=1.69, p=.001$
9 Reminds workers who need it to work safely	0.12	$F(79,302)=1.45, p=.018$
10 Makes sure we follow all the safety rules	0.21	$F(96,302)=1.99, p<.001$
11 Insists that we obey safety rules when fixing equipment or machines	0.10	$F(79,302)=1.29, p=.074$
12 Says a "good word" to workers who pay special attention to safety	0.16	$F(79,302)=1.69, p=.001$
13 Is strict about safety at the end of the shift	0.18	$F(79,302)=1.79, p<.001$
14 Spends time helping us learn to see problems before they arise	0.16	$F(79,302)=1.72, p=.001$
15 Frequently talks about safety issues	0.15	$F(79,302)=1.61, p=.003$
16 Insists we wear our protective equipment	0.08	$F(79,302)=1.36, p=.043$
17 Encourages workers to report all safety accidents and near misses	0.18	$F(79,302)=1.85, p<.001$
18 Lets all members of the team know where they stand	0.14	$F(79,302)=1.60, p=.004$
19 Understands our teams job problems and needs	0.11	$F(79,302)=1.49, p=.012$
20 Recognises the potential of all employees in our work group	0.18	$F(79,302)=1.89, p<.001$
21 Use their available power to solve our work related problems	0.09	$F(79,302)=1.40, p=.028$
22 Would "bail out" team members at his/her own expense if they really need it	0.12	$F(79,302)=1.50, p=.011$
23 Makes decisions that team members would defend and justify to other workers	0.17	$F(79,302)=1.74, p=.001$
24 Has effective working relationships with employees in our work group	0.19	$F(79,302)=1.95, p<.001$
25 Has a genuine concern for the welfare of employees in our work group	0.14	$F(79,302)=1.62, p=.003$

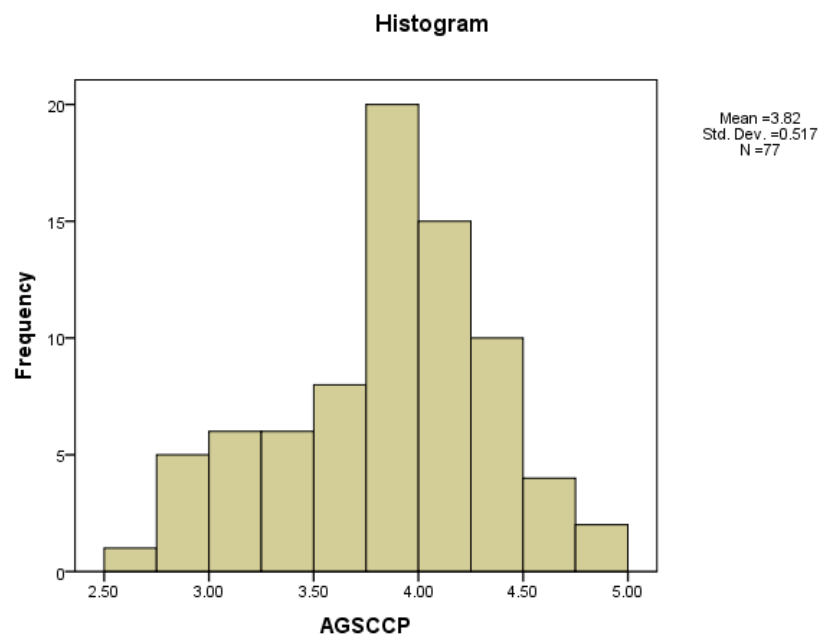
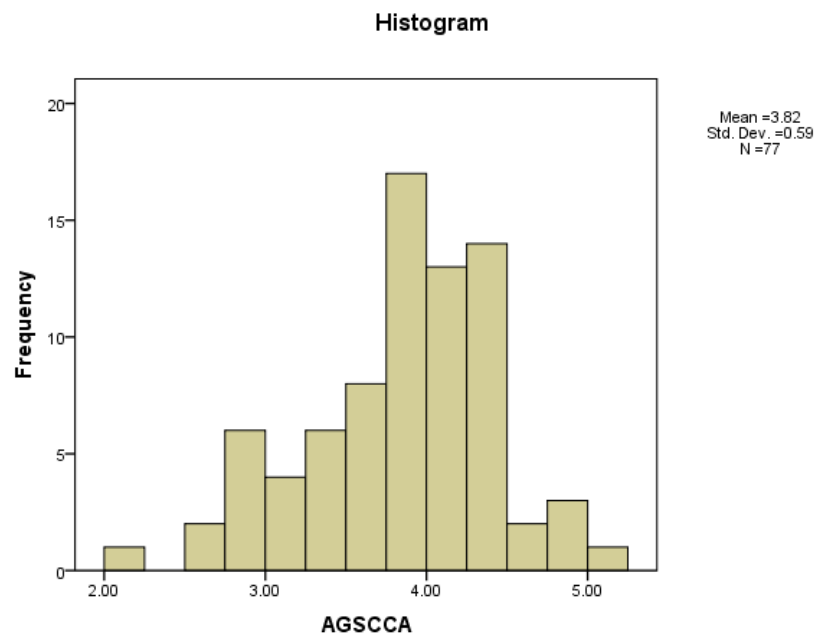
Table F.3. CSA aggregation ICC and ANOVA results for Management Safety Climate and Social Exchange Scales Items.

