24-7 Safety Climate: Developing a Brief 24-Item, Seven Dimension Measure of Work Safety Climate for Monitoring and Remediating Safety Concerns

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List of Published Papers

The following papers were published and are included as studies in the chapters of this dissertation.

Summers, D., Sarris, A., Harries, J., & Kirby, N. (2022). The development of a brief and practical work safety climate measure. *International Journal of Industrial Ergonomics*, 87, 103255. DOI: 10.1016/j.ergon.2021.103255

List of Submitted Papers

The Validity and Measurement Equivalence of a Brief Safety Climate Questionnaire across Casual and Permanent Workers. Submitted to Safety Science December, 2021.

Safety Climate across Worker and Job Characteristics: An Investigation of Subcultures. Submitted to the Journal of Occupational and Organizational Psychology, February, 2022.

A Brief Supplementary Measure of Organisational Change Capability Factors to Accompany Work Safety Climate Assessments and Facilitate Remedial Interventions. Submitted to the Journal of Organizational Behaviour, May 2022.

List of Conference Presentations

The studies I have presented at conferences to date, in chronological order, are as follows:

Development of a brief cross-industry measure for monitoring safety climate was presented as a peer-reviewed oral presentation at the bi-annual APS 13th Industrial Organisational Psychology Conference, Adelaide, Australia, 11-13 July 2019 (Study one)

Safety climate: It's No Accident was presented as a peer-reviewed poster presentation at the 13th Annual Florey Postgraduate Research Conference, Adelaide, South Australia on September 24, 2019 (Study two)

Work safety is no accident: Development of a brief safety climate measure is scheduled to be presented as a peer-reviewed live presentation at the bi-annual APS 14th Industrial Organisational Psychology Conference, Gold Coast, Australia, 7-9 July 2022 (Study three)

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Abstract

This thesis aimed to develop a brief multi-dimensional, cross-industry work safety climate measure that could be used for regular monitoring, but that was also comprehensive enough for identifying and remediating safety concerns. Use of such a brief measure could contribute to reducing the human and financial costs of safety accidents, with the extensive length of many safety climate measures considered a barrier to regular use. A literature review suggested that the most efficient way to develop a brief measure involved shortening an existing reliable, valid and comprehensive cross-industry work safety climate measure. After a rigorous review of measures, the 50-item, 7-dimension Nordic Occupational Safety Climate Questionnaire (NOSACQ-50; Kines et al., 2011) was selected as a basis for the brief measure.

Study one examined the NOSACQ-50 reduction using statistical and additional practical usefulness methods (i.e., item readability, item importance rankings from safety researchers and practitioners). NOSACQ-50 data from disability support (N = 366) and hospitality workers (N = 111) were used for statistical reduction methods. Expert opinions and importance rankings were collected from safety researchers (N = 5) and practitioners (N = 14). Statistical and practical usefulness findings were combined to derive a 24-item NOSACQ (NOSACQ-24). The NOSACQ-50 diagnostic value and dimensional structure were maintained to enable use of existing safety climate benchmarks and for use of the NOSACQ-50 when more comprehensive evaluation was indicated.

Study two investigated the NOSACQ-24 construct, external, and concurrent validity; measurement equivalence; and benchmarking capabilities. Confirmatory factor analysis (CFA) was performed to confirm model fit using disability support and hospitality workers (N = 474) NOSACQ responses. External validity was established using responses from casual workers (N = 120) and vocational education and training (VET) workers (N = 53). Results further supported the NOSACQ-24 validity.

Study three extended the NOSACQ-24 validity investigations and examined acuity for identifying safety subcultures associated with various demographic and job-related variables.

NOSACQ-24 responses from VET workers (N = 549) were utilised, with safety climate subcultural differences demonstrated for managerial function, work-type, workplace location, employment status, and gender. Thus, the NOSACQ-24 retained the NOSACQ-50's capacity to identify subcultural differences offering further support for the validity and practical usefulness of the NOSACQ-24.

Study four sought to develop a 4-item supplementary measure to accompany the NOSACQ-24 to identify organisational change capability issues that might impede successful safety intervention implementation. These items were derived from research evidence associated with factors facilitating or hindering organisational change and included: overall change capability, overt top management support, use of champions of change, and worker buy-in. Mixed methodology was employed to validate the measure using qualitative and quantitative responses from VET workers (N= 485). Results provided initial support for the change capability measure and suggested that with further validation and development, the combination of the NOSACQ-24 and 4-item change capability measure could be a useful practical measure for identifying safety concerns requiring remediation and for providing a measure of an organisation's ability to successfully implement change, thus reducing the high failure rate of change interventions reported in the research literature.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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Chapter 1: Introduction

1.1 Foreword

The aim of this thesis was to develop a brief practical measure for work safety climate that is sufficiently brief for organisations to able to use it regularly for monitoring purposes. The brief measure was also developed to be sufficiently comprehensive to be able to identify emerging work safety issues so that they can be remediated before reaching a critical point involving safety incidents or accidents that are costly in both human and financial terms. The approach taken to developing this brief work safety climate measure was to base it on an established and comprehensive 50-item, 7-dimension measure of work safety climate (the Nordic Occupational Safety Climate Questionnaire [NOSACQ-50]; Kines et al., 2011) with proven reliability, validity and practical application.

The research studies undertaken to develop this brief and practical measure of work safety climate were based on a combination of well-established methods and theories, and novel approaches for improving the practicality of measurement tools, including selection of items from the comprehensive measure that were most practically relevant rather than just statistically relevant. This chapter outlines the conceptual foundations of work safety climate and the related concept of work safety culture, the existing models for each construct, distinctions between these concepts, current measurement approaches for work safety climate, theories that contributed to the selection of work safety climate questionnaire items, the item reduction approaches taken, and the next steps in developing the brief work safety climate measure. The chapter concludes with a brief outline of the included studies.

With regard to the development of a brief practical measure for work safety climate the core research aims of this thesis can be summarised as: 1) develop a brief measure for work safety climate based on an existing and comprehensive measure, with a focus on combining statistical and practical criteria for item selection; 2) move beyond exploratory approaches and incorporate confirmatory statistical analyses to assess the validity of a brief practical work safety climate measure; 3) assess the

applicability of the developed safety climate measure across different occupational groups to determine measurement equivalence; and 4) examine the capability of the developed measure with regard to identifying potential work safety subcultures through exploration of group and individual level differences.

1.2 Conceptual Foundations

When investigating work safety climate and work safety culture, particularly if aiming to develop an assessment measure as is the goal of this thesis, it is first important to understand the origins of the broader theories of organisational climate and organisational culture. In doing so, the conceptual models that form the foundation of work safety climate and work safety culture can be accounted for. The following review of organisational culture and climate theories aims to highlight the research and theories that underpin facet-specific cultures and climates that have emerged over time, such as work safety climate and culture.

The early organisational culture researchers (e.g., Denison, 1996) depict culture as an amalgamation of norms, traditions, myths, and expectations within an organisation, and as such these tend to be an unconscious influence on work behaviours and attitudes. A key organisational culture researcher who has expanded this concept is Schein (1985) who defines organisational culture as the collective way in which members of an organisation think, feel, and act, and argues that underlying cultural beliefs are developed in organisations as they manage issues, integrate as a group, and adapt to the external environment. The methods and actions deemed most successful or desirable by the group are then passed on to new members of the organisation, who come to accept them as constituting "the way we do things around here" (Reason, 1998, p. 294). Schein (1985) describes organisational culture in terms of three levels: artefacts, espoused values and behaviours, and basic assumptions. Artefacts represent the most surface level of culture and the most obvious to an independent observer, and they can take the form of signs, dress codes, artwork, how employees address each other or even the volume at which they talk to each other. Espoused values represent

the things an organisation presents to the world about its culture and normative behaviours and ways of working, such as mission statements, company values, and obligations. Any changes to these values can initiate a level of change to the overall culture including its normative behaviours and surface level artefacts such as its mission statement. Lastly in Schein's model are basic assumptions. These represent the least visible, sometimes unconscious, core components of an organisation's culture and can include beliefs about what behaviours will lead to success, and how employees should work together. These underlying assumptions are often the strongest indicators of an organisation's culture and can thus act as the strongest levers for cultural change. However, being below the surface means they are also the hardest to influence.

In comparison, it was arguably Lewin et al. (1939) who initiated the study of organisational climate over eighty years ago, and in the time since organisational climate has become understood as the shared perceptions of employees with regard to priorities, practices, procedures and attitudes that are supported and rewarded within their organisation. Zohar and Hofmann (2012) propose that organisational climate emphasises perceptions and experiences as they relate to specific organisational situations, and in this sense is psychologically based. Organisational climate informs employees of what is expected of them by rewarding or punishing certain behaviours and acting as a form of social cue (Loh et al., 2019). Organisational climate influences many organisational conditions such as workload, role conflict, emotional demands, and justice (Dollard & Bakker, 2010), and as such can impact employee performance across a variety of domains. Compared to organisational culture, the most influential part of which affects beliefs that are often unconsciously held, organisational climate represents a temporally specific 'snapshot' of the more surface elements of organisational culture.

From a methodological perspective organisational climate and organisational culture have been traditionally examined through different approaches. Organisational climate was more often examined through quantitative assessments using survey methods, and results were then aggregated to reflect group-level rather than individual perceptions (Schneider et al., 2011). Comparatively,

organisational culture research has traditionally been more qualitatively oriented (Loh et al., 2019) in order to explore the underlying beliefs by which it is transferred between employees within organisations. As Denison (1996, p. 621) puts it:

> If researchers carried field notes, quotes, or stories, and presented qualitative data to support their ideas, then they were studying culture. If researchers carried computer printouts and questionnaires and presented quantitative analysis to support their ideas, then they were studying climate.

While organisational culture has also been measured using quantitative measures by contemporary researchers (e.g., Mearns et al., 2013), this has been confined to the more surface level elements of culture like normative behaviours and overt values. It has been argued by Schein and Schein (2017) that these methods cannot assess the underlying and often unconscious beliefs that make organisational culture so influential, and which can only be examined using qualitative methods. Thus, quantitative measures of organisational culture are often very similar to measures of organisational climate in so far as they both assess surface level features of the organisation that are aggregated at the group-level. Nevertheless, the methodological distinction in research approaches between organisational culture and climate has largely remained.

Given the extremely broad nature of the concepts organisational culture and organisational climate, the research literature has identified several facet-specific variants of each construct, and in particular, it has been argued that there can be multiple different organisational climates, and that different subcultures are possible within an overall organisational culture within the same organisation (Kuenzi & Schminke, 2009). This concept of multiple facet-specific organisational climates and the notion that organisational climate is multidimensional can be traced back to James and James (1989). Facet-specific organisational climates include an ethical climate (Martin & Cullen, 2006; Victor & Cullen, 1988), a customer service climate (Hong et al., 2013; Schneider et al., 1980), and the focus of this thesis – a safety climate (Zohar, 1980).

1.3 Safety Climate and Safety Culture

The terms organisational safety culture and organisational safety climate are often used interchangeably in the literature. However, much like the broader concepts of organisational culture and organisational climate, this thesis considers the concepts as theoretically related but conceptually distinct. This is an important distinction considering the different methodological approaches traditionally employed to measure both climate and culture. Within the research literature there is no widely accepted definition or consensus for what comprises either work safety climate or work safety culture (Vu & De Cieri, 2015a), thus this section will begin with a brief outline of each term and the theoretical models that fit within the constructs.

1.3.1 Safety Culture

It was in the late 1970s that safety investigators determined the importance of moving from previously simplistic analyses of human error or technical failures, to more complex understandings of the role cultural factors play with respect to safety within an organisation. Understanding the causes of system failures that may result in extremely damaging accidents is crucial to preventing these incidents occurring. Weigmann et al. (2004) have summarised the progression of theories of accident causation, starting at the technical period, wherein rapid technological developments resulted in mechanical malfunctions and largely unreliable equipment. Next is the period of human error which attributed human operators as the cause of system failures. Examples of this era include the 1979 Three-Mile Island nuclear core malfunction wherein responsibility for the incident was assigned to the people involved. Following the period of human error comes the sociotechnical period, in which incident analysis considers the combination of both human and technical factors. Finally, the most contemporary stage of accident analysis and prevention has been termed the “organizational culture period” (Weigmann et al., 2004, p. 118), which highlights the team environments under which many workers perform their duties, and as such the accepted norms and behaviours as they relate to safety are influenced by the culture of a workplace. This organisational culture period is particularly

relevant in relation to work safety climate as a measurement of a safety culture specific to a point in time. Hence, understanding the foundation of safety climate theory is essential for developing an assessment of work safety climate. In the next sections a chronological listing of safety culture theories will be examined.

1.3.1.1 Turner's Theory of Man-Made Disaster (1978)

One of the earliest analyses of what is now termed safety culture comes from Turner (1978) who studied man-made disasters such as the 1966 Aberfan rubbish tip slide, the Hixon level crossing accident of 1968, and the 1973 Isle of Man Summerland fire. From his analysis Turner proposed six stages that form a causal chain, ultimately leading to a safety incident. Stage 1 is the adherence to culturally accepted norms by groups and individuals in an attempt to manage risks; Stage 2 involves warning signs developing and passing by unnoticed or being ignored. This was termed the incubation period; Stage 3 involves the warning signs that have accumulated reaching a head and culminating in a large-scale disruptive event. It is at this point previous beliefs about warning signs are challenged and the culture is disrupted; Stage 4 is the onset of an accident or incident. The consequences become apparent and cultural precautions collapse; Stage 5 is the rescue and salvage stage. Rapid analysis of the situation and event occur in order to undertake cultural readjustments; Finally, Stage 6 involves a complete cultural readjustment. Previously held beliefs and norms are shifted to fit what is now the new cultural norm, precautionary measures are established and the focus moves to ensuring no such incident occurs again.

According to Turner (1978) the incubation period (Stage 2) is the most important stage in the chain, as this is where cultural norms that can result in disaster develop. Warning signs can pass by unnoticed for a number of reasons including difficulty handling information in complex situations or when tasks are vague, cultural lags in the existing precautionary framework, a cultural reluctance to fear the worst possible outcome, or because of erroneous assumptions. Turner was even able to identify organisational subcultures and their impact on overall culture: "Each organisational unit or

sub-unit will have developed its own distinctive sub-culture and its own version of rationality" (Turner, 1978, p. 101). Hence, it is theorised that elements of a wider organisational culture contribute immensely in the susceptibility to workplace safety incidents.

While this theory highlights the role of organisational factors in safety management, criticisms have been raised with regard to the linear and direct causal relationship implied between stages, with no mention of indirect relationships or feedback loops (Vu & De Cieri, 2015b).

1.3.1.2 Schein's Organisational Safety Culture (1985)

As previously mentioned, Schein (1985) contributed immensely to the development of organisational culture theory, and his model is often applied to the assessment of organisation safety culture. Safety can be attributed to all three levels of Schein's culture model. At the artefact level, visible warning and hazard signs, mandated personal protective equipment, and rewards for safe working behaviours can all promote a positive safety culture. At the espoused values level, promoting working safety over achieving production goals, or promoting the goal of zero workplace injuries contribute to the development of safety culture. Lastly, underlying assumptions can incorporate the beliefs and values that employees internalise with regard to safety, such as being able to voice safety concerns without fear of punishment from management. When all three levels of this culture model align an organisation would be considered to have a positive safety culture, as the collective ways in which workers act, think, and feel all actively promote safe working behaviours. Later research also suggested the existence of three distinct organisational subcultures: the operator culture, the engineer culture, and the executive culture (Schein, 1996). Safety is likely to be valued differently according to each subculture, and organisational changes can create conflict between the subcultures.