Item	ICC	ANOVA
1 Reacts quickly to solve the problem	0.19	$F(79,304)=1.86, p<.001$
2 Insists on thorough and regular safety audits	0.18	$F(79,304)=1.82, p<.001$
3 Continually improves safety levels	0.14	$F(79,304)=1.65, p=.002$
4 Provides all the equipment needed	0.20	$F(79,304)=1.98, p<.001$
5 Are strict about working safely when work falls behind schedule	0.22	$F(79,304)=2.10, p<.001$
6 Quickly corrects any safety hazards (even if it's costly)	0.17	$F(79,304)=1.73, p=.001$
7 Provides detailed safety reports to workers	0.07	$F(79,304)=1.15, p=.220$
8 Considers a person's safety behaviour when promoting	0.18	$F(79,304)=1.80, p<.001$
9 Requires each manager to help improve safety in their department	0.15	$F(79,304)=1.75, p<.001$
10 Invests a lot of time and money in safety training	0.23	$F(96,304)=2.20, p=.001$
11 Uses any available information to improve existing safety rules	0.18	$F(79,304)=1.87, p<.001$
12 Listens carefully to worker's ideas about improving safety	0.15	$F(79,304)=1.64, p=.003$
13 Considers safety when setting production speed and schedules	0.17	$F(79,304)=1.75, p=.001$
14 Provides workers with a lot of information on safety issues	0.23	$F(79,304)=2.15, p<.001$
15 Regularly holds safety-awareness events	0.11	$F(79,304)=1.50, p=.011$
16 Gives safety personnel the power they need to do their job	0.14	$F(79,304)=1.62, p=.003$
17 Emphasize the importance of reporting all safety accidents and near misses	0.13	$F(79,304)=1.69, p=.001$
18 Are honest and "up front" in their dealings with employees	0.20	$F(79,304)=1.92, p<.001$
19 Understand employees' job problems and needs	0.16	$F(79,304)=1.66, p=.002$
20 Recognise the contributions of employees	0.16	$F(79,304)=1.73, p=.001$
21 Can be trusted to do what is best for employees	0.20	$F(79,304)=1.91, p<.001$
22 Are understanding when employees make honest mistakes	0.12	$F(79,304)=1.42, p=.024$
23 Make decisions that employees feel confident to defend to other workers	0.17	$F(79,304)=1.72, p=.001$
24 Have effective working relationships with employees	0.10	$F(79,304)=1.38, p=.035$
25 Show genuine concern for the welfare of employees	0.13	$F(79,304)=1.60, p=.004$

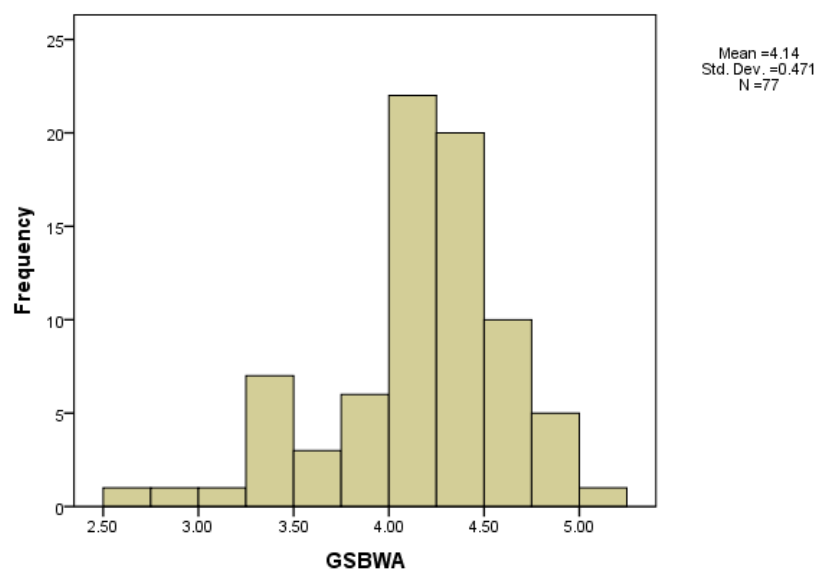
## Appendix G: Group-Level Scale Distributions



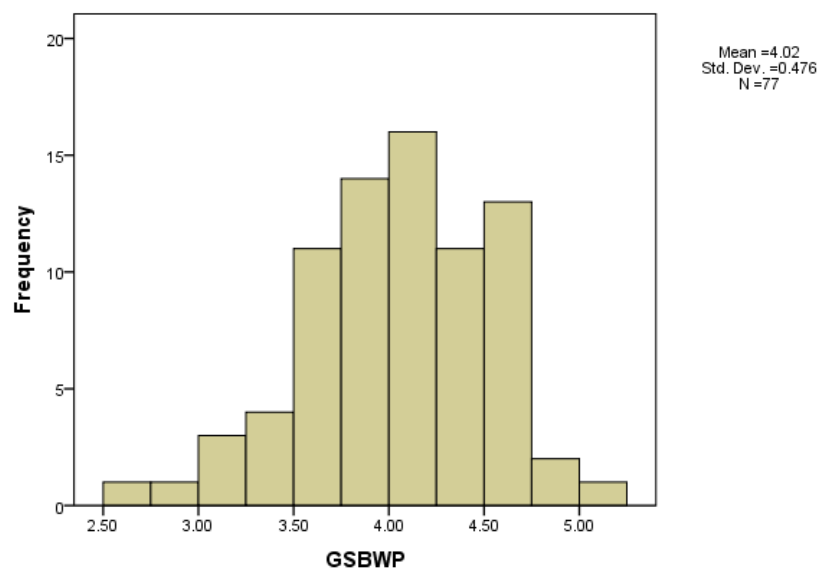


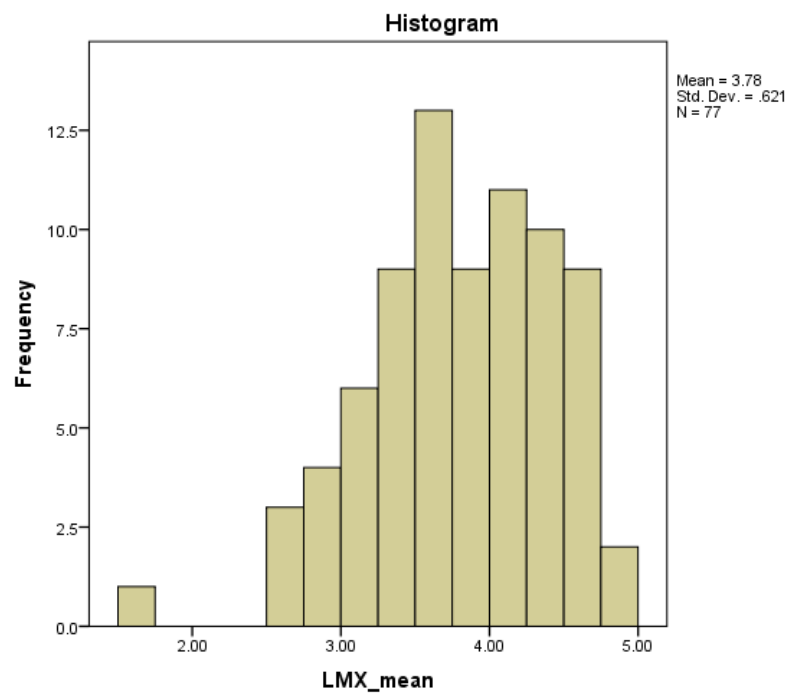
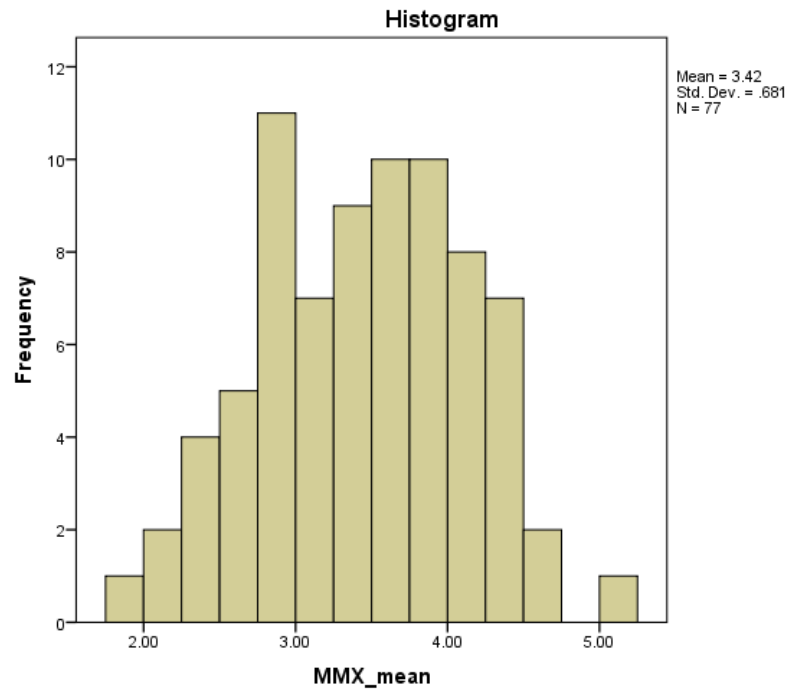