Schein's conceptualisation has been utilised by Nielsen (2014) in order to assess and improve safety culture within an industrial plant. In this study the artefact level "was operationalized as behavioural indicators, structural conditions, documents, and safety climate. The espoused values were operationalized as attitudes towards safety and structural conditions" (p. 10) and the author

then combined the artefacts and espoused values to deduce the basic assumptions. Through both qualitative and quantitative assessment of this safety culture significant improvements were noted in safety performance, safety culture indicators, and a changed trend in overall injury rates.

1.3.1.3 Geller's Model of Total Safety Culture (TSC; 1994)

The next chronological safety culture model to be developed was by Geller (1994). The total safety culture (TSC) model promotes employees to feel responsible for safety and to go beyond "the call of duty" (Geller, 1994, p. 18) to intervene when unsafe conditions or behaviours are identified. It does this by comprising three interrelated and ever shifting factors: personal factors (which include knowledge, skills, abilities, beliefs, and personalities), environmental factors (such as up to date equipment and the physical layout of the workplace), and behavioural factors (both safe and unsafe practices, going beyond one's own role to uphold and encourage safe working). Geller promoted ten principles of TSC and argued that if employees understand and accept the principles, they can then become involved in the design and implementation of remedial actions to target poor safety culture.

The ten principles promoted by Geller are as follows: (1) The culture and not government safety agencies such as the United States Occupational Safety and Health Administration (OSHA), should drive the safety process. This indicates that safety should be driven using a bottom-up approach with employees achieving safety goals for their own protection and not to just comply with company regulations; (2) Behaviour-based and person-based factors determine success. This can be objectively evaluated with the observation and recording of behaviours that have been targeted for safety interventions, such as not wearing personal protective equipment; (3) Focus on process, not outcomes. Geller argued that safety professionals often focus on the outcome instead of the process, which he equated to "trying to play golf, tennis or baseball by watching the scoreboard instead of the ball" (Geller, 1994, p. 20). This can lead to underreporting of incidents or near-misses to reduce overall safety concerns, and therefore does not remedy the processes that allow for unsafe behaviours to continue; (4) Behaviour is directed by activators and motivated by consequences. Here it is suggested

that unsafe behaviours are often naturally followed by rewards, such as convenience or faster job completion. As such, consequences for unsafe work practices such as corrective feedback or safety reminders are essential in order to promote a positive TSC; (5) Focus on achieving success, not on avoiding failure. Developing a measurement system that tracks and displays safety accomplishments is considered essential by Geller in order to compete with the positive reinforcement associated with production goals; (6) Observation and feedback lead to safety behaviours. Here it is encouraged to observe co-worker behaviours and offer supportive feedback when positive safety behaviours are viewed, or corrective feedback when negative safety behaviours are viewed; (7) Effective feedback occurs via behaviour- and person-based coaching. Geller contends that all workers should be trained in effective coaching strategies, and to recognise the importance of reacting appropriately in order to maximise the effectiveness and long-term continuation of safety-related coaching; (8) Observing and coaching are key actively caring processes. To change work behaviours interpersonal observation and feedback are essential tools. As TSC requires all employees to participate in safety actively caring behaviours must be taught and motivated; (9) Self-esteem, belonging and empowerment increase actively caring for safety. Fostering these feelings within individuals and groups is essential for the continued promotion of safe behaviours in a workplace; and (10) Shift safety from a priority to a value. It is this point that solidifies the focus on developing a positive safety culture. Geller argues that safety should be a value that workers can carry with them regardless of competing priorities, and he promotes safety as a social norm within a positive TSC.

The TSC model was one of the first to identify the essential role co-workers play in the promotion of safety behaviours. Where it has previously focussed on management behaviours to drive change in a top-down process, Geller's promotion of actively caring for safety optimises the safety of other employees from the ground floor.

1.3.1.4 Reason's Safety Culture and 'Swiss Cheese' Model (1997)

Reason (1997) proposed a model for safety culture that can be observed in high reliability organisations (HRO); that is, organisations that successfully avoid critical incidents in an environment where risk factors and work complexity are high, such as nuclear power plants or air traffic management. In this model the overarching concept of safety culture is said to be attributable to five unique subcultures. The first is an informed culture, in which the operators of organisational systems are up-to-date regarding current human, technical, organisational and environmental factors that impact safety systems. The sharing of safety information with workers is key to an informed culture. Next is a reporting culture, whereby workers are willing and able to report near-miss and critical incidents without fear of reprisals from management. Not only do workers have to be certain that reports will remain confidential, but they must also see that the reports are acted upon. If reports are not acted upon then workers may become discouraged to report future incidents or near-misses, which contributes to a negative overall safety culture. The third subculture discussed by Reason is a just culture, an atmosphere of trust that encourages and rewards workers for providing safety-related information. Similarly, a just culture provides clarity around acceptable and unacceptable safety behaviours by disciplining transgressors who act recklessly, but not those who make errors unintentionally. A flexible culture is then discussed, which is one where the organisation and workers in it are capable of adapting effectively to changing environments and demands. This flexibility enables safety experts to exert a level of control in crisis situations, regardless of the natural hierarchy. The last culture discussed by Reason is a learning culture, which refers to an organisation that is able to learn from past mistakes and adapt to the future based on internally or externally provided safety information. Combined, these unique subcultures contribute to an overall safety culture and can be understood and developed by HROs to reduce the likelihood of catastrophic safety failures occurring.

Related to Reason's model of safety culture is the 'Swiss Cheese' model of organisational accidents (Reason, 1997). According to this metaphor, hazards are prevented within a complex system due to a series of barriers or protections. Arguably the five subcultures identified within his safety

culture model can act as barriers to accidents, but layers of defence also include "technical devices, physical barriers, protective equipment, system design, regulatory rules, training and supervision" (Vu & De Cieri, 2015b, p. 18), all of which are shaped by an organisation's safety culture. According to this model, accidents occur through the simultaneous failure or degradation of protective factors over time. When multiple layers of defence have been compromised, the integrity of the safety systems is challenged, and hazards can quickly turn to accidents.

1.3.1.5 Kennedy and Kirwan's Safety Culture Model (1998)

Kennedy and Kirwan (1998) argue that a poor safety culture will be directly observable through safety management practices. Safety management is considered to be the formal and documented system that controls against organisational risks. Examples of safety management include the organisation's policies, procedures, resources, and training. In their model of safety culture, four layers can be examined. At the core of the model is organisational culture, with safety culture and safety climate inhabiting the middle layer, and the outer most layer consisting of safety management practices. Due to this, Kennedy and Kirwan argue that the largely intangible nature of organisational and safety culture make the constructs inappropriate for assessing safety failures. Instead, the focus should be on more observable and measurable components of safety such as management practices (e.g., enforcing the use of personal protective equipment) that constitute the safety climate and safety practices in order to anticipate safety failures before they occur. However, the model has been criticised for not demonstrating the relationships between all four layers (Vu & De Cieri, 2015b), which is a key component in distinguishing the constructs from one another.

1.3.1.6 Guldenmund's Framework for Safety Culture (2000)

Guldenmund (2000) examined twenty years of safety culture and safety climate literature, resulting in an integrative framework that comprises both safety attitudes, drawn from Cox and Cox's (1991) research and Schein's (1985) culture model. At the centre of the model, much like Schein's model, are the basic assumptions that form the core of safety culture. Guldenmund argues that this

level can only serve as an explanatory variable, “i.e., they explain the attitude structure found” (p. 249) as they can only be inferred, not directly observed.

The next level, or middle layer, in this model comprises the espoused values that are determined to be relatively explicit and conscious in the minds of workers, observable through organisational policies, procedures, accident and incident reports, and training manuals. These espoused values also relate to worker attitudes towards hardware, software, people, and behaviour. This middle layer is what Guldenmund perceives to be safety climate.

At the outer and most visible layer in this model are the artefacts. These represent directly observable examples such as dress code, personal protective equipment, and inspection reports, but they are much harder to derive assumptions about safety culture from. Instead, Guldenmund proposes that this level is a manifestation of safety climate, which in turn is a reflection of safety culture.

This framework, while comprehensive, has been criticised for the proposed unidirectional rather than bidirectional relationship linking attitudes to behaviours (Cooper, 2000). Additionally, Vu and De Cieri (2015b) contend that a major criticism of Guldenmund’s (2000) framework is the proposition that safety climate can be assessed through attitudes, rather than perceptions. This will be discussed further in the section on safety climate.

1.3.1.7 Cooper’s Reciprocal Safety Culture Model (2000)

Cooper’s (2000) model of reciprocal safety culture is grounded in the theory of reciprocal determinism. It is reciprocal relationships between the person, the job, and the situation that form the basis of this model. The three elements in this model as they relate to safety culture comprise internal psychological factors (the person) such as knowledge, abilities, intelligence, and personality; observable ongoing safety-related behaviours (the job) such as complying with safety rules, wearing of personal protective equipment, coaching others to perform their duties safely; and objective situational features (the situation) such as the operating procedures, available equipment, and

proximity to heavy machinery. In contrast to Guldenmund's (2000) model, all these factors are proposed to influence one another through reciprocal determinism and provide a common framework that can be used to develop benchmarking standards across organisations. Despite the holistic approach this model provides, incorporating both environmental and psychological factors, some critics have argued that the practical aspects of collecting behavioural observations limits the usefulness of the model in organisational settings (Anderson, 2005). Additionally, as organisations may not wish to highlight regularly unsafe working behaviours (Hopkins, 2006) an issue arises with the potential for underreporting. However, both of these criticisms have been addressed by Cooper (2009) as intervention design issues, not conceptual criticisms, "with strong evidence showing they are unwarranted" (Cooper, 2016, p. 8).

In his revised reciprocal safety culture model (Cooper, 2016), it is argued that by focussing on the common root causes of safety incidents, organisations are able to drive desired behaviours. By optimising the situational aspects (such as work pressure and availability of safety equipment) an organisation encourages desired behaviours at the job-level (such as wearing personal protective equipment and adhering to safety rules) and ultimately enhances various psychological factors at the person level (e.g., values, attitudes, norms, and perceptions). This proposition was then empirically tested and largely supported by Cooper et al. (2019).

1.3.1.8 The Egg Aggregated Model (TEAM) of Safety Culture (Vierendeels et al., 2018)

This safety culture model incorporates safety culture literature, safety culture studies, and existing safety culture models from a variety of scientific disciplines such as engineering, sociology, and psychology, to develop a conceptual 'big picture' model of safety culture (Vierendeels et al., 2018). Termed 'The Egg Aggregated Model' due to its graphical representation, this model comprises a technological domain, a human domain, and an organisational domain. The elements within each unique domain are interrelated and influence one another. The technological domain comprises observable factors such as available technology, safety procedures, and training, as well as safety

outcome measures. The organisational domain comprises perceptual factors such as safety climate, trust in the organisation, leadership, communication, and management commitment. The human domain involves personal psychological factors and relates to an individual's motivations as they relate to safety behaviours. All three proposed domains are inter-related and have measurement outcomes that can be examined to determine an organisation's safety culture, or as the authors refer to it, the "safety DNA" (Vierendeels et al., 2018, p. 338).

1.3.1.9 Industry-Specific Safety Culture Models

Given the focus of this thesis is to develop a brief and practical measure for workplace safety climate that is applicable across industries and organisations, the scope of this review will not cover industry-specific safety culture models in detail. However, it is worthwhile noting that many such models exist. A selection of examples are as follows:

Helmreich and Merrit (1998) developed a model of safety culture within the aviation and medical industries and argued that national culture, professional culture, and organisational culture all exert positive and negative impacts on safety culture. However, the authors have been criticised for making no connection between organisational culture and organisational climate, whilst simultaneously identifying organisational culture as the major determinant of organisational climate (Vu & De Cieri, 2015b).

Grote and Künzler (2000) employed their sociotechnical model in order to assess safety culture within petrochemical production organisations. In this model the authors argue that by incorporating elements of safety management, organisational culture, and sociotechnical system design, the proposed shortcomings of existing safety culture models can be overcome. Their proposed model argues for proactively integrating safety into organisational structures and processes (proactiveness) and optimizing interactions between work systems and technology (sociotechnical integration) in order to account for both material and immaterial aspects (value consciousness) of an organisation.

Choudhry et al. (2007) developed a conceptual model for safety culture specifically within the construction industry, consisting of three key mechanisms – person, behaviour, and environment/situation. Utilising Cooper's (2000) model of safety culture, Choudhry et al. (2007) incorporated industry-specific elements such as project-specific site safety plans, and safety audits into the environment/situation in order to address the unique challenges faced by construction workers. Later research by Fang and Wu (2013) argued that the inconsistent environment experienced by construction workers, and the multi-organisation structure of owners, contractors, and subcontractors warrants the construction sector having its own unique safety culture model.

Reader et al. (2015) developed an international safety culture model in order to assess safety culture in the air traffic management industry. It is proposed that "…differences in safety culture between and within international organizations (e.g., on risk communication) …have been identified as contributing to organizational mishaps" (Reader et al., 2015, p. 771). Hence, the researchers associated safety culture with Hofstede's (2001) five national culture dimensions and were able to predict the rank-order of European regions on the safety culture dimensions based on several regional cultural norms such as openness to communication on safety, uncertainty avoidance, and masculinity. The model was able to operate consistently across national boundaries and occupational groups, indicating that national cultural traits may influence the development of safety culture in air traffic management organisations.

1.3.1.10 Safety Culture Summary

While no theory of safety culture can cover all aspects of workplace safety or accident prevention, and while there are numerous definitions of safety culture within the literature, the most common themes include: safety culture as enduring, stable, and relatively resistant to change; safety culture is defined at the group-level or higher and relates to shared values; safety culture impacts safety behaviours; safety culture is a sub-facet of organisational culture; safety culture can be a reflection of the relationship between reward and punishment systems and safety performance;

safety culture consists of underlying beliefs about safety culture that are often held unconsciously by individuals. Hence, the more surface levels of an organisation's safety culture are often manifested in the safety climate. As such, an assessment of work safety climate can provide a 'snapshot' of work safety culture and provide data regarding areas for improvement and development. With regular monitoring of safety climate, the promotion of which is one of the primary aims of this thesis, organisations can prevent developing safety issues from reaching a critical stage. In the following section the concept of safety climate will be discussed with the intention of demonstrating how the terms are conceptually related, but ultimately distinct.

1.3.2 Safety Climate

Organisational safety climate has been a subject of safety research for over four decades, since Zohar's (1980) original conceptualisation. A key distinction between safety culture and safety climate as summarised by Arzahan et al. (2022) is that whereas safety culture relates to an organisation's set of values, safety climate refers to the perceptions of organisational and environmental factors that influence these values. Hence, the two constructs share a bi-directional relationship. As a result, a considerable array of safety climate research has focussed on the measurement of the construct in order to provide additional safety information for organisations as they attempt to retrospectively or proactively assess safety concerns. The specific measurement of safety climate and the factors that comprise these measures are the focus of a later section in this thesis, and hence this section will focus on specific safety climate models that have emerged throughout the research literature. Understanding the development of these models over time is crucial for maintaining the conceptual foundation of safety climate when developing a new measure, and particularly if attempting to reduce an existing measure.

1.3.2.1 Glendon and Stanton's Model of Safety Culture and Safety Climate (2000)

Given the overlapping relationship between safety culture and safety climate, many models of safety climate are derived from safety culture theory. For example, Glendon and Stanton (2000)

who modified Schein's (1985) organisational culture theory and explicitly distinguished between the concepts of culture and climate. Changes to Schein's original model included: graphical arrows to highlight the relationship between organisational culture and organisational climate; a horizontal breadth axis representing the extent to which cultural elements are shared or localised subcultures; and a diagonal axis of time (Figure 1). Despite presenting an overarching safety culture model, many of Glendon and Stanton's propositions contributed significantly to the development of safety climate research. These include the notion that the assessment of safety attitudes, overt beliefs, and perceptions actually represent safety climate as a temporally specific indication of safety culture, and the bi-directional relationship between safety climate and safety culture. The case study presented by Glendon and Stanton involved comparing safety features from a single organisation on two occasions over a three-year period and ultimately supported the relationship between an increasingly positive safety climate and increasingly positive safety outcomes.

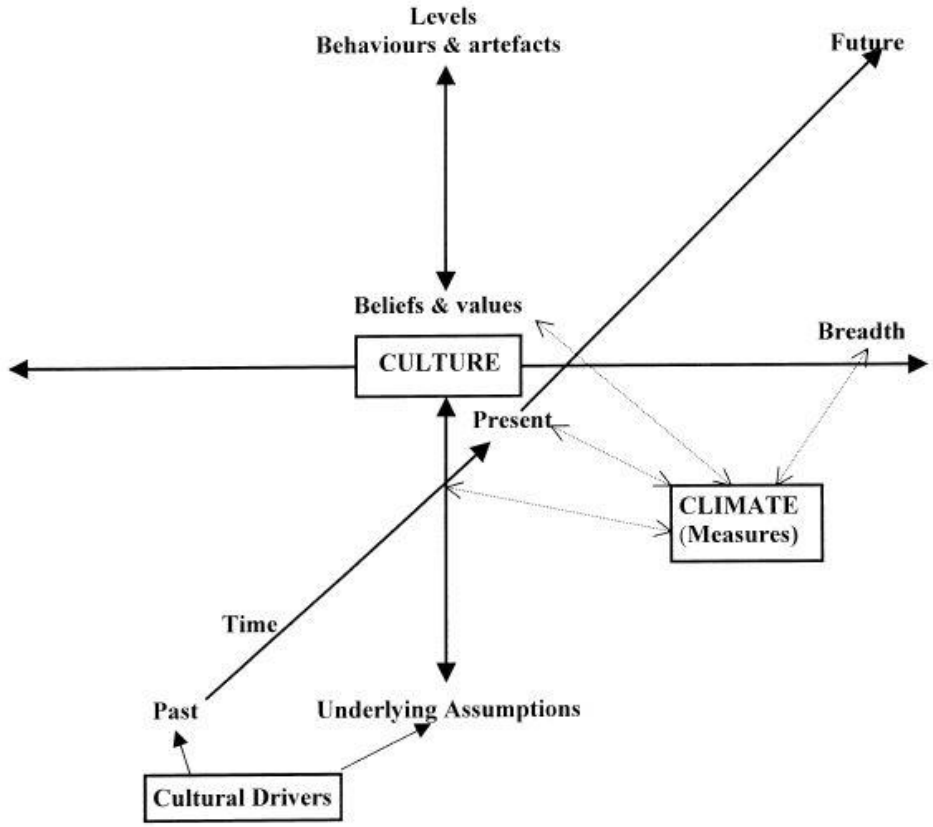

Figure 1: Glendon and Stanton's (2000) Model of Safety Culture and Safety Climate

1.3.2.2 Griffin and Neal's Safety Climate Framework (2000)

Griffin and Neal (2000) developed a framework to assess employee perceptions of safety-related factors within a working environment, and ultimately linked safety climate perceptions to worker safety performance through two constructs – safety knowledge and safety motivation. In their model safety climate is conceptualised as a higher order factor comprising worker perceptions of management values, safety communication, safety practices, safety training, and safety equipment. These perceptions are proposed to influence safety performance; however, the relationship is mediated through motivation and knowledge. Safety performance was identified as comprising two unique components: (1) safety compliance which refers to the core safety activities that need to be adhered to such as wearing personal protective equipment, and (2) safety participation which relates to voluntary safety activities such as attending safety meetings and encouraging the safety of others. Griffin and Neal (2000) contend that perceptions of safety climate should be distinguished from perceptions of individual knowledge, motivation, and behaviour, and propose that safety climate should not include risk perceptions:

> Furthermore, the exclusion of factors such as affective reactions to safety and perceptions of risk from the construct of safety climate allows a clearer focus on the key element of climate, namely, the perceptions of values, policies, and procedures within the organization. (Griffin & Neal, 2000, p. 356)

Later, research by Neal and Griffin (2004) determined that safety climate influences the knowledge and motivations of workers, which subsequently impacts safety behaviours and thus safety outcomes.

Despite providing a strong explanatory model developed over several studies that has been replicated across industries (Braunger et al., 2013), this model does not appear to employ a multi-level approach (Vu & De Cieri, 2015b) that other researchers have employed (e.g., Zohar & Luria, 2005). Similarly, Flin (2007) notes that the role of management is not well specified across supervisory roles, site managers, or senior management (Flin, 2007).

1.3.2.3 Zohar's Group-Level Model of Safety Climate (2000; 2003) and Zohar and Luria's (2005) Multilevel Model of Safety Climate

Dov Zohar has arguably exerted the greatest influence on the field of safety climate research. His 1980 paper "Safety Climate in Industrial Organizations: Theoretical and Applied Implications" was the first to define the term. Derived from organisational climate theory, Zohar (1980) theorised that "Workers in different companies share common perceptions regarding safety in their organization. The sum of these perceptions is the safety climate in each organization" (p. 98). These perceptions were reported to have a psychological influence on determining appropriate and acceptable behaviours. In his later research safety climate has been defined as "…shared perceptions with regard to safety policies, procedures, and practices" (Zohar, 2011, p. 143).

Zohar (2000) moved away from previous safety climate models that only considered the organisational level and included subunits in his analysis. It was proposed that while policies and procedures regarding safety are established at the organisation level, they are enforced through supervisors at the subunit level. Through empirical assessment it was ultimately suggested that workers develop homogeneous perceptions of supervisory safety practices, and that these vary between subunits. Similarly, safety climate scores were able to predict safety records in the preceding months of the study at the subunit level, suggesting that safety climate assessments can be used as a leading indicator for safety outcomes. As such, Zohar (2000) argued that two levels of analysis (the organisational and subunit levels) should be examined when researching climate perceptions.

In subsequent research Zohar (2003) proposed a motivational explanatory mechanism, similar to Griffin and Neal (2000), whereby workers' behavioural-outcome expectancies mediate the relationship between climate perceptions and safety behaviours. This model takes competing demands into account and suggests the true value of safety is always weighed with other organisational goals such as productivity. As he explains "whenever safety issues are ignored or made contingent on production pressures, workers will infer low safety priority" (Zohar, 2003, p. 126).

Despite this, Zohar (2003) has been criticised for failing to explain how expectations of behavioural consequences motivate errors (Flin, 2007).

This development through the previous studies culminated in Zohar and Luria's (2005) multilevel safety climate model, which is suggested by some to be the most advanced theoretical model to date (Vu & De Cieri, 2015b). This model also proposes that safety climate should be measured at both the group (subunit) and organisation level, and that separate scales should be developed to achieve this. Similar to Zohar's (2003) research, this model stresses the multiple, often conflicting goals that workers face such as safety, quality, and production. While formal policies primarily determine organisational safety climate perceptions, subunit supervisors can initiate discretion with regard to what is enforced or rewarded. This results in supervisory practices accounting for the main source of group-level safety climate perceptions. Zohar and Luria (2005) determined that climates at both levels were globally associated, in that group (subunit) safety climate mediated the effects of organisational safety climate on employee safety behaviour. Additionally, the research expanded upon previous models and showed that climate variability between groups was negatively related to climate strength and formality of procedure; hence, as procedures become increasingly formalised the discretionary abilities of supervisors are greatly reduced, which results in reduced between-subunit variability.

By conceptualising safety climate as a multilevel construct, safety practitioners are able to more effectively identify areas of concern and remediate these issues before they reach the stage of an accident or incident. Hence, an effective measure of work safety climate should theoretically account for various levels, particularly with regard to the role of co-workers and leadership in promoting positive or negative safety climates. This highlights the contribution of Zohar and Luria's (2005) model to the assessment of safety climate and paved the way for researchers to examine the role of co-workers as another level of safety climate influence (Brondino et al., 2013; Kines et al., 2011).

1.3.2.4 Flin's Model of Safety Climate (2007)

As with safety culture models, some safety climate models were developed with reference to a specific industry. Flin's (2007) model, much like that of Zohar and Luria (2005), conceptualises safety climate as a multilevel construct, although it is specific to the healthcare industry as it examines worker and patient injury. Flin (2007) also draws on motivational influences to reflect the expectations regarding outcomes for particular behaviours, much like Griffin and Neal (2000). However, unlike previous models Flin (2007) highlights errors as a result of unsafe behaviours, rather than an antecedent. It is proposed that errors occur when workers "do not follow procedures, rush to finish tasks, take calculated risks" (Flin, 2007, p. 660). These errors can then result in patient or worker injury. With reference to the healthcare industry, Flin (2007) argues that researchers need to examine not only climate perceptions but also the resulting expectations as these are what provide motivations for acting in a safe or unsafe manner.

1.3.2.5 Current State of Research

The development of safety climate research has demonstrated a shift in focus from single-level to multilevel models. However, this does not discredit single-level models, and in fact such models (e.g., Griffin & Neal, 2000) have been linked to safety outcomes in meta-analytic studies. Still there is no conceptual consensus on the best way to model safety climate, although this thesis argues that multilevel models provide the greatest practicality when it comes to targeting safety interventions at specific levels of an organisation. Many studies of safety climate have linked safety climate to safety outcomes through various theoretical foundations. Social exchange theory proposes that positive behaviours inherently promote reciprocal behaviours, and this has been used to explain why positive safety climates result in positive safety behaviours from workers (Kines et al., 2011; Mearns & Reader, 2008). Similarly, Bakker and Demerouti's (2007) Job Demands-Resources (JD-R) model proposes that wellbeing and performance are influenced by the existence of organisational demands (e.g., workload, time pressure) and organisational resources (e.g., autonomy, positive work

relationships). Safety climate has been identified as a job resource by researchers (Beus et al., 2016; Kvalheim & Dahl, 2016) and hence the JD-R model has also been employed to explain the relationship between safety climate and safety outcomes. This relationship will be further explored in a following section.

1.3.2.6 Safety Climate Summary

This section on safety climate and the various models that comprise the construct was compiled with the intention of distinguishing the concept from that of safety culture. As demonstrated, safety climate is considered an indication of safety culture at a temporally specific point and at a more visible surface level. Hence, while the models for safety climate and safety culture share some overlap and conceptual foundations, the terms safety climate and safety culture will henceforth be used independently of one another, except in cases where the original authors have used the terms interchangeably.

1.4 Safety Climate and Safety Outcomes

The relationship between safety climate and safety outcomes has been heavily researched, particularly given the substantial cost of workplace accidents and incidents. The World Health Organization in collaboration with the International Labour Organization (2019) reported over 360,000 global workplace deaths due to occupational injury. In an Australian context, Safe Work Australia (2021a) reported 194 deaths and 120,355 serious injury claims for the 2020-21 financial year, with a median cost of $13,500 AUD per claim. Similarly, total claims yielded a median 6.6 weeks of lost work. In the USA the National Safety Council estimated the total cost of workplace injuries to be $171 billion USD in 2019 (NSC, 2021), which included wage and productivity losses, medical expenses, and administrative expenses. In South Korea this figure has been estimated at $27,244 million USD, equating to 2.1% of the country's gross domestic product (Kim, 2021). Regardless of country, workplace injury and accidents are responsible for huge personal, societal, and economic losses.

Individuals, organisations, and communities are all impacted by the direct and indirect impacts of safety incidents or accidents. Direct costs can include the financial compensation paid to victims of safety incidents, as well as medical expenses and rehabilitation costs. Additionally, a direct cost of workplace safety incidents includes loss of production if work has to stop or is delayed. Indirect costs can include decreased staff morale in the situation where a co-worker has been seriously injured or killed, increased insurance premium costs for an organisation or individual, the cost of hiring and training new workers to replace the injured worker, and a negative public image in the case of widely reported incidents (Rikhardsson & Impgaard, 2004).

Regardless of the moral responsibility to protect workers from injury or death, organisations may also have a financial responsibility to reduce negative safety outcomes. However, this does not only include workplace accidents or incidents. As Beus et al. (2016) state "Whereas accidents clearly indicate the absence of safety, a lack of accidents cannot necessarily be used to infer the presence of safety" (p. 354), hence it is important to examine the relationship between safety climate and broader safety outcomes. In doing so, the importance of developing a brief safety climate measure for the purpose of monitoring safety and preventing potential issues from reaching a critical point is highlighted. If existing measures of safety climate are considered too lengthy to be practically implemented on a regular basis, the advantage of work safety climate as a leading indicator is diminished. Hence, the following section will summarise key research examining the relationship between safety climate and safety outcomes.

1.4.1 Meta-Analytic Research

Meta-analysis comprises data collection and analysis techniques that produce a summary of quantitative literature on a particular topic. Meta-analysis is performed once a series of studies have been undertaken in order to extract effect-size estimates from these studies and compute an across-study effect size that summarises the total body of literature examined, as well as the variance of

these estimates (Aguinis et al., 2011). From gathering primary-level study effect sizes, meta-analysists are able to estimate the overall strength and direction of a specific effect or relationship.

Given safety climate studies have existed for over four decades, there are numerous individual studies investigating the relationship between safety climate and various safety outcome measures. As such, for this thesis it has been determined that a brief chronological summary of various meta-analyses that have examined this relationship is the most appropriate method to summarise the relevant information.

1.4.1.1 The Relationship between Safety Climate and Safety Performance: Clarke (2006)

To this author's knowledge the earliest recorded safety climate meta-analysis was undertaken by Clarke (2006). This study hypothesised that a more positive safety climate would be significantly related to lower occupational accident and injury rates, and higher safety performance (as measured by safety participation and safety compliance) in workers. As mentioned in the above section on Griffin and Neal's (2000) safety climate framework, safety compliance is defined as adhering to mandatory safety procedures, whereas safety participation relates to voluntary safety activities such as helping colleagues and attending voluntary safety meetings. Clarke (2006) further hypothesised that higher safety performance would be significantly related to fewer accidents and injuries, and that the relationship between safety performance and accidents/injuries would be stronger than the relationship between safety climate and accidents/injuries. The last hypothesis Clarke (2006) tested related to study design acting as a moderator variable in the relationship between safety climate and accident involvement. Study design was split into retrospective or prospective designs. Whereas retrospective designs measure injuries or accidents before the administration of safety climate measures, prospective designs measure accidents or injuries for a period of time after administration of a survey. In order to be selected for this meta-analysis, identified studies must have contained a measure of safety climate, and a criterion measure in terms of occupational accidents, injuries, safety compliance, or safety participation. As such, a total of 35 studies were included in the analysis.

Despite safety climate demonstrating a small negative relationship with occupational accidents and injuries indicating a more positive safety climate was associated with fewer accidents or injuries, the credibility value (a Bayesian statistic similar to a confidence interval) indicated the relationship failed to demonstrate validity generalisation and hence this relationship could not be supported. However, the relationship between safety climate and safety performance was supported, with safety climate demonstrating significant positive relationships with both compliance and participation. This relationship was slightly stronger for safety participation. Meta-analytic results suggested that the effect of safety climate on safety performance was not consistent across occupational settings, and moderator variables may be present in the relationship. Results also indicated a small significant relationship between safety performance and occupational accidents, and this association was consistent across occupational settings. With regard to the moderating effect of study design in the safety climate and accident/injury relationship, support was found for prospective but not retrospective study designs. This finding supports rejection of a reverse causation hypothesis, that is, safety climate influences accident involvement rather than accident involvement influences safety climate.

Clarke's (2006) meta-analysis ultimately supports the relationship between safety climate and safety performance. A weak non-significant association was also demonstrated between safety climate and accident involvement, although this was moderated by study design. At a practical level this meta-analysis supports workplace interventions that target developing a more positive safety climate, with the author asserting that this is "likely to yield real benefits in terms of increased safety compliance and participation, and a reduction in occupational accidents and injuries" (Clarke, 2006, p. 325).