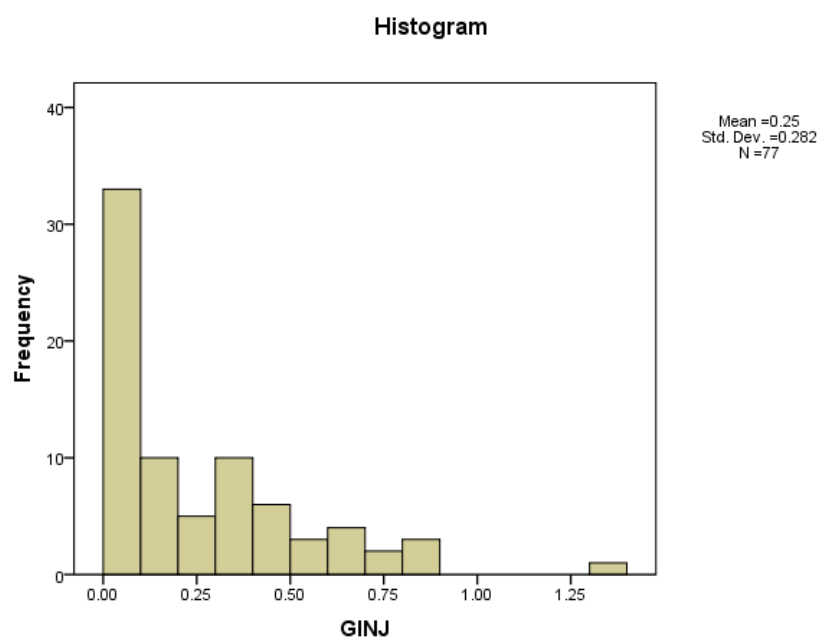
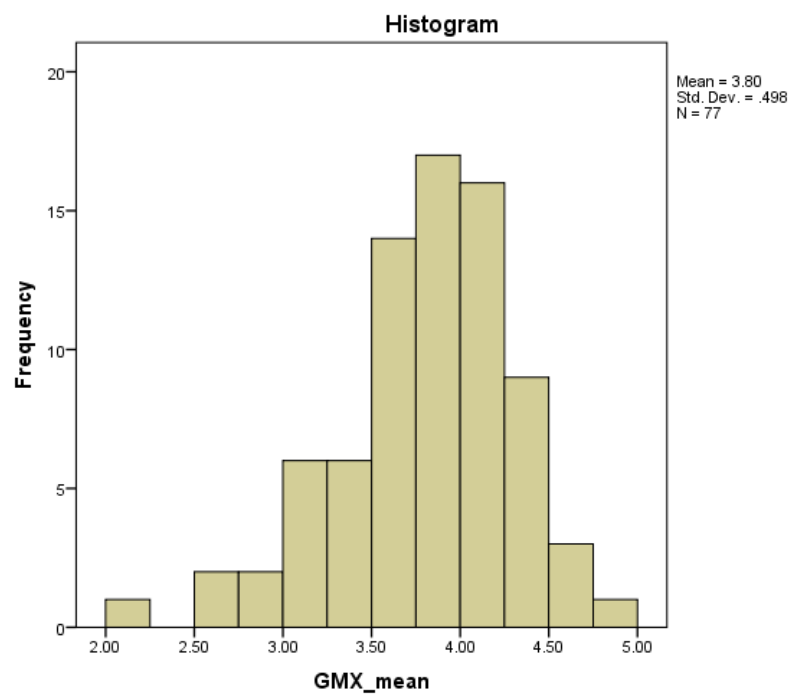
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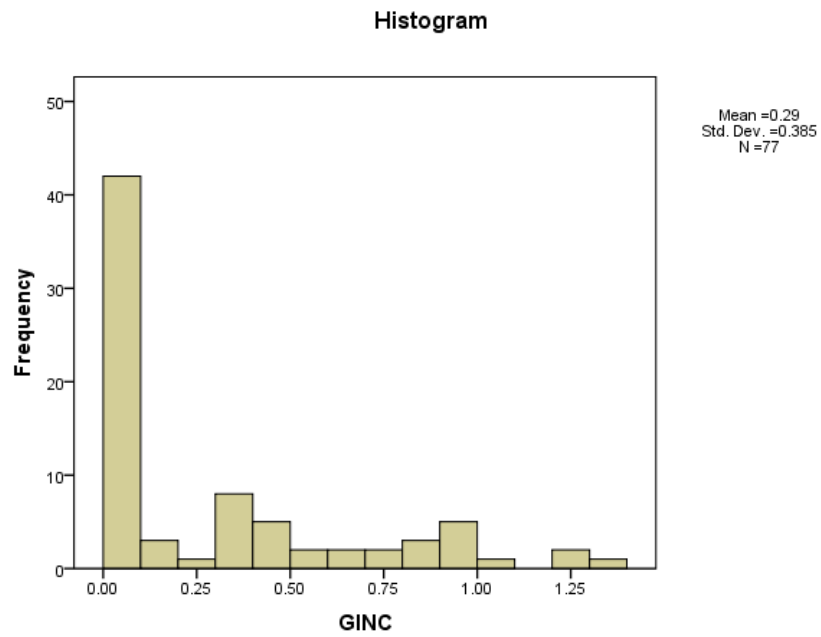