1.4.1.2 Workplace Safety: A Meta-Analysis of the Roles of Person and Situation Factors: Christian et al. (2009).

This meta-analysis built on the foundation of Clarke (2006) by splitting the concept of safety climate into psychological safety climate and group safety climate. Psychological safety climate was defined as "individual perceptions of safety-related policies, practices, and procedures pertaining to safety matters that affect personal well-being at work", and group-level safety climate was defined as "shared perceptions of work environment characteristics as they pertain to safety matters that affect a group of individuals" (Christian et al., 2009, p. 1106). Safety climate was conceptualised as a distal (rather than proximal) factor in this study, meaning it was determined to be a situation-related factor. Safety knowledge (a proximal or person-factor) was also explored in this study as an antecedent to safety performance. Similar to Clarke (2006) safety climate was proposed to positively influence safety performance and negatively influence safety outcomes. However, in this meta-analysis safety performance also included the Hofmann et al. (2003) six safety citizenship behaviours (communication and voice, helping, stewardship, whistle-blowing, civic virtue, and initiating safety change) and a higher order safety performance factor comprising broader measures of overall safety-related behaviours in addition to specific task and contextual behaviours. Safety climate was hypothesised to have a stronger relationship with safety participation as opposed to safety compliance given the motivational desire of employees to reciprocate the perceived safety actions of managers, and the voluntary nature of participation. It was hypothesised that safety knowledge would have a strong positive relationship with safety performance, and that safety knowledge would correlate more strongly with safety compliance than safety motivation. Lastly, group-level safety climate was expected to have a stronger relationship with safety performance than psychological climate. In general, the researchers expected proximal factors including safety knowledge and safety motivation to have a stronger influence on safety performance than distal factors such as personality traits or risk-taking propensity.

Studies were included in the meta-analysis if they were assessed as meeting the criteria for inclusion by two independent researchers. To be included in the meta-analysis studies must have reported an effect size between one or more antecedent and one or more safety outcome; the outcome must have occurred on the job; and the job or outcome must not be driving related. The exclusion of driving outcomes was argued to be necessary due to many studies confounding work-related driving with personal-use driving. Similarly, antecedents for driving accidents were reportedly different when compared to other workplace accidents. A total of 90 studies were included in the meta-analysis.

As was anticipated by Christian et al., proximal factors (safety knowledge and safety motivation) were more strongly related to safety performance than any of the distal factors (Big five personality traits, internal locus of control, risk-taking propensity, and job attitudes) Safety performance was strongly related to both knowledge and motivation; however, safety knowledge was not significantly related to safety outcomes. Safety climate was related to safety performance at both the group and individual level, and this effect was considered moderate. However, group-level safety climate was not shown to have a stronger relationship with safety performance than psychological (or individual-level) climate. As hypothesised, both psychological safety climate and group-level safety climate were more strongly related to safety participation than safety compliance. At the group-level there was not conclusive evidence for moderation effects; however, it was reported that archival safety performance (i.e., number of accidents during the year) had a stronger relationship with safety climate than self-reported safety performance. Given self-report accident data are often underreported or inaccurate, this subsequently supports the relationship between safety climate and objective safety outcome measures.

Christian et al. (2009) indicated that safety climate was positively related to both safety knowledge and safety motivation. As with Clarke (2006) this supports the relationship between positive safety climate and reduced accidents/injuries. Safety climate was shown to have a stronger relationship with safety participation as opposed to safety compliance. This in turn supports the role

of leaders in developing a positive safety climate given the influence they have on providing rewards for workers enacting voluntary safety behaviours. Group/organisational safety climate had stronger relationships with safety performance than individual psychological safety climate; and, in comparison with Clarke (2006), positive group/organisational safety climate was significantly related to fewer accidents/injuries, which was likely a result of the larger sample size in this study. Ultimately, the results of this meta-analysis support developing a positive safety climate as a means to maximise safety motivation and knowledge, resulting in safe workplace behaviours and fewer accidents or injuries.

1.4.1.3 Safety Climate and Injuries: Beus et al. (2010)

In contrast to the previous meta-analyses which were primarily concerned with the relationship between safety climate and injuries, Beus et al. (2010) argue that there are key theoretical distinctions between the impact of safety climate on injuries and of injuries on safety climate. As such, this meta-analysis examined these relationships while maintaining the distinctions between psychological and organisational safety climate set by Christian et al. (2009). Beus et al. (2010) also explored the role of key proposed moderating effects – length of time over which workplace injuries were assessed, content contamination (the inclusion of content not associated with the construct) and measurement deficiency (failure of a measure to adequately represent the construct) of safety climate (relative to Zohar, 2003), and the operationalisation of injuries. As such, this meta-analysis examined several hypotheses. It was proposed that the impact of safety climate on injury, and injury on safety climate would be stronger for organisational safety climates (e.g., groups or organisations) compared to psychological safety climate (e.g., individuals). It was also suggested that higher levels of safety climate content contamination, and higher levels of safety climate content deficiency would be associated with weaker safety climate → injury relationships. The safety climate → injury relationship was hypothesised to be moderated by injury operationalisation in that the inclusion of more than just Occupational Safety and Health Administration (OSHA) injuries (defined as requiring more than basic

first aid treatment) would be associated with stronger relationships than including only OSHA-reportable injuries. Lastly, the injury → safety climate relationship was hypothesised to be moderated by injury operationalisation whereby OSHA-reportable injuries will have a stronger effect on safety climate than the inclusion of more than OSHA-reportable injuries.

In order to be included in this meta-analysis studies must have reported a relationship between a safety climate measure and an outcome measure for workplace injuries. These must have also included an appropriate effect size or sufficient information to permit the computation of one. Studies also had to provide enough information to determine if reported injuries occurred before or after the assessment of safety climate. Information relevant to moderator analyses was required for inclusion in relevant analyses. These criteria resulted in 32 injury → psychological safety climate effect sizes, 10 injury → organisational safety climate effect sizes, and 11 organisational safety climate → injury effect sizes. Only one study was identified for the psychological safety climate → injury relationship, hence this could not be examined via meta-analysis.

With regard to analyses of the injury → organisational safety climate versus organisational safety climate → injury relationships, the former was determined to be marginally stronger, suggesting that injuries are stronger predictors of safety climate than vice versa. Compared with Christian et al. (2009) the reported effect sizes for the safety climate → injury relationship were smaller in this study. The injury → organisational safety climate relationship was stronger than the injury → psychological safety climate relationship. Length of time interval over which injuries were assessed only acted as a moderator variable for the organisational safety climate → injury relationship. This was not the case for the injury → safety climate relationship wherein length of time for assessing injuries did not moderate the relationship for either organisational or psychological safety climate. Deficiency in safety climate measures moderated the injury → safety climate relationship at both the organisational and psychological level, wherein greater deficiency was related to weaker relationships, however this was not the case for the safety climate → injury relationship. Contrary to what was hypothesised, greater content contamination was associated with stronger,

rather than weaker, relationships between injury and safety climate for both organisational and psychological safety climate. Lastly, the inclusion of more than OSHA-reportable injuries, or only OSHA-reportable injuries was not found to have a meaningful moderating effect on the safety climate → injury relationship, or injury → safety climate relationship, respectively.

The finding that injuries have a slightly stronger relationship with safety climate than safety climate has with injuries is consistent with Zohar (2003) and supports the assertion that workers' perceptions of safety climate change following experience of workplace injuries. Similarly, the slightly stronger effect may be related to the fact that injuries have a direct impact on safety climate perceptions, whereas safety climate perceptions are related to injuries through enacted behaviours. However, it is important to note that the difference in strength of relationships was very small. Similarly, this relationship highlights organisational safety climate as a dynamic construct (e.g., affected by the occurrence of injuries) that should be monitored regularly in order to be used most effectively as a preventative assessment for injury prevention. With regard to the ability of a safety climate assessment to predict future injuries diminishing over time, this also makes sense conceptually as safety climate is a temporally specific representation of worker perceptions. However, with regard to the injury → safety climate relationship, the impact of injuries on safety climate appears largely unaffected by the injury time frame, and the authors propose that this is due to the rarity of workplace injuries which results in long-term memory of the event (Jacobs, 1970). Hence, early intervention into safety concerns is essential for reducing the possibility of workplace injuries, and for developing and maintaining a positive safety climate over time.

1.4.1.4 A Meta-Analytic Investigation of the Link between Job Demands, Job Resources, Burnout, Engagement, and Safety Outcomes: Nahrgang et al. (2011)

The meta-analysis by Nahrgang et al. (2011) utilised the JD-R model (Bakker & Demerouti, 2007) to explore the relationship between the proposed demands/resources and burnout, engagement, and safety outcomes. In this study safety climate was conceptualised under 'supportive

environment' as a job resource. Other job resources in this study include knowledge, autonomy, social support, and leadership. However, for the purpose of summarising the meta-analysis, discussion will be limited to the role of safety climate and its relationship with outcome variables. Job resources were hypothesised to have a positive relationship with engagement, which for the purpose of this study was defined as "the extent of involvement, participation, and communication in safety-related activities" (Nahrgang et al., 2011, p. 74). Similarly, job resources were proposed to have a negative relationship with burnout, which is characterised in this study as "a syndrome of exhaustion, cynicism, and lack of efficacy experienced by employees" (Nahrgang et al., 2011, p.73). Through these relationships it was then hypothesised that burnout would be positively related to, and engagement would be negatively related to, safety outcomes (accidents and injuries, adverse events, and unsafe behaviour). Given the demonstrated mediation effect psychological strain has on safety climate and safety outcomes (e.g., Fogarty, 2005), the researchers proposed that burnout and engagement would both mediate the relationship between job demands/job resources, and safety outcomes.

To be included in the meta-analysis, identified studies must have demonstrated sufficient information to meet the research needs. If a study had appropriately reported effect sizes, description of variables, and description of the sample, it was included in the analysis. The final set of studies totalled 179, in which 20 articles reported more than one independent sample, resulting in a final total of 203 independent samples. When compared to previous meta-analyses, Nahrgang et al. (2011) addressed an important limitation from Christian et al. (2009) by including driving-related jobs/outcomes, and unpublished articles. This resulted in a much larger sample size than previous meta-analyses, and included the majority of safety climate research conducted in the transportation industry. Hence, Nahrgang et al. (2011) arguably offer the most comprehensive estimate of safety-related relationships.

Strong support was provided for the relationship between safety climate as a job resource and engagement. Similarly, there was strong support for the negative relationship between safety climate as a job resource and burnout. In support of the JD-R model as a whole, it wasn't just safety

climate that demonstrated these relationships. All of the proposed job resources were positively related to engagement and negatively related to burnout. In terms of the relationships between burnout, engagement, and safety outcomes, burnout was significantly related to both accidents/injuries and adverse events, but it was not significantly related to unsafe behaviour. Comparatively, engagement was significantly related to adverse events and unsafe behaviour, but it was not significantly related to accidents and injuries. When examining the relative importance of job resources, the researchers reported that safety climate explained the largest percentage of variance in engagement and compliance (42% and 34%, respectively), unsafe behaviour (49.8%), and was also one of the highest contributors to variance explained for burnout (22.8%). Results of mediation analyses indicated that the effects of safety climate on adverse events were partially mediated by compliance and burnout; however, safety climate also had a direct effect on accidents and injuries. Finally, when examining the effects of jobs resources across industries, autonomy, leadership, and safety climate explained the largest percentage of variance in burnout. However, some have criticised this study for its conceptualisation of engagement and burnout. The constructs were not directly assessed in the meta-analysis, and instead variables such as anxiety and depression were used as indicators of burnout, and variables such as participation, communication, and information sharing were used to indicate engagement (Casey et al., 2017).

The results of the Nahrgang et al. (2011) meta-analysis once again support the relationship between safety climate and safety outcomes, and support the construct as a job resource as part of the larger JD-R framework. This study reported that burnout was detrimental to, and engagement was a motivator for, working safely. As reported by the researchers “social support and safety climate are key job resources that contribute the most to burnout, engagement, and safety outcomes” (Nahrgang et al., 2011, p. 81). When compared to the Christian et al. (2009) meta-analysis, Nahrgang et al. (2011) reported safety climate, rather than safety knowledge as the job resource with the largest amount of variance explained with regard to compliance and engagement. Furthermore, the supportive environment provided by a positive safety climate consistently explained variance in burnout,

engagement, and safety outcomes across industries. This is compared to job demands for which the type of job demand differed across industries. Hence, regardless of industry type, improving social support, safety leadership, and organisational safety climate are argued to be the best ways to improve overall safety.

1.4.2 Summary of Meta-Analysis Studies

Across several meta-analyses it has been demonstrated that safety climate has a significant impact on safety outcomes. Additionally, these results highlight the potential usefulness of safety climate interventions when attempting to improve work safety in an organisation, and support safety climate as an integral component in key occupational stress frameworks (e.g., the JD-R model; Bakker & Demerouti, 2007). Despite the last meta-analysis occurring over a decade ago, there have been more recent systematic reviews, which are also considered as providing the strongest relevant evidence, supporting the effectiveness of developing a positive safety climate to reduce incidents and improve safety performance indicators (Kalteh et al., 2021). Overall, these studies have consistently demonstrated that people work more safely when they perceive safety to be valued among their work and social groups. Through these meta-analyses the concept of safety climate is also highlighted as an effective leading indicator for safety outcomes (Zohar, 2010), meaning it can be applied in practical settings to monitor safety and identify emerging work safety issues for remediation before they become critical and result in a costly accident or incident. However, while the relationship between safety climate and safety outcomes is clear, the most effective method for measuring safety climate is still a contested issue.

1.5 Safety Climate Measurement

As discussed in the previous section, the research literature demonstrates support for work safety climate as a predictor, or leading indicator, of various safety outcomes. Safety climate measurement can also be used in a practical setting in order to achieve a variety of goals; for example, accurately targeting work safety interventions to areas where they are needed, establishing an

organisational baseline by which to measure the effectiveness of implemented safety solutions, benchmarking work safety climate against industry standards, and monitoring levels of safety climate to identify emerging issues and prevent them through remediation from reaching a critical stage. However, there remains no consensus on the most appropriate method by which to measure the construct. Currently there exists a large number of publicly available measures for the assessment of organisational safety climate (Vu & De Cieri, 2015a), ranging from four items to over one hundred. Assessment length is an important issue for safety climate measurement as longer tools are likely to discourage regular use from an organisational perspective and may result in reduced quality of data through increased response burden on participants (Nielsen et al., 2016). Issues related to survey length will be covered in a later section, however, additional issues with safety climate measurement such as general or industry-specific focus, established reliability and validity, referent focus, and factorial structure must also be considered. This section will examine these issues.

1.5.1 General and Industry-Specific Safety Climate Measurement

One of the more persistent contentions between safety climate researchers is whether cross-industry or industry-specific measures are most appropriate for assessing the construct. Unfortunately, this is a very difficult question to answer given the large number of safety climate measures available of both types. In an extremely comprehensive review of safety culture and safety climate measurement tools, Vu and De Cieri (2015a) identified 206 publicly available measures for safety climate. While the majority of measures available assess general perceptions of safety climate (e.g., Beus et al., 2019; Kines et al., 2011; Zohar & Luria, 2005) industry-specific measures have been examined for a variety of organisational types including healthcare (Singer et al., 2007), manufacturing (Ghahramani & Khalkhali, 2015), agriculture (Seo et al., 2004), truck drivers (Huang et al., 2013a), remote utility/electrical workers (Huang et al., 2013b), and aviation (Evans et al., 2007). The argument for general cross-industry measures is that they provide a context-free assessment of safety climate and can similarly be benchmarked to compare performance with numerous other organisations (Beus

et al., 2019). However, as mentioned in earlier sections, some researchers deem certain industries to have unique safety concerns such as construction (e.g., Choudhry et al., 2007) requiring consideration. Zohar (2010) too has suggested that different industries are likely to have unique safety climate dimensions, and thus industry-specific measures should be developed. However, for these measures generalisability is limited and may not even include similar organisations within the same industry.

In a single-study empirical assessment of context-specific and general safety climate assessments, Keiser and Payne (2018) reported similar inconsistent results. Their study added contextual information to an existing general safety climate measure resulting in five contextualised measures for different laboratories: animal biological, biological, chemical, human subjects/computer, and mechanical/electrical. The researchers then compared the criterion-related validity of the contextualised safety climate measure and the general safety climate measure as they related to six safety outcomes (knowledge, participation, compliance, injuries, incidents, and near misses). The researchers ultimately reported statistical equivalence between the general safety climate measure and four of the five context-specific safety climate measures (animal biological, biological, chemical, mechanical/electrical) and suggested that content specificity may enhance the criterion-related validity of safety climate measures only in "less-safety-salient contexts" (Keiser & Payne, 2018, p. 489) such as the computing laboratory in this study.

To further address this contention, Jiang et al. (2019) performed a meta-analysis comparing the predictive validity of universal and industry-specific safety climate measures. At a practical level this kind of assessment is important for safety climate research, as the authors' state "an accurate estimate of the criterion-related validity of universal and industry-specific safety climate scales can also provide insights into the future development of workplace safety and interventions to improve safety climate" (Jiang et al., 2019, p. 42). It was hypothesised that industry-specific safety climate measures would exhibit stronger relationships with safety behaviour and risk perceptions specific to an organisation than universal safety climate measures, and universal safety climate measures would

exhibit stronger relationships with more general outcome measures and adverse events (such as errors and near misses) than industry-specific safety climate measures.

To be included in the Jiang et al. (2019) meta-analysis, identified studies had to report a relationship between a safety climate assessment measure and a measure of at least one criterion variable, as well as report an appropriate correlation. The meta-analysis included a total of 120 independent samples.

Consistent with the key meta-analytic studies outlined in an earlier section, Jiang et al. (2018) reported a positive relationship between safety climate and safety behaviour, and negative relationships between safety climate and risk perceptions, accidents/injuries, and other adverse events. In line with the hypothesised relationships, industry-specific safety climate measures demonstrated stronger correlations with safety behaviour, and risk perceptions, when compared to general measures. Comparatively, general safety climate measures demonstrated stronger correlations with accidents/injuries, and other adverse events when compared to industry-specific measures. These results further demonstrate the potential advantages and disadvantages of each measurement type and indicate that neither measure is objectively superior to the other. Where general safety climate measures appear to better predict more general objective safety outcomes such as near misses and errors, industry-specific measures appear to better predict subjective or self-reported safety outcomes, such as safety behaviours and perceptions of risk.

The two studies above provide inconsistent results regarding the effectiveness of industry-specific or general safety climate measures. Similarly, the previously mentioned meta-analysis by Nahrgang et al., (2011) reported that job resources were consistent in explaining variance in burnout, engagement, and safety outcomes across all industries examined, whereas job demands differed. As suggested by Zohar (2014), the decision to employ general or industry-specific measures may depend on the use of the outcome data. As the goal of this thesis is to develop a safety climate measure with the broadest applicability possible, the focus will be on general or cross-industry measures henceforth. As previously highlighted, industry-specific measures do have some key advantages over general

measures; however, it is argued that a well-constructed, reliable, and valid measure for safety climate could be implemented and benchmarked across different industries in different countries and thus would have the greatest applicability for monitoring safety climate and for identifying and remediating emerging safety concerns to improve safety outcomes.

1.5.2 Reliability, Validity, and Item Generation

Reliability and validity are both considered essential when assessing a measure of a construct. Reliability refers to the consistency of a measure, and whether the results can be reproduced under the same conditions. Cronbach's alpha is typically the statistical measure used to assess reliability, or internal consistency, and for measures of safety climate a Cronbach's alpha statistic equal to or greater than 0.7 is considered acceptable for unidimensional measures, or each dimension in a multidimensional measure (Vu & De Cieri, 2015a). Validity is broader as a concept and comprises several varieties including convergent validity (correlation with another scale measuring the same construct), discriminant validity (no correlation with another scale measuring a different construct), known-group validity (significant mean differences in construct scores between groups that are predicted to differ), concurrent validity (correlation with an associated outcome variable), and predictive validity (correlation with an outcome variable expected to be related with the construct, measured retrospectively). Measurement equivalence is another form of assessment to ensure the same construct is being measured across different groups and is an important component of generalising results.

While reliability is frequently reported and much easier to assess, a persistent issue with safety climate measurements is a lack of rigorous validation processes (Singh & Verma, 2020; Shea et al., 2021). In an analysis of 206 safety climate measures, Vu and De Cieri (2015a) reported only 18 as satisfactory with regard to item generation techniques, dimensionality, reliability, and validity. Dimensionality and factor structure of safety climate measures will be assessed in a later section of

this thesis, whereas item generation deficiency and reliability and validity concerns will be addressed now.

The fact that only 18 of 206 safety climate measures were deemed appropriate by Vu and De Cieri (2015a) indicates that a large proportion of safety climate measures are either not being appropriately conceptualised and developed, or they are not being appropriately validated. This poses a significant threat to safety climate research as inconsistent relationships between safety climate and various outcome variables as a result of poor measurement may result in questions regarding the construct's usefulness as a leading indicator for safety concerns. Hence, appropriate examination of the reliability and validity of a work safety climate assessment is essential and comprises a key aim of this thesis. Furthermore, inappropriate design and evaluation methodologies can lead to what is currently, in effect, a large number of safety climate measures available to the public, with still no consensus on what comprises an effective measure. This has led some researchers to suggest that "rather than construct more questionnaires, researchers should correlate safety climate constructs with existing safety performance metrics to establish convergent and discriminate validities" (Singh & Verma, 2020, p. 678). While Vu and De Cieri (2015a) only required one additional form of validation (e.g., construct validity, criterion validity, convergent validity, content validity) in order for a measure to be considered satisfactory, this thesis contends that for a general measure of safety climate to be deemed not only acceptable in statistical terms but also practically useful, it must demonstrate extensive evidence of validation. It is worthwhile noting that most of the measures deemed satisfactory by Vu and De Cieri (2015a) did exhibit more than one form of validity; however, five in total (Brown et al., 2000; Díaz-Cabrera et al., 2007; Glendon & Litherland, 2001; Håvold, 2007; and Prussia et al., 2003) only demonstrated discriminant validity.

With regard to item generation for safety climate measures, conceptual ambiguity and lack of consensus regarding dimensionality poses a significant issue. Likewise, the very fact that the terms safety culture and safety climate are still used interchangeably in the research literature (Arzahan et al., 2022) suggests existing measures may either propose to measure the incorrect construct (Vu & De

Cieri, 2015a), or may have content contamination (Beus et al., 2010). The lack of a unifying conceptual model has also been suggested to reflect the state of development in safety climate research (Newaz at al., 2018) where an inductive rather than deductive approach is taken. Establishing what comprises item generation in any scale development process is essential (Shea et al., 2021). In order to be deemed satisfactory by Vu and De Cieri (2015a) authors must have used multiple methods to establish content validity including a literature review, subject matter expert review, and pre-testing of the scale. For the purpose of this thesis, it is suggested that in addition to the previously mentioned methods, assessing the practicality of items through safety practitioner review may also be a viable technique for assessing content validity and selecting the safety climate items most valuable to organisations in terms of identifying what kinds of safety issues needs to be remediated.

1.5.3 Safety Climate Levels and Referents

As mentioned in earlier sections, Zohar (2000) conceptualised safety climate with multiple referents whereby policies and procedures regarding safety are generated at the organisational level and implemented at the group-level through supervisory practices. Referents can be understood as the focus of worker climate perceptions as they relate to safety climate (Shea et al., 2021). Zohar and Luria's (2005) safety climate measure has two separate scales, one focussing on organisational-level safety climate, and one for group-level safety climate. However, many safety climate researchers do not follow this approach, instead opting to address different referents implicitly at the item level (Shea et al., 2021). It is now widely accepted that individual perceptions of safety toward referents can be aggregated to represent within- or between-group perceptions. This is then used to represent the collective perceptions of groups, rather than individuals, which reflects a key feature of safety climate as a construct (Griffin & Curcuruto, 2016). Multiple referents for safety climate perceptions are now arguably the norm, and the number of referents has grown from just organisation and supervisors to also include the influence of co-workers (Brondino et al., 2012; Brondino et al., 2013). In fact, Shea et

al. (2021) examined conceptualisations of safety climate subscale dimensions by referent and identified the most frequently used individual referents as workplace, management, and co-workers.

Previous research has reported that co-worker support acts as a moderating variable in the relationship between supervisor safety leadership and safety perceptions, supervisor safety leadership and work unit safety, and senior management safety leadership and safety perceptions (McCaughey et al., 2013). Similarly, perceived co-worker safety norms have been positively associated with safety motivation in healthcare workers (Rickett et al., 2006). This supports the inclusion of co-workers in the pathway from safety climate to safety outcomes. However, many safety climate measures do not assess specific referents using separate scales, which is inconsistent with what was proposed by Zohar and Luria (2005). Some measures instead implement a referent-shift approach by wording questions as 'We who work here' rather that 'I…' in order to encourage the individual respondent to report shared perceptions within the workgroup, rather than individual perceptions (Kines et al., 2011). Additionally, by constructing dimensions of safety climate that specifically reference work groups (e.g., management, co-workers) specific action can still be taken towards remediating safety concerns as they relate to these groups, thus increasing the accuracy of safety interventions. This is particularly important when considering previous research has demonstrated that managers respond more positively to safety climate surveys when compared to workers (Chan et al., 2021; Gambashidze et al., 2021; Quach et al., 2019). Additionally, worker-manager discrepancies in perceptions of safety climate have been positively correlated with injury rates (Marín et al., 2019). Thus, examining both management and co-worker safety climate is crucial for effective safety management and injury prevention.

Hence, over time safety climate measurements have developed to include additional groups of reference, moving away from the more traditional measures that primarily focussed on management and supervisor practices. It is argued in this thesis that this trend may be likely to continue as organisations become less hierarchical, ultimately diminishing the impact of top management and enhancing the influence of immediate workgroups on safety perceptions.

1.5.4 Factorial Structure

A primary contributor to the issues surrounding measurement of safety climate comes from, as Beus et al. (2019) state, "a broad lack of appreciation of the construct's multilevel conceptualization and content domain" (p. 2005). This has ultimately resulted in a large number of measures for safety climate that do not align with one another being developed, and it has continued the conceptual ambiguity present in the literature. It was Flin (2007) who proposed that a set of universal, cross-industry safety climate dimensions would be beneficial for safety climate researchers. However, while most researchers now view safety climate as a multi-dimensional and multi-level construct (Griffin & Curcuruto, 2016) there is still no consensus for a universal set of safety climate dimensions. Several researchers have examined the wide variety of safety climate measures to ascertain the most common themes, and these will be summarised now.

In an early factor analysis of safety climate instruments, Dedobbeleer and Beland (1998) proposed that only two key factors (management commitment and worker involvement) had been properly replicated across studies. Flin et al. (2000) identified the most commonly measured dimensions in industrial measures of safety climate as management, safety systems, risk, work pressure, competence, and to a lesser extent, procedures/rules. In a literature review of 16 safety climate scales, Seo et al. (2004) identified five dimensions of safety climate, namely management commitment to safety, supervisor safety support, co-worker safety support, employee participation in safety related decision making and activities, and competence level of employees with regard to safety. Of the 18 satisfactory safety climate measures identified by Vu and De Cieri (2015a), the core dimensions included management commitment to safety, employee involvement or empowerment in safety, and safety communication. Griffin and Curcuruto (2016) found key themes to be perceptions of management commitment to safety, safety systems and procedures, and training and competence. In the development of a cross-industry measure for safety climate, Beus et al. (2019) identified leader safety commitment, safety communication, safety training, co-worker safety practices, safety equipment and housekeeping, safety involvement, and safety rewards as the core dimensions. More

recently Shea et al. (2021) examined 49 safety climate measures and classified 222 unique subscales into seven core dimensions: safety systems, safety commitment, prioritisation of safety, safety communication, safety involvement, safety training, and safety rewards. Subscales that did not fit into these classifications were reported as other/mixed, with these dimensions representing areas not widely examined as part of safety climate. The example given by Shea et al. (2021) is safety justice.

Within the healthcare industry Arzahan et al. (2022) compiled the prevailing dimensions of safety climate to be management commitment, supervision, participation, and involvement; safety resources, policies, and training; risk management and communication; safety rules, procedures, equipment, and rewards; and worker's involvement and participation. Similarly, within the manufacturing industry Singh and Verma (2020) identified the most common themes assessed in safety climate questionnaires as top management commitment and supervisors attitude to safety, quality of safety training and personal protective equipment use training, workers safety participation and communication, workers safety commitment, workers safety priority, work pressure, workplace environment, workers trust in the efficacy of safety system, and job security and satisfaction.

Given that the highest percentage of safety climate literature has involved the construction industry (Han et al., 2021), it is not surprising that a variety of researchers have examined prevailing safety climate themes within this field. For example, Newaz et al. (2018) through a systematic literature review proposed five core components for construction industry safety climate: management commitment; safety system; supervisor's role; workers' involvement; and group safety climate. Comparatively, Alruqi et al. (2018) who were also examining safety climate dimensions within the construction industry identified management commitment to safety, supervisory safety response, safety rules and procedures, communication, worker involvement, training, risk-taking behaviour, and workload pressure as the most common safety climate dimensions.

Evidently there is no consensus for core dimensions that contribute to work safety climate. That said, management commitment/priority is by far the most common dimension in safety climate measures. This may be unsurprising considering management typically drive the priority of workers,

and the value that is placed on safety in comparison with competing demands (e.g., production) is likely to impact worker perceptions of safety. In the Beus et al. (2010) meta-analysis outlined in an earlier section, perceived management commitment to safety was identified as the safety climate dimension most predictive of subsequent injury. This meta-analysis further identified a number of dimensions said to contaminate the factorial structure of safety climate such as job safety/risk and individual safety attitudes. Regardless of the dimension structure determined to best represent work safety climate, contemporary safety climate researchers such as Shea et al. (2021) have suggested that "when developing new or refining current measures of safety climate, scholars should go beyond the exploratory analysis (i.e., EFA [exploratory factor analysis]) and incorporate confirmatory techniques such as CFA [confirmatory factor analysis] or Rasch analysis" (p. 11). This approach of expanding on exploratory techniques and moving towards confirmatory analyses of factor structure comprises a key research aim of this thesis. The researchers (Shea et al., 2021) also identify five key steps for safety climate researchers to follow when attempting to advance the understanding and measurement of safety climate: (1) establish the theoretical framework and clarify the definition of safety climate, (2) measures should accurately reflect the referents in safety climate, (3) clarity and consensus on the dimensions should be addressed, (4) specify measures *a priori* and use confirmatory analytic techniques to develop or refine measures, and (5) evaluate measures of safety climate to establish validity as a multilevel rather than single-level construct.

1.5.5 Safety Climate Measurement Summary

Given the various conceptual issues related to safety climate measurement highlighted in this section (such as subpar item generation techniques, inappropriate reliability and validity, single-referent measures, and unclear factor structures), the goal of this thesis is to develop a brief, reliable and practical measure for work safety climate that is applicable across industries, and addresses the aforementioned concerns. With a variety of core safety climate dimensions identified across measures, and the many differences identified even within measures for the same industry (e.g.,

construction) this thesis argues that the most appropriate method for development of a brief measure may involve item reduction of an existing, validated measure with an appropriate dimension structure. This approach would satisfy the call from safety climate researchers (e.g., Singh & Verma, 2020) to focus on the reliability and validity of existing scales instead of developing new measures, while simultaneously introducing a novel method for item reduction that focuses on practicality in order to enhance applicability across industry types. Hence, in the following section various item reduction techniques will be examined.