Histogram









## Appendix H: Incremental validity test of Co-worker Scales

To test if the inclusion of coworker commitment to safety in a global conceptualisation of safety climate representing management and supervisor safety climate a series of supplemental hierarchical MRAs were conducted on the individual level data, and both ILSA and CSA data for injury, near miss, worker's active safety behaviours and worker's proactive safety behaviours. In all analysis at step one of the hierarchical regression management (AOSC-M) and supervisor commitment to safety (AGSC-S) entered and coworker subscales (AGSC-CA or AGSC-CP) at Step 2. Results including changes in incremental variance, unstandardised ( $B$ ) and standardised ( $\beta$ ) regression coefficients, and squared semi-partial correlations in the hierarchical MRAs are reported in Table form.

For the individual level data results for the injury outcomes indicated that while the predictive power of the model at step one was significant  $R^2 = .05$ ,  $F(2, 316) = 9.06$ ,  $p < .001$ , that when the two safety climate - coworker subscales were entered into the analysis the incremental variance was not statistically significant  $\Delta R^2 = .001$ ,  $\Delta F(2, 314) = 0.23$ ,  $p = .793$ . Results for the near miss incident outcome also indicated that the predictive power of the management and supervisor safety climate subscales in the model when entered in step 1 was significant  $R^2 = .04$ ,  $F(2, 316) = 5.82$ ,  $p = .003$ . However again, when the two safety climate - coworker subscales were entered into the analysis at step two, the incremental variance was not statistically significant  $\Delta R^2 = .004$ ,  $\Delta F(2, 314) = 0.57$ ,  $p = .565$ .

In contrast when the active and proactive safety behaviours of workers were used as criterion variables, coworker safety climate showed significant incremental variance at Step 2 in both hierarchical MRA procedures (Active:  $\Delta R^2 = .23$ ,  $\Delta F(2, 314) = 66.58$ ,  $p < .001$ ; Proactive  $\Delta R^2 = .14$ ,  $\Delta F(2, 314) = 36.64$ ,  $p < .001$ ). In combination safety climate variables accounted for 46% of variance in worker's active safety behaviours and 39% of variance in proactive safety behaviours.

For the ILSA data results for the injury outcomes indicated that while the predictive power of the model at step one was significant  $R^2 = .13$ ,  $F(2, 74) = 5.72$ ,  $p = .005$ , that when the two safety climate - coworker subscales were entered into the analysis

the incremental variance was not statistically significant  $\Delta R^2 = .02$ ,  $\Delta F(2, 72) = 0.75$ ,  $p = .475$ . Results for the near miss incident outcome also indicated that the predictive power of the management and supervisor safety climate subscales in the model when entered in step 1 was significant  $R^2 = .15$ ,  $F(2, 74) = 6.64$ ,  $p = .002$ . However again, when the two safety climate - coworker subscales were entered into the analysis at step two, the incremental variance was not statistically significant  $\Delta R^2 = .04$ ,  $\Delta F(2, 72) = 1.60$ ,  $p = .209$ .

In contrast when the active and proactive safety behaviours of workers were used as criterion variables, coworker safety climate showed significant incremental variance at Step 2 in both hierarchical MRA procedures (Active:  $\Delta R^2 = .29$ ,  $\Delta F(2, 72) = 25.84$ ,  $p < .001$ ; Proactive  $\Delta R^2 = .14$ ,  $\Delta F(2, 72) = 12.06$ ,  $p < .001$ ).

Table H.1. *Incremental Variance, Unstandardised (B) and Standardised ( $\beta$ ) Regression Coefficients, and Squared Semi-partial Correlations ( $sr^2$ ) for Predictor in the Hierarchical Multiple Regression for ILSA Group-level Models Predicting Safety Outcomes*

Variable	GSB Active				GSB Proactive			
	B	[95% CI]	$\beta$	$sr^2$	B	[95% CI]	$\beta$	$sr^2$
Step 1	$\Delta R^2 = .32^{***}$				$\Delta R^2 = .45^{***}$			
AOSC-M	.13	[-.09, .36]	.16	.010	.30	[.09, .51]**	.36	.062
AGSC-S	.38	[.14, .62]**	.44	.090	.33	[.11, .54]**	.37	.068
Step 2	$\Delta R^2 = .29^{***}$				$\Delta R^2 = .14^{***}$			
AOSC-M	-.08	[-.29, .12]	-.10	.004	.52	[-.16, .26]	.06	.001
AGSC-S	.21	[.02, .40]*	.24	.027	.21	[.02, .41]*	.24	.027
AGSC-CA	.49	[.31, .67]**	.61	.157	.09	[-.10, .28]	.11	.005
AGSC-CP	.08	[-.17, .33]	.08	.002	.42	[.16, .67]**	.46	.061
	$R^2 = .60^{***}$				$R^2 = .59^{***}$			