1.6 Brief Survey Measures

As previously mentioned, a common issue facing safety researchers in both research and practical settings is assessment measure length. Both longer and briefer measures have their advantages and disadvantages. While longer measures can more comprehensively assess a construct such as safety climate, shorter measures can result in greater participant engagement and more efficient data collection (Huang et al., 2017). Longer survey completion times have been shown to increase response burden in participants (Nielsen et al., 2016), and meta-analytic evidence has negatively associated response burden with response rates (Rolstad et al., 2011). Additionally, if used as a monitoring measure, a brief safety climate survey could potentially identify areas that may then warrant further investigation with a more comprehensive measure or relevant parts of that measure. Harrison et al. (2018) further note that issues of survey non-compliance may be particularly concerning in the more traditionally safety-critical industries such as mining, oil and gas, and construction. Hence, brief survey measures can have a significant advantage in safety research, and this directly relates to a core research aim of this thesis. There are two primary methods for reducing the number of items in a composite scale, classical test theory (CTT) and item response theory (IRT).

1.6.1 Classical Test Theory and Item Response Theory

Classical test theory (CTT) is a quantitative approach to assessing the reliability and validity of a scale based on the items it contains. At a fundamental level, CTT assumes that each observed score

on a measure (e.g., safety climate) is a linear combination of an underlying true score and error. Any error present in the measurement becomes a part of a respondent's true score, which in turn impacts the validity of the measure since the score no longer represents only the construct being measured (Himelfarb, 2019). Under CTT, as the value of a true score increases, you should also observe increases in items representing the same concept. CTT assumes that random error for observed scores is normally distributed, and therefore the expected value of random fluctuations is taken to be zero (Cappelleri et al., 2014), and random errors are assumed to be uncorrelated with a true score. Hence, CTT is often used to assess the reliability and validity of measures. In collaboration with factor analytic techniques (processes by which the number of factors present in a scale are identified) CTT can generate understandings of dimensionality and data structure. It has been suggested that much of the attraction for using CTT is the fundamental observed score decomposition (Raykov & Marcoulides, 2016) which allows researchers to assess the relevance of items or factors as they relate to an underlying construct. As such, based on the observed reliability and validity of individual items, CTT allows researchers to shorten composite measures within a statistically acceptable framework.

More recently interest in item response theory (IRT) has increased in popularity as an item reduction technique. IRT represents a probabilistic non-linear modelling technique that focuses on displaying correlated multivariate responses in a structured manner and it is often used to evaluate and develop measurement scales of an underlying latent variable (Cai et al, 2016). With regard to measuring specific constructs, IRT calculates the probability of a respondent selecting different response options for each individual item, and also estimates each item's ability to differentiate respondents. While often used to assess measures that contain correct or incorrect answers (such as academic tests in the field of education), it can be applied to Likert type response measures. In this case, higher levels of the underlying trait (e.g., safety climate) will lead to higher probabilities of a stronger endorsement (e.g., selecting 'strongly agree') (Huang et al., 2017). Unlike classical test theory, IRT accounts for both an item's ability to discriminate and the difficulty of the item. This information is then incorporated into the model. This is argued to provide researchers with more information than

CTT when selecting the most effective items for measuring an underlying construct. However, some researchers have argued that the criticism of CTT's effectiveness for item reduction in comparison with IRT is unjustified, and is largely a result of incorrect use of CTT historically (Raykov & Marcoulides, 2016).

1.6.2 Safety Climate Measures and Item Reduction

With specific regard to safety climate measures, Hahn and Murphy (2008) used a combination of CTT and factor analysis to develop a 6-item measure of safety climate from an existing 16-item measure. Reliability was examined in the form of Cronbach's alpha, and convergent and discriminant validity were examined through correlations with related and un-related outcome variables. Comparatively, Huang et al. (2017) employed an IRT approach to reduce Zohar and Luria's (2005) existing measure of safety climate by identifying the most statistically useful items in terms of discriminating ability, and retention of original scale information. As a result, the researchers were able to produce two versions of the original 16-item organisation-level and 16-item group-level safety climate measures, transforming these into a reduced 8-item organisation-level and 11-item group-level measure, and a further reduced 4-item organisational-level and 4-item group-level measure, respectively.

Outside of CTT and IRT, Harrison et al. (2018) used a novel planned missing data design in order to reduce the number of questions participants need to answer when responding to safety climate questionnaires. In this study participants were randomly allocated a selection of safety climate items from a measure, and through multiple imputation missing data was able to be effectively simulated, ultimately reducing the required items by 25% and 57% across both studies, whilst retaining access to comprehensiveness of the full scale. However, one criticism of this method for safety climate research is that examination of individual differences for items becomes difficult as each participant may be given different safety climate questions, hence the aggregation of responses

may not represent true underlying trends. Instead, the proposed method is more effective at managing missing data so that valid interpretations can be drawn from a final data set.

One approach that has not been taken when examining item reduction techniques is the introduction of practically focussed criteria, which is a key research aim of this thesis. Subject matter experts and safety researchers are often consulted when selecting items for safety climate scales; however, safety practitioners are rarely incorporated. Considering many safety climate measures are ultimately designed for industry use, this represents an area for development. By surveying safety practitioners regarding the items they consider to be of most value in terms of their practical importance and incorporating this information into item selection in combination with statistical acceptability criteria, safety researchers may be able to develop a measure that is both reliable and valid as well as practically useful and efficient. Similarly, rarely do safety surveys consider the concept of item readability when designing survey measures. This may be a potential oversight in safety research particularly considering many traditionally high-risk work environments (e.g., construction, manufacturing) have lower requirements for education, and often employ workers from culturally and linguistically diverse backgrounds. By incorporating these factors into a safety climate measure researchers may be able to develop a tool that encourages regular monitoring in order to enhance capability as a leading indicator for safety outcomes, and results in the most reliable and valid responses from participants.

1.6.3 Summary of Item Reduction Methods

As previously discussed, subject matter experts and practitioners are often employed when developing new measures. Gajewski et al. (2013) argue that content validity is supported by subject matter experts providing quantitative ratings of the extent to which items represent a targeted construct. The use of subject matter experts to determine construct validity is used across various measures and assessment tools (e.g., Abubbakar et al., 2020; Burns & Yates, 2022), including those

used for workplace safety (e.g., Casey et al., 2019), and this approach is also supported by Shea et al. (2021) with regard to best practice for safety climate scale development.

However, a far less common technique involves the use of safety practitioners and experts to determine which items should be retained when attempting to reduce an existing established measure. Input from safety practitioners regarding the practical value of safety climate survey items can potentially contribute significantly to item selection criteria; however, these items may not represent the most statistically valuable. Instead, items selected as important by safety practitioners may reflect content that is relevant in applied, rather than theoretical settings. Hence, with a primary aim of this thesis being the development of a brief and practical work safety climate to be used for regular monitoring in order to identify and remediate safety concerns before they become critical, this approach is likely to yield significant value.

Despite IRT often being recommended as the statistically superior method for item reduction (Raykov & Marcoulides, 2016), the method proposed in this thesis is one that incorporates additional criteria for item selection outside of purely statistical value. Similarly, items with high statistical value may exceed reading capabilities of many participants essentially reducing the validity of these items in a practical setting. Some of the highest risk industries for safety incidents include areas such as manufacturing and construction. Many of the workers employed in these sectors may come from lower educational backgrounds, or culturally and linguistically diverse backgrounds. Hence, the readability of a safety climate survey in these settings (among others) is likely to play a significant role in attaining high quality data from participants. A common method for assessing readability is the Flesch-Kincaid Grade Level, which is approximately equivalent to education grade in the United States. For example, a Flesh-Kincaid Grade readability score of 10 would require the reader to have a Year 10 reading level to understand the text. It has been recommended by some researchers that a grade 8.0 reading level should be the benchmark for most scales (Hall et al., 2010).

Thus, the item reduction method proposed in this thesis aims to select the most practically relevant and useful items (e.g., based on being selected as important by safety practitioners and item

readability) that simultaneously meet the statistical acceptance requirements of both CTT and factor analysis. Given a key aim of this thesis is to develop a brief and practical measure for work safety climate that encourages regular implementation, this approach is deemed appropriate based on previous scale development theory.

1.7 The Nordic Occupational Safety Climate Questionnaire (NOSACQ-50)

As has been previously stated in this chapter, this thesis recommends that the most effective method to produce a brief and practical measure for safety climate may involve modifying an existing validated and reliable safety climate measure. This approach aligns with suggestions from safety climate researchers to focus on validating and enhancing existing measures, rather than producing new ones (Curran et al., 2018). As such, the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50; Kines et al., 2011) was determined to be the most appropriate basis for a brief measure for the following reasons.

Kines et al. (2011) define safety climate as "a social unit's shared perceptions at a given time of management and workgroup safety policies, procedures and practices" (p. 638). The NOSACQ-50 was designed by a team of Nordic safety researchers and had representatives from all five Nordic countries. The items for the measure were originally developed in English, then translated to all five Nordic languages, and then translated back to English in order to maintain semantic consistency.

The final version of the NOSACQ comprises 50 questions, with 29 positively worded and 21 negatively worded. Twenty-two of the items are management focussed questions, and 28 are workgroup focussed questions divided across seven key dimensions: (1) management safety priority, commitment and competence; (2) management safety empowerment; (3) management safety justice; (4) workers' safety commitment; (5) workers' safety priority and risk non-acceptance; (6) safety communication, learning, and trust in co-workers' safety competence; and (7) workers' trust in the efficacy of safety systems. Originally items were presented with a 5-point Likert response type; however, Rasch analyses indicated a higher frequency of reversed thresholds for the 5-point response

format when compared to a 4-point response format, and hence the option of a neutral response was removed. Given the 4-point scale, results over 2.5 (the mathematical mean) are considered positive; however, the developers acknowledge that at this level there would be room for safety climate improvements. As such a score below 2.70 was determined to represent a low level of safety climate with a great need of improvement, a score between 2.70 and 2.99 represented a fairly low level of safety climate with need of improvement, a score of 3.00 to 3.30 represented a fairly good level of safety climate with slight need for improvement, and a score of more than 3.30 represented a good level of safety climate for maintenance and continuing development (The National Research Centre for the Working Environment, 2022a)

A significant advantage of the NOSACQ-50 is that it is based not only on organisational climate theory, but also draws on social exchange theory (Blau, 1986) and Perceived Organisational Support (POS; Eisenberger et al., 1986), highlighting the relational component of safety climate (Shea et al., 2021). According to social exchange theory positive behaviours that benefit another party are promoted through a normalised expectation for reciprocation. With regard to safety climate, this suggests that as management demonstrate a value for the safety of workers, safe organisational behaviours are encouraged via obliged reciprocation. Similarly, POS theory suggests that when employees perceive their organisation to care about their health and wellbeing, attachment toward the organisation is likely to increase. Higher levels of POS are argued to positively impact safety climate and have been empirically demonstrated to lower accident rates (Wallace et al., 2006).

As described by Shea et al. (2021), the concept of safety commitment tends to be measured using management and supervisors as the referents; however, the NOSACQ does not distinguish between levels of management. Kines et al. (2011) acknowledge that safety climate dimensions related to management may be perceived differently depending on the level of management (i.e., top management, site management, line management, supervisor) but decided against separate evaluations of individual levels of management for three reasons: (1) workers may struggle to distinguish between front-line management and other levels of management, resulting in ambiguous

responses and threatening the validity of the measure; (2) safety climate refers to shared perceptions of broader management practices, not ratings of an individual manager; and (3) from a practical perspective considering different levels of management would double or triple the required items in the measure making it impractical for use in organisations. That said, the questionnaire does differentiate between hierarchical levels with specific focus on both management and workgroup practices. In order to prevent individual perceptions being assessed at the workgroup-level the researchers implemented a referent-shift approach so that individual participants are encouraged to report on shared perceptions. This alters the focus of questions from 'I feel that…' to 'We who work here…' in order to effectively measure shared perceptions.

Previous studies have attempted to develop and utilise brief versions of the NOSACQ for research purposes. Forsell et al. (2017) examined safety climate within the Swedish merchant fleet using a 12-item version of the NOSACQ. Items selected for this measure were drawn from the original seven dimensions; however, five of the dimensions were only represented by one item, and five items were taken from a single dimension – "Management Safety Priority, Commitment and Competence". The items selected for the NOSACQ-12 were then grouped to represent two components of safety climate, namely "Management Safety Priority" and "General Security Climate" rather than the seven areas originally identified by Kines et al. (2011), thus reducing the measure's diagnostic value. Similarly, Ajslev et al. (2017; 2018) used a five-item version of the NOSACQ, assessing both management and worker level safety climate. The items selected for this measure came from four of the original seven NOSACQ dimensions and included two items from the "Management Safety Priority, Commitment and Competence" and a single item from the "Management Safety Empowerment", "Workers' Safety Commitment", and "Workers' Safety Priority and Risk Non-Acceptance" dimensions. Hence, despite being developed for practical use, neither the five nor twelve item versions of the NOSACQ examine the seven core components of work safety climate outlined by Kines et al. (2011). It is argued in this thesis that an effective practical brief safety climate measure derived from the

NOSACQ-50 should, if possible, represent each of the original seven dimensions, thus retaining to some extent its diagnostic value.

The NOSACQ-50 has been widely administered across numerous studies and industries, and its translation into over 40 languages indicates that the measure has gained considerable acceptance among researchers and practitioners (Strauch, 2015). Each of the different language versions of the NOSACQ-50 also give the opportunity for participants to provide qualitative responses, for example, the English version of the survey ends with the statement "If you wish to elaborate on some of your answers, or if you have any comments regarding the study, you are welcome to write them here". The 50-item measure was also one of the 18 deemed satisfactory in a review of 206 safety climate measures by Vu and De Cieri (2015a). Another primary benefit of the NOSACQ is that is has been used previously to identify safety problems and assess the effectiveness of workplace safety interventions designed to remediate those safety problems (Kirby et al., 2014). Similarly, while not a widely reported or commonly assessed dimension, the management safety justice dimension adds significant value to an assessment of work safety climate. This can relate back to one of the earliest conceptualisations of safety culture (previously mentioned in section 1.3.1.4), wherein Reason (1997) proposed that effective organisational safety was reliant on a just culture that rewards employees for providing safety-related information. Kines et al. (2011) extend this and argue that just treatment and procedures as they relate to reports of accidents and near-misses may positively influence safety responsibility and safety behaviours. If employees do not feel comfortable reporting safety concerns, then they may be more likely to try and cover up mistakes or underreport near-misses, resulting in inaccurate safety information and a potential increase in unsafe or risky behaviours. Lastly, the NOSACQ-50 has a regularly updated international benchmarking database, which as of January, 2022 includes responses from 63,531 workers and 18,823 managers across six continents, 575 work sites, and 37 industrial sectors. If a brief version of the NOSACQ can also utilise the NOSACQ benchmarking database, particularly in terms of the norms for the seven dimensions, safety researchers and

practitioners may be able to share safety best practice in order to improve broader safety outcomes across industries.

1.7.1 NOSACQ-50 Summary

The NOSACQ-50 was deemed an appropriate basis from which to produce a brief, statistically acceptable and practically focussed measure for work safety climate. The intention of an abridged NOSACQ was not to replace the original, but instead to draw on the various benefits of brief measures outlined in section 1.6. In research, a brief overall measure of work safety climate may be beneficial when included as part of a wider test battery or assessment examining safety climate with additional outcome variables. In practice, such a measure, if retaining some diagnostic capability, would allow organisations to consistently and proactively monitor safety climate without undue burden on employees, allowing for the identification and remediation of emerging safety concerns before they reach a critical stage. Identified areas of concern might be further investigated using relevant parts of the full NOSACQ or the full measure may still be used for a more a comprehensive safety assessment if safety issues have become critical. A brief safety climate measure will further benefit safety researchers and practitioners by providing a means of assessing the effectiveness of implemented safety solutions and adding to the literature on best practice for safety interventions. Finally, a brief safety climate measure that is regularly used for monitoring would assist in maintaining a positive work safety climate once it has been established.

1.8 Implementing Effective Organisational Change

Measures of work safety climate, such as the NOSACQ-50, have been successfully used to identify workplace safety issues requiring remediation. The brief version of the NOSACQ proposed in this thesis aims to retain as much of the structural integrity and acuity of the full NOSACQ as possible in order to effectively identify safety issues requiring intervention. While identifying safety issues is the first step in reducing negative safety outcomes, implementing solutions to safety concerns is the second, and assessing the effectiveness of these interventions is the third. However, successful

implementation of work safety initiatives requires consideration of the factors that act as change facilitators or barriers to the change process.

1.8.1 Barriers to Successful Organisational Change Initiatives

Contemporary organisations are faced with the need to change operational processes and procedures on an increasingly regular basis, with Bareil et al. (2007) reporting that 46% of organisations are undergoing three or more complex changes at any one time. However, while change initiatives are occurring frequently many fail altogether, with change failure rates of 70% reported (Hallencreuttz & Turner, 2011; Vakola, 2013). Recent research by Stouten et al. (2018) reported that executive level employees believe only one in three organisational change interventions are successful. Furthermore, research also indicates that for successfully implemented changes, 75% actually fail to achieve their original goal (Hallencreutz & Turner, 2011; Nikolaou et al., 2007). Various factors are considered as contributing to the failure of change initiatives, including factors associated with the organisational context (e.g., low stakeholder engagement or ownership, high levels of organisational change) and also factors associated with the change management process (e.g., lack of steering committees, failure to undertake adequate planning) (Biggs et al, 2014). Importantly, failure to successfully implement change initiatives also risks loss of stakeholder support for future changes (Gruen et al., 2008).

1.8.2 Critical Success Factors for Changes

Successful implementation of organisational change also requires consideration of the key facilitating factors. Four key factors associated with successful change have been identified and supported within the change management literature. These factors include: the perceived change capability of the organisation, top management overt support for the change, the use of champions of change to facilitate changes and remove obstacles, and worker buy-in and ownership of the change.

It has been demonstrated that workers are more likely to support a change if they feel it is necessary, appropriate and that it will improve their daily lives (Holt et al., 2007). It has additionally

been shown that previous negative experiences with change are likely to increase resistance to future change (Bordina et al., 2011; Fuchs & Prouska, 2014). This concept is grounded in the unfreezing, moving, and freezing model proposed by Lewin (1947). Therefore, examining employee perceptions of their organisation's overall change capability may reflect consideration of any important factors relevant to the organisation's capacity to implement changes. Additionally, assessing how workers perceive the overall capability of their organisation to implement procedural improvements based on their previous experience is crucial for understanding whether future changes will garner support or resistance. Hence, examining employee perceptions of their organisation's overall change capability is supported in the change management literature (Borges & Quintas, 2020). As stated by Chrusciel and Field (2006, p. 505) in their analysis of critical success factors for organisational change "the need to address the staff person's perception of the organization's ability to deal with change" is paramount to success.

Top management support has been argued by some to be the single most important critical success factor when implementing an organisational change (Young & Jordan, 2007), and Stouten et al. (2018) reported that effective communication from management can reduce resistant behaviours by up to 43%. This concept aligns with the broader climate perspective, in that if top management are shown to support change, employees may be more likely to engage in change processes with the hope of being rewarded. By the same token, it has been suggested that if changes are initiated by supervisors or line managers, but do not have the appropriate support or resourcing available from top management, the change is unlikely to maintain momentum or proceed (Kirby et al., 2017).

Champions of change represent individuals from within an organisation who are selected to advocate for, and remove barriers to, organisational change (Ginsberg & Abrahamson, 1991). These champions may comprise individuals or committees specially designated to support change initiatives, and act as driving forces by rallying workers to comply (Kirby et al., 2014). As existing members of their respective organisations, champions of change are able to deliver positive messages of change through internal networks. Champions of change may also act as the voice of the workers when

discussing change with higher levels of management, hence they play a crucial role in developing support for and helping to successfully implement change initiatives.

Change is deemed more likely to succeed when workers buy-in to change and play an active role in the process (Kirby et al., 2014). Buy-in can be established through collaborative and consultative practices in the pre-implementation stage of the change cycle. By allowing workers to share their questions or concerns with those responsible for change, organisations can increase the feeling of control their employees have over change. As stated by Choi and Ruona (2011, p. 49) "individuals are not passive recipients of organizational change but actors who actively interpret and respond to what is happening in their environments", hence consulting with workers and garnering buy-in to the change process is critical for successful change to occur.

Previous applied research by Kirby et al. (2014) used the three critical change factors for implementing organisational change that have been identified in the change literature in order to help ensure the successful implementation of interventions designed to remediate identified critical safety concerns. The three critical change factors identified were: (1) overt top management support; (2) designation of 'champions of change'; and (3) worker empowerment and buy-in. This thesis proposes that a fourth factor, overall change capability, is also important in order to understand employee perceptions of their organisation's ability to implement changes successfully.

It is proposed that a brief reliable and validated supplementary measure for overall change capability, top management support, champions of change, and worker buy-in to accompany organisational assessments may benefit both safety researchers and practitioners. In combination with a brief, reliable and valid measure for monitoring work safety climate, organisations would be able to identify areas of strength and/or needs for development of procedures for implementing safety-related changes that can maximise support for, and reduce resistance to required change initiatives. In addition to the use for regular safety climate monitoring, organisations could further use the brief work safety climate measure to assess the effectiveness of implemented solutions based on the differences in safety climate scores pre- and post-intervention. In addition to the use of a brief

change capability measure with a brief work safety climate measure to ensure the success of implemented safety interventions, the brief change capability measure could also be used, due to its general nature, to assess and monitor an organisation's capability to implement any needed change. Combining brief measures of work safety climate and change capability could then encourage the sharing of best practices for identifying and successfully remediating safety concerns and for improving safety climate.

1.8.3 Organisational Change Summary

Through effective use of the identified critical change capability factors, Kirby et al. (2014) were able to demonstrate significant and effective workplace changes resulting in an increase in perceptions of work safety climate and in measures of relevant mental and physical health outcomes. Thus, a brief, supplementary measure to assess the three critical change factors used by Kirby et al. (2014) and the overall change capability of the organisation could prove valuable for safety management practices. Such a measure could be included as part of existing organisational surveys or pulse measures, or in combination with safety climate assessments in order to improve the effectiveness of implemented remediation strategies.

1.9 Research Aims and Overview

The overall aim of this thesis is to develop a brief, reliable, valid and practically useful multi-level and cross-industry measure of work safety climate, incorporating some practical design elements that have largely been missing within the research literature, such as readability and engagement with safety practitioners. The purpose of a brief measure of work safety climate is to enable and encourage efficient regular monitoring from organisations in order to identify and remediate emerging safety concerns before they reach a critical stage, and to ensure the maintenance of a positive work safety climate once it has been established. Using a combination of theory-driven and methodologically sound practices the reliability, various forms of validity, measurement equivalence and practical application of the measure were assessed. A similar process was then applied to a 4-item

supplementary measure assessing the critical components for successful organisational implementation of interventions to improve work safety.

Four studies are reported in this thesis, three explore hypotheses that contribute to the overall research goal of developing a brief safety climate measure and the fourth study reports on the development of a supplementary measure for use in conjunction with the brief safety climate measure to assess organisational capability for change when implementing initiatives to address identified safety issues.

1.9.1 Study 1 Research Aims: The Development of a Brief and Practical Work Safety Climate Measure

The first study aimed to develop the brief version of the NOSACQ-50 that could be used for regular safety monitoring but that was also comprehensive enough for identifying and remediating safety concerns. In order to reduce the full 50-item NOSACQ and obtain a brief version, a novel approach was utilised that combined traditional statistical item reduction methods (i.e., exploratory factor analysis and classical test theory) in combination with methods designed to identify the most practically useful items for inclusion in a cross-industry safety climate measure. These practical usefulness methods included individual assessment of NOSACQ questionnaire items by both safety researchers and safety practitioners from a range of industry sectors and readability was assessed for individual NOSACQ items to ensure that items in the brief version were readily understandable by most workers. In addition to addressing the aim of identifying items for a brief NOSACQ version, this study aimed to demonstrate a procedurally sound and practically efficient item reduction method that considers both statistical findings and methods that enhance the practical usefulness of measures for use in applied environments. Findings for Study 1 are presented in Chapter 2.

1.9.2 Study 2 Research Aims: The Validity and Measurement Equivalence of a Brief Safety Climate Questionnaire across Casual and Permanent Workers

Having identified 24 items for inclusion in the brief NOSACQ version in Study 1, the second study aimed to investigate the validity (construct, external, and concurrent validity) and measurement equivalence of the NOSACQ-24, in addition to investigating whether the existing NOSACQ safety climate benchmarks could be utilised with the brief version. Confirmatory factor analysis was used to confirm the fit of the NOSACQ-24 to the seven-dimension model of the full NOSACQ, correlations with health and wellbeing outcome measures, and paired samples t-test comparison of the full and brief versions were used with two separate samples to investigate validity, measurement equivalence, and benchmarking capabilities of the brief NOSACQ developed in the first study. Findings for Study 2 are presented in Chapter 3.

1.9.3 Study 3 Research Aims: Safety Climate across Worker and Job Characteristics: An Investigation of Safety Subcultures

Study three extended the NOSACQ-24 validity investigations undertaken in Studies 1 and 2 and examined the acuity of the NOSACQ-24 for identifying safety subcultures associated with various demographic and job-related variables. Whilst safety climate measurement tools can provide organisations with a valuable perspective to predict worker safety attitudes and behaviours, the presence of safety climate differences amongst groups within the same organisation have been found to have important implications for the effectiveness of implemented safety interventions. The capacity to identify such subcultures has been demonstrated for the NOSACQ-50, and this third study aimed to examine whether the NOSACQ-24 retained this ability, a finding that would indicate further validation of the brief version of the NOSACQ for practical purposes. Findings for Study 3 are presented in Chapter 4.

1.9.4 Study 4 Research Aims: A Brief Supplementary Measure of Organisational Change Capability Factors to Accompany Work Safety Climate Assessments and Facilitate Remedial Interventions

The previous three studies addressed the development and validation of a brief version of the NOSACQ that was brief enough to be used for regular work safety climate monitoring but that retained sufficient detail to be able to inform interventions to remediate safety concerns. However, the research literature concerning the low success rates of implemented organisational changes has shown that the success of implemented interventions also requires consideration of the change capability of an organisation. In order to enhance the effectiveness of any implemented interventions developed following use of the safety climate measure, a 4-item *change capability* supplementary scale that could accompany the NOSACQ-24 was developed and evaluated in this fourth study. A mixed methodology approach was utilised to validate the change capability measure using qualitative and quantitative responses. Findings for Study 4 are presented in Chapter 5.

Chapter 2: The Development of a Brief and Practical Work Safety Climate Measure

2.1 Statement of Authorship

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Denvar Summers, first author, PhD Candidate

This paper reports on original research conducted by Denvar Summers during the period of his Higher Degree by Research candidature and is not subject to any obligations of contractual agreements with a third party that would constrain its inclusion in this thesis. He is the primary author of this paper. He was responsible for the conception of this study, literature review, developing the research aims and hypotheses and data analyses; and wrote the original manuscript. Mr Summers was the first author and corresponding author for the manuscript and was primarily responsible for revisions to the paper. His overall percentage of contribution to the paper is 80%.

Dr Aspa Sarris, Dr Neil Kirby and Dr Julia Harries were the supervisors and/or contributors of the research program to which this manuscript belongs. They collaborated with Mr Denvar Summers on the development of the content and structure of the manuscript and assisted with editing and proof reading. Mr Summers was responsible for the conceptualisation of the research aims and hypotheses, literature review, statistical analysis and write-up of this manuscript. Their role was to discuss the feasibility of his research proposals, provide support and assistance when he encountered difficulties and to provide feedback and editing on manuscript drafts. They give permission for this paper to be incorporated in Mr Summers' submission for the degree of Doctor of Philosophy from the University of Adelaide.

Statement of Authorship

Title of Paper	The development of a brief and practical work safety climate measure
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Principal Author

Name of Principal Author (Candidate)	Denvar Summers
Contribution to the Paper	Performed analyses on all samples, interpreted data, wrote manuscript, and acted as corresponding author.
Overall percentage (%)	80%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature	Date 27/05/2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate to include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author FNR	Aspa Sarris
Contribution to the Paper	Supervised development of work, helped in manuscript evaluation. As we are unable to reach Aspa Sarris at this time, principal supervisor Neil Kirby and co-supervisor Julia Harries have accepted the proposed Statement of Authorship and hence Neil Kirby will sign as outlined in the FAQs for HDR Submission with Publications
Signature	Date 7/6/2022

Name of Co-Author	Julia Harries
Contribution to the Paper	Helped in data collection, data interpretation, editing and evaluation of manuscript.
Signature	Date 7/6/2022.

Please cut and paste additional co-author panels here as required.

2.2 Preamble

The central aim of this first study was to develop a brief and practical measure for work safety climate that was sufficiently brief to enable regular safety surveillance but that was also comprehensive enough for identifying and remediating safety concerns. Important features of this brief measure included consideration of safety climate as a multilevel construct and that it was applicable across industry sectors. An existing reliable and valid measure for work safety climate, the 50-item Nordic Occupational Safety Climate Questionnaire (NOSACQ-50) was utilised as the basis of the brief measure. Reasons for selecting the NOSACQ-50 included that it assessed perceptions of both management and co-worker safety attitudes and behaviours, it has been translated into 40 languages, and has a regularly updated international database for benchmarking safety climate across multiple industry sectors.

In order to develop a brief measure of the NOSACQ that retained the structural integrity and diagnostic capabilities of the full version, a novel item reduction approach was utilised that combined statistical best practice item reduction or retention procedures and methods to enhance the practical usefulness of the tool. These methods included expert opinion responses from safety researchers and safety practitioners from a range of industry sectors regarding items they deemed most valuable, correlations with health and wellbeing outcome measures, and readability assessments. Drawing on statistical and practical methodologies, and item reduction research, a 24-item version of the NOSACQ was proposed. NOSACQ survey responses from disability support workers and employees from a large hospitality organisation were examined in order to assess the reliability, validity and factor structure of the proposed brief measure.

This study was intended to examine the effectiveness of a novel approach to item reduction that incorporates practical elements rather than purely statistical measures. The proposed measure was found to be comparable with the original version, thereby enabling the more comprehensive measure to be used for more detailed analysis of safety issues identified by the brief measure if indicated and providing support for this item reduction approach. Both safety researchers and

practitioners may benefit from use of the measure proposed in this study in order to more effectively monitor or measure safety climate and remediate identified safety concerns.

2.3 Abstract

Background: Safety climate represents employees' shared perceptions of the value an organisation places on safety. Frequently safety climate measures are lengthy to comprehensively assess critical work safety factors, which makes their completion time consuming, particularly when used in conjunction with other work or performance measures. Consequently, organisations only employ such measures during safety crises, compromising their usefulness as a leading work safety indicator for identifying and remediating emerging safety issues before they become critical. **Objective:** This study used statistical and practical methodological procedures to develop a brief safety climate measure for the regular monitoring and remediation of safety issues. **Method:** An existing comprehensive and valid work safety climate measure (Nordic Occupational Safety Climate Questionnaire [NOSACQ-50]), was administered to disability support workers (N = 366) and hospitality employees (N = 111). Appropriate statistical procedures and practical usefulness measures including expert opinions of work health and safety researchers (N = 5) and practitioners (N = 14), correlations with physical and mental health measures, and item readability contributed to the selection of the most reliable and practically useful items for the brief measure. **Results:** Utilising statistical and practical usefulness methods, a brief 24-item safety climate questionnaire was developed. **Conclusion:** Study results support the usefulness of this brief 24-item work safety climate measure for both practice and research purposes. The study also demonstrated a procedurally sound and practically efficient item reduction method that considers both statistical findings and methods that enhance the practical usefulness of the measure in applied environments.