Note. N=77; AOSC-M= Aggregated Organisation Safety Climate-Managers; AGSC-S=Aggregated Group Safety Climate-Supervisors; AGSC-CA= Aggregated Group Safety Climate- Coworkers Active; AGSC-CP= Aggregated Group Safety Climate- Coworkers Proactive; GSB-A= Aggregated Safety Behaviours- Workers Active; GSB-P= Aggregated Safety Behaviours- Workers Proactive;  $\beta$  = Standardised regression coefficients; B = Unstandardised regression coefficients; Estimate 95% confidence interval in parenthesis,  $sr^2$ = squared semi-partial correlations, \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

For the CSA aggregated data, management and supervisor safety climate scales were both separated into their active and proactive dimensions. Results for the injury and near miss outcomes replicated those found in the ILSA analysis indicated that while the predictive power of the overall models were statistically significant the incremental variance of coworker safety climate was not statistically significant for either the injury ( $\Delta R^2 = .01$ ,  $\Delta F(2,70) = 0.58$ ,  $p = .561$ ) or near miss incident outcomes ( $\Delta R^2 = .04$ ,  $\Delta F(2,70) = 1.69$ ,  $p = .193$ ). However, when the active and proactive safety behaviours of workers were used as criterion variables, coworker safety climate again showed significant incremental variance at Step 2 in both hierarchical MRA procedures (Active:  $\Delta R^2 = .26$ ,  $\Delta F(2, 70) = 22.19$ ,  $p < .001$ ; Proactive  $\Delta R^2 = .13$ ,  $\Delta F(2,70) = 11.73$ ,  $p < .001$ ). Results are reported in Table H.2

Table H.2. *Incremental Variance, Unstandardised (B) and Standardised ( $\beta$ ) Regression Coefficients, and Squared Semi-partial Correlations ( $sr^2$ ) for Predictor in the Hierarchical Multiple Regression for CSA Models Predicting Safety Outcomes*

Variable	GSB Active				GSB Proactive			
	B	[95% CI]	$\beta$	$sr^2$	B	[95% CI]	$\beta$	$sr^2$
Step 1	$\Delta R^2 = .34^{***}$				$\Delta R^2 = .47^{***}$			
AOSC-MA	.11	[-.19, .41]	.14	.005	.30	[.02, .57]*	.38	.034
AOSC-MP	.02	[-.26, .30]	.02	.001	.05	[-.21, .30]	.05	.001
AGSC-SA	.31	[.04, .59]*	.42	.047	-.19	[-.44, .06]	-.25	.017
AGSC-SP	.04	[-.26, .34]	.05	.001	.48	[.21, .75]***	.54	.092
Step 2	$\Delta R^2 = .26^{***}$				$\Delta R^2 = .13^{***}$			
AOSC-MA	-.18	[-.44, .07]	-.23	.011	.08	[-.18, .34]	.10	.002
AOSC-MP	-.01	[-.22, .24]	.01	.001	-.02	[-.25, .21]	-.02	.014
AGSC-SA	.27	[.06, .49]*	.37	.037	-.20	[-.42, .02]	-.26	.019
AGSC-SP	-.04	[-.28, .20]	-.04	.001	.40	[.16, .64]***	.45	.063
AGSC-CA	.44	[.23, .64]***	.52	.108	.14	[-.07, .34]	.16	.010
AGSC-CP	.19	[-.05, .45]	.23	.015	.37	[.13, .62]**	.42	.052
	$R^2 = .60^{***}$				$R^2 = .60^{***}$			

Note. N=77; AOSC-MA= Aggregated Organisation Safety Climate-Managers Active; AOSC-MP= Aggregated Organisation Safety Climate-Managers Proactive; AGSC-SA=Aggregated Group Safety Climate-Supervisors Active; AGSC-SP=Aggregated Group Safety Climate-Supervisors Proactive; AGSC-CA= Aggregated Group Safety Climate- Coworkers Active; AGSC-CP= Aggregated Group Safety Climate- Coworkers Proactive; GSB-A= Aggregated Safety Behaviours- Workers Active; GSB-P= Aggregated Safety Behaviours- Workers Proactive;  $\beta$  = Standardised regression coefficients; B = Unstandardised regression coefficients; Estimate 95% confidence interval in parenthesis,  $sr^2$  = squared semi-partial correlations, \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$



### Appendix I: Individual Level Stratified Social Exchange Model

This series of model testing was conducted with valid data on all individual safety behaviours, safety climate and social exchange scales. Table I.1 shows the descriptive statistics, scale reliabilities and zero-order correlations for the scales.

Table I.1 *Means, Standard Deviations and Zero-Order Correlations for Individual Safety Behaviours, Safety Climate and Social Exchange Scales*

Variable	Mean	SD	$\alpha$	1	2	3	4	5	6	7	8
1 OSC-M	3.79	0.78	.95								
2 MMX	3.46	0.98	.94	.83**							
3 GSC-S	3.78	0.82	.96	.65**	.64**						
4 LMX	3.80	0.90	.93	.48**	.56**	.78**					
5 GSC-CA	3.82	0.82	.88	.49**	.50**	.52**	.36**				
6 GSC-CP	3.84	0.77	.90	.53**	.54**	.57**	.41**	.70**			
7 GMX	3.80	0.73	.90	.31**	.37**	.30**	.33**	.59**	.56**		
8 ISB-WA	4.19	0.67	.83	.42**	.39**	.43**	.26**	.66**	.54**	.42**	
9 ISB-WP	4.06	0.72	.87	.44**	.39**	.45**	.25**	.51**	.59**	.31**	.67**

Note. N=318;  $\alpha$  = Cronbach's Alpha; \* $p < .05$ , \*\* $p < .01$ ,

Statistically significant positive bivariate correlations between the social exchange, safety climate and individual safety behaviours provide initial support for Hypotheses 12, 13 and 14. Overall stronger correlations are observed between social exchange variables and active and proactive GSC-C than between social exchange scales and ISB-W subscales. This trend potentially reflects the use of group-based referents for the social exchange variables rather than individual-based referents. Of particular note are the relatively weaker correlations between LMX and both the active and proactive components of individual safety behaviours.

As shown in Table I.2 the independence model was easily rejected. While all three models fit the data well chi square difference tests indicated a significant improvement in model fit when the pathways between OSC-M and both active and proactive GSC-C were included. This result does not support the full mediation model proposed in Hypothesis 12. Instead the alternate partial mediation model was found to provide the most parsimonious solution.

Table I.2      *Assessment of Fit and Model Differences for the Work-level Model of Social Exchange and Safety Climate (Individual-level SEM)*

Model	$\chi^2$	df	CFI	NFI	SRMR	RMSEA (90% CI)
<i>Fit criteria</i>			>.95	>.95	<.08	<.10
Independence (#1)	3020.83***	36	-	-	-	-
Mediation (#2)	33.90*	19	1.0	.99	.03	.05 (.02,.07)
Partial Mediation (#3)	26.40 n.s	17	1.0	.99	.03	.04 (.00,.07)
Direct SX (#4)	24.39*	13	1.0	.99	.03	.05 (.02,.08)
Difference ( $\Delta\chi^2$ ) #1-#2	2986***	17				
Difference ( $\Delta\chi^2$ ) #2-#3	7.50*	2				
Difference ( $\Delta\chi^2$ ) #3-#4	2.01 n.s	4				

Note.  $N=318$ ;  $\chi^2$  = Chi-square statistic, CFI = Comparative Fit Index, NFI = Normed Fit Index, SRMR = Standardised Root Mean Square residual, RMSEA = Root Mean Square Error of Approximation (RMSEA). \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

### Direct Effects

Parameter estimates for the direct and indirect pathways between Social Exchange constructs, the dimensions of Safety Climate and Individual Safety Behaviours for the final model are presented in Table I.3. In support of Hypothesis 13, examination of the unstandardised structural equations for the partial mediation model indicated significant positive relationships between MMX and OSC-M; and LMX and GSC-S. Significant positive relationships were also observed between GMX and both GSC-CA and when LMX and MMX were controlled. Direct effects for the safety climate variables were consistent with previous modelling.

With the inclusion of the direct pathways between OSC-M and GSC-CA and GSC-CP the significant path between OSC-M and GSC-S indicates that on average, a one point increase in workers' ratings management safety climate is associated with a 0.39 point increase in their ratings of Group Safety Climate at the supervisory level

and 0.15 ( $p < .05$ ) and 0.17 ( $p < .01$ ) increases respectively for the Active and Proactive dimensions of Group Safety Climate- Coworker. A one unit increase in GSC-S resulted in a 0.30 unit increase in GSC-C Active and 0.34 unit increase for GSC-C Proactive ( $p < .001$ ).

In combination these findings indicate that the distal influences of management and supervisor commitment to safety indirectly impacts individual safety behaviours through the establishment of strong group safety norms represented by coworker safety climate, offering partial support for Hypothesis 12. Furthermore, workers' perceptions of the quality of social exchanges occurring at each level of the organisational hierarchy are closely associated with the perception of safety climate at the corresponding level such that high quality social exchanges are linked to high safety climate ratings supporting Hypotheses 13 and 14.

### **Indirect and Total Effects**

Unstandardised coefficients for the partial mediation model indicated that the indirect pathways from OSC-M to ISB-W were statistically significant for both Active and Proactive dimensions (0.21,  $p < .001$ ). The relationship between OSC-M and Coworker Climate was mediated by Supervisor Safety Climate. Furthermore the positive associations between GSC-S and individual workers' safety behaviours were mediated by the corresponding coworker safety climate dimensions.

In relation to the indirect impact of social exchange variables on safety climate and individual safety behaviours, the indirect pathways from both MMX and LMX to the two ISB-W dimensions were all statistically significant, small effects, ranging from (0.11 to 0.15,  $p < .001$ ). Significant indirect effects were also observed for the influence of MMX and LMX on Coworker Climate. The positive indirect associations between GMX and individual workers safety behaviours were mediated by the corresponding coworker safety climate dimensions.

Table I.3 *Parameter Estimates for the Work-level Model of Social Exchange and Safety Climate (Individual-level SEM)*

Path	Direct Effect			Indirect Effect		Total Effect	
	St	Unst	SE	Unst	SE	Unst	SE
<b>MMX</b>							
→OSC-M	0.89	0.70*** (0.65,0.76)	.027			0.70***	.03
→GSC-S				0.28***	.03	0.28***	.03
→GSC-CA				0.19***	.04	0.19***	.04
→GSC-CP				0.22***	.04	0.22***	.04
→ISB-WA				0.13***	.03	0.13***	.03
→ISB-WP				0.15***	.03	0.15***	.03
<b>LMX</b>							
→GSC-S	0.64	0.58*** (0.51,0.65)	.037			0.58***	.04
→GSC-CA				0.17***	.04	0.17***	.04
→GSC-CP				0.19***	.04	0.19***	.04
→ISB-WA				0.11***	.03	0.11***	.03
→ISB-WP				0.13***	.03	0.13***	.03
<b>GMX</b>							
→GSC-CA	0.59	0.66*** (0.54,0.78)	.059			0.66***	.06
→GSC-CP	0.50	0.52*** (0.41,0.62)	.053			0.52***	.05
→ISB-WA				0.44***	.05	0.44***	.05
→ISB-WP				0.36***	.05	0.36***	.04
<b>OSC-M</b>							
→GSC-S	0.38	0.39*** (0.31,0.47)	.042			0.39***	.04
→GSC-CA	0.15	0.15* (0.01,0.29)	.072	0.12***	.03	0.27***	.06
→GSC-CP	0.18	0.17** (0.05,0.30)	.066	0.13***	.03	0.31***	.05
→ISB-WA				0.18***	.04	0.18***	.04
→ISB-WP				0.21***	.04	0.21***	.04
<b>GSC-S</b>							
→GSC-CA	0.30	0.30*** (0.17,0.43)	.066			0.30***	.07
→GSC-CP	0.37	0.34*** (0.22,0.45)	.061			0.34***	.06
→ISB-WA				0.20***	.05	0.20***	.05
→ISB-WP				0.23***	.04	0.23***	.04
<b>GSC-CA</b>							
→ISB-WA	0.91	0.67*** (0.59,0.75)	.043			0.67***	.04
<b>GSC-CP</b>							
→ISB-WP	0.75	0.69*** (0.59,0.79)	.051			0.69***	.05

Note. St= Standardised; Unst= Unstandardised; Estimate 95% confidence interval in parenthesis, SE=Standard Error, \* $p<.05$ , \*\* $p<.01$ , \*\*\* $p<.001$

To determine the practical significance of the findings, disturbance terms from the structural equations for the endogenous variables in the model were assessed. In the

partial mediation model the percentage of explained variance for all variables are considered large effects. Results indicated that 82% of variance in the Active and 57% of Proactive safety behaviours of individual workers may be explained by the dimensions of safety climate and social exchange. As a more conservative estimate the reduced form equations indicate that total effects of the three social exchange variables on individual safety behaviours account for 53% of the variance in Active safety behaviours and 36% of Proactive Behaviours.

To understand how both the processes of social exchange and safety climate impact on individuals' safety behaviours it is important to consider the hierarchical relationship between the various constructs. First, the most distal dimension of Manager-member exchange has a major impact on management's commitment to safety, explaining 79% of the variance in OSC-M. The influence of both OSC-M and LMX in combination then account for 80% of the variance in GSC-Supervisors. When the quality of group member social exchanges is considered in combination with the influence of OSC-M and GSC-S over two thirds of the variance in coworkers' safety climate can be accounted for (Active= 67%; Proactive 68%).

Overall the strongest effects were found for the prediction of active over proactive safety practices. These results indicate that while establishing high quality social interactions amongst workers at all levels of the organisation will assist in the promotion of positive organisation and group-level safety climates, the benefits manifest most strongly in the formation and maintenance of compliance related group norms. When considered in combination, the above results indicate that the partial mediation model hypothesising the direct influences of more distal management safety climate on both active and proactive group-level coworker safety climate dimensions is supported, while the full mediation model proposed in Hypothesis 12 was not supported. Furthermore, the proximal influence of coworker safety climate fully mediates the influence of more distal supervisory and management safety and leadership practices on individual workers' safety activities. The standardised structural coefficients for the final model are represented in Figure I.1.

*Figure I.1.* Significant standardised coefficients for the final partial mediation model of social exchange, safety climate and individual safety behaviours.

Appendix J: Group-Level Scale Distributions