Keywords: NOSACQ, Safety assessment, Leading safety indicator

2.4 Introduction

Safety climate (Zohar, 1980) is understood as employees' shared perceptions of management and workgroup policies, practices, and procedures as they relate to workplace safety (Kines et al., 2011). Conceptually related but distinct from safety culture (Shea et al., 2021), a substantial body of research supports the relationship between a positive safety climate and favourable safety outcomes. These include safety commitment and compliance (Ajslev et al., 2017; Barbaranelli et al., 2015), safety participation (Beus et al., 2016; Griffin & Neal, 2000), safety motivation (Beus et al., 2016; Neal & Griffin, 2006), mindful safety practices (Dahl & Kongsvik, 2018), and self-reported safety behaviours (Pousette et al., 2008). Meta-analytic studies consistently demonstrate a direct, positive relationship between safety climate and safety-related behaviour and a negative association between safety climate and safety incidents at both the group and individual level (Beus et al., 2019; Christian et al., 2009). As a leading indicator, safety climate is useful as a predictor of safety outcomes when compared to traditional lagging indicators such as accident rates, lost time, and fatalities (Givehchi et al., 2017; Seo et al., 2004).

Although numerous safety climate measures have been developed, methodological issues such as unclear operationalisation of key terms such as 'safety climate' or 'injuries', content deficiency, and limited applicability affect their overall application and practicality (Beus et al., 2019). Similarly, despite the increasing use of big data for safety management decisions (see Wang & Wang, 2021 for a comprehensive review), the understanding of temporally specific perceptions of safety will remain important for many organisations, particularly those with fewer employees, and those without the technological capabilities for big data analysis, such as cloud computing and the development of machine learning algorithms. Regardless, a widely accepted, brief safety climate measure that can be implemented regularly for monitoring purposes could, if shared, further contribute to existing databases of safety big data (Ouyang et al., 2018).

A review by Vu and De Cieri (2015) found that of over 200 publicly available work safety climate measures, only 18 were considered satisfactory. Criteria used for identifying a satisfactory

measure included item development methods, internal consistency (α >0.7), and construct validation. Of the measures reviewed by Vu and De Cieri, the Nordic Occupational Safety Climate Questionnaire (NOSACQ; Kines et al., 2011) was one of the most satisfactory. Unlike the majority of other satisfactory measures reviewed that were only management focussed, the NOSACQ is a 50-item scale that measures three management and four worker focussed safety climate dimensions. This management and worker-level structure is consistent with Zohar's (2000) conceptualisation of safety climate encompassing organisation-level safety climate arising from worker perceptions of managements' safety policies and procedures, and workgroup-level safety climate from perceptions of safety practices utilised to implement safety policies and procedures within workgroups.

The NOSACQ has demonstrated acceptable reliability and validity across numerous studies (The National Research Centre for Work Environment, 2022b; 2022c), it has applicability across industry sectors, and has been translated into 40 languages, adding to its acceptance as an appropriate measure (Strauch, 2015). Guldenmund (2000) suggested that the variety of safety climate scales currently available makes benchmarking safety climate data difficult; however, NOSACQ has a large and regularly updated international benchmarking database for various organisational-types and industry sectors.

A practical problem with most work safety climate measures, including the 50-item NOSACQ, is that to be comprehensive they consist of a large number of items. Although useful for diagnosing a work safety crisis, completion time represents a response burden for participants (Nielsen et al., 2016). A meta-analysis by Rolstad et al. (2011) showed that greater response burden due to questionnaire length is negatively associated with response rates. Related to this, time taken to implement safety climate measures can be a deterrent for organisations, who therefore only implement the measures diagnostically rather than proactively to monitor safety conditions and identify emerging safety issues before they become critical (Flin, 1998). O'Connor et al. (2011) argue that using long questionnaires also increases the possibility of non-random measurement errors when collecting safety climate data; and it has been suggested that motivation to participate will be higher

if questionnaires are quick and easy to complete (Krosnick & Presser, 2010). Accordingly, it would be useful for monitoring purposes if a brief safety climate measure could be created by selecting relatively few but critical items from an existing comprehensive measure as this would support its validity and allow the more comprehensive measure to be used for more detailed analysis of safety issues identified by the brief measure when required.

A brief work safety climate measure requiring reduced administration time would not only allow regular monitoring to identify emerging safety issues for remediation before they become critical, but it would also benefit research by allowing a work safety climate measure to be included in a battery of other measures without unduly increasing the response burden. However, to maintain the validity and reliability of the original measure from which a brief measure was derived, detailed methodological guidelines need to be followed. Goetz et al. (2013) propose six objectives when shortening composite measurement scales: (1) Document the original scale validity and the shortening objective; (2) Consider the conceptual model; (3) Preserve content validity; (4) Preserve psychometric properties; (5) Document the justification for item retention; and (6) Validate the short-form measure in an independent sample. The objectives outlined by Goetz et al. highlight one of the only attempts to structure and improve the methodology of developing brief versions of more comprehensive measurement scales.

Considering that large safety climate inventories pose issues related to time constraints in research and practical settings, this study aimed to use the guidelines provided by Goetz et al. (2013) as a basis for developing a brief work safety climate measure from an existing comprehensive instrument using both traditionally applied statistical approaches, and additional selection approaches to augment the practical usefulness of the measure. The NOSACQ-50 was selected for this purpose from other existing measures as it was identified as a satisfactory measure (Vu and De Cieri, 2015), it is not an industry-specific measure, it has been widely translated into other languages, has a benchmarking database that allows organisations to compare their safety climate levels with others

from similar industry types, and it has been used successfully in previous studies to identify and remediate work safety issues (Kirby et al., 2014).

The potential to shorten the NOSACQ has been recognised by others. Previous studies that have utilised brief versions of the NOSACQ-50 include Ajslev et al. (2017; 2018) who employed a five-item abridgement that they considered indicative of primary safety climate themes identified in the literature, namely, managerial and employee safety commitment, participation and engagement. However, the five items cover only four of the seven NOSACQ-50 dimensions. Similarly, Forsell et al. (2017) employed a validated 12-item NOSACQ version in their safety climate study involving the Swedish merchant fleet. Items selected represented the original seven-dimension NOSACQ-50 structure; however, five of the seven dimensions were only represented by one item and five items were drawn from the Management Safety Priority, Commitment and Competence dimension. While this brief NOSACQ version may be suitable in a battery of measures for research purposes, as was the case in the study undertaken by Forsell et al. (2017), a measure for regular monitoring may be more practically useful if it covers all seven of the existing NOSACQ-50 dimensions and retains more than one item of each of the dimensions. Thus, while this brief measure may be appropriate for research purposes in a larger survey, the goal of regular safety climate monitoring would arguably be best achieved by representing each of the seven original NOSACQ-50 dimensions equally, with at least several items so that the full scale versions of particular dimensions could be used to further investigate problems identified in the items used from one or more of those dimensions.

Traditionally, item reduction techniques for developing a brief measure would be psychometric, with reliance on statistical results for item selection (Rolstad et al., 2011). Although some studies have used safety climate researchers to provide a theoretical base for item selection (e.g., Beus et al., 2019; Kines et al., 2011) and to ensure that critical values and behaviours are assessed, rarely (if ever) are practitioners consulted. To ensure that the most practically and theoretically useful items are selected for safety climate evaluation, traditional item selection statistical methods (i.e., factor analyses, reliability analyses) need to be augmented by both work

safety climate researcher and practitioner opinions (e.g., Work Health and Safety advisors or safety officers) from a range of different organisations. To further maintain the functionality, usefulness and content validity of the comprehensive version in a brief version, additional practical methods such as retaining levels of readability, and relationships to important dependent measures such as health and wellbeing also need to be considered.

Thus, this study aims to develop a brief, practical and general safety climate measure (i.e., non-industry-specific) using a combination of both statistical and practical analyses. A brief measure of this kind that is comprehensive enough to be used for monitoring and identifying specific emerging safety issues, and that allows for industry benchmarking may aid in facilitating a consensus for what could be considered best work safety practice (Pather, 2014).

2.5 Materials and Method

2.5.1 Participants

Three participants groups provided information for this research:

Safety researchers*:* Five safety researchers (three with PhDs and two with Honours degrees) from the University of Adelaide independently reviewed the NOSACQ items to identify items suitable for inclusion in a brief measure based on their work safety research experience. The safety researchers ranked each item using an electronic format.

Safety practitioners*:* Fourteen safety practitioners from different types of organisations within Australia were surveyed to identify the practically useful safety climate items for their particular organisation/industry for inclusion in a brief measure. The job roles of these participants included human resource managers/coordinators (n = 7), work health and safety representatives (n = 4), and work safety advisors (n = 3). Participants were recruited through advertisements placed on the National Safety Council of Australia online network and in the Australian Institute of Health and Safety eNewsletter. The survey was distributed to all practitioners who responded to the advertisement

indicating their interest in participating. Safety practitioners responded using either physical pen and paper surveys, or electronic online surveys, depending on preference.

Participants (10 male, 4 female) had a mean age of 47 years (SD = 8.95), averaged 19 years of work health and safety experience (SD = 8.95), and had educational backgrounds ranging from technical qualifications (e.g., Certificate IV in Work Health and Safety; n = 7) to tertiary qualifications (e.g., Graduate Diplomas, Masters Degrees, and PhDs; n = 7). Using the Australian Bureau of Statistics (ABS) classification of organisation size, participants represented small (n = 1), medium (n = 3), and large (n = 10) organisations. Of the 19 industry-types identified by the ABS (Trewin & Pink, 2006), 12 were represented: Agriculture, Forestry and Fishing; Mining; Manufacturing; Construction; Wholesale Trade; Retail Trade; Transport, Postal and Warehousing; Professional, Scientific and Technical Services; Public Administration and Safety; Education and Training; Health Care and Social Assistance; and Other Services (such as not-for-profits). Thus, a diverse range of work safety expertise contributed to development of the brief measure.

NOSACQ Respondents*:* Existing data from 477 participants (213 male, 260 female, 4 unspecified) with a mean age of 45.71 years (SD = 12.36) contributed to the statistical analysis portion of the project (366 Disability Support Workers [DSWs] and 111 Hospitality employees). Disability support work carries significant safety risks for employees, including repetitive strain injuries from heavy lifting, slips and falls due to hazards, muscle stress due to workload, as well as many psychosocial injury risks such as threats of violence from clients (SafeWork SA, 2021a). Hospitality work also carries safety risks such as muscular and musculoskeletal trauma, slipping hazards, fatigue, and cuts and burns, and also psychosocial risks such as violence, harassment and bullying (SafeWork SA, 2021b). Mean employment length was 9.09 years (SD = 8.95) for DSWs and 10.43 years (SD = 8.93) for hospitality employees. The DSW NOSACQ data were made available from a commissioned research study for SafeWork SA (Kirby et al., 2014) and the hospitality NOSACQ data came from a study by Heffernan et

al. (2018). DSW data were collected using pen and paper methods, and hospitality data were collected using electronic online methods.

2.5.2 Measures

Work Safety Researcher and Practitioner Questionnaire: Safety researchers and practitioners were provided with NOSACQ-50 items and asked to "…rank the [NOSACQ] questions within each dimension according to their importance for assessing work safety attitudes and behaviours". Practitioners had the words "…in your type of organisation" included. A ranking example was provided. Practitioners were additionally asked two open-ended questions: "Are there any comments you would like to make about your rankings of the above safety climate items?" and "Are there any areas of safety that are important for the industry sector that you work in that were not included in the above list of safety items?".

Nordic Occupational Safety Climate Questionnaire (NOSACQ-50): The DSWs and hospitality worker respondents each rated their workplace safety climate using the 50-item NOSACQ. The NOSACQ measures seven safety climate dimensions: (1) Management Safety Priority, Commitment and Competence; (2) Management Safety Empowerment; (3) Management Safety Justice; (4) Workers' Safety Commitment; (5) Workers' Safety Priority and Risk Non-Acceptance; (6) Safety Communication, Learning, and Trust in Co-Worker Safety Competence; and (7) Workers' Trust in the Efficacy of Safety Systems. The measure utilises a 4-point Likert response (Strongly Agree, Agree, Disagree, Strongly Disagree) and employs positively (n = 29) and negatively (n = 21) worded questions. The NOSACQ-50 has consistently shown reliable and valid results across the research literature, and has an international benchmarking database of 57,270 workers and 17,098 leaders. According to the NOSACQ official interpretation guide, an average overall score of more than 3.30 out of four indicates a good safety climate level allowing for maintaining and continuing developments. A score of 3.00 to 3.30 indicates a fairly good safety climate level with slight need of improvement. A score of 2.70 to 2.99 shows a fairly low safety climate level with need of improvement, and a score below 2.70

indicates a low safety climate level with great need of improvement. Appendix shows the full scale NOSACQ-50.

Health and Wellbeing Outcome Measures: In addition to the NOSACQ respondent data available from the DSW study by Kirby et al. (2014) and the study of hospitability workers by Heffernan et al. (2018), data for two health and wellbeing self-report measures were also available to examine the validity of the brief version of the NOSACQ compared with the full version. These measures were the Copenhagen Burnout Inventory (CBI; Kristensen et al., 2005) and the SF-8 Health Survey (Ware et al., 2000).

The 19-item CBI contains three scales that measure personal, work-related, and client-related burnout. Higher scores on the CBI scales represent higher levels of reported burnout. All three scales have shown high internal reliability, have differentiated well between occupational settings, and have been shown to predict future job outcomes including job absence and intention to quit (Kristensen et al., 2005). CBI responses were available for the DSWs and hospitality workers.

The SF-8 contains eight physical and mental health items covering general health, physical functioning, role physical (extent that physical health impacts work), bodily pain, vitality, social functioning, mental health, and role emotional (extent that emotional/mental health impacts work). These measures produce a score of general physical health and general mental health, with higher scores representing better health. The measure has been shown to be effective in monitoring the health of large-scale populations in outcome studies (Yiengprugsawan et al., 2014). SF-8 responses were only available for the DSWs.

2.5.3 Data Analysis

A priori power analysis was conducted using G*Power (3.1.9.7) to compute required sample sizes using a 0.80 power level and $\alpha = .05$ significance criterion to detect a medium effect size ($d = 0.3$), with results showing appropriate sample sizes for all planned analyses. Normality of measures was investigated visually and using z-score calculations of skewness and kurtosis. Due to skewed

distribution (12 measures), bootstrapping (using the bias-corrected and accelerated method with 2000 iterations) was used to calculate confidence intervals for descriptive statistics and to confirm parametric findings.

With respect to sample size for Factor Analysis, the literature supports the current sample as adequate based on minimum sample size of N = 100-150 (Tabachnik & Fidell, 2001) or N = 200 (Kline, 2005), and numbers of observed variables using a ratio of five cases per variable when latent variables have multiple indicators (Bentler & Chou, 1987), which in this case is 5*50 = 250.

2.5.4 Ethics

Ethical approval for this research was obtained through the University of Adelaide: Human Research Ethics Subcommittee (Code number: 19/61).

2.5.5 Procedure

Two approaches were used to reduce the 50-item NOSACQ to a brief version and these involved traditional statistical item reduction procedures and additional practical item reduction approaches.

The statistical item reduction procedures and inclusion and/or exclusion criteria included:

1. Exploratory Factor Analysis (EFA) undertaken using principal components extraction employing an oblique rotation (as correlated factors were expected based on extant theory). Following the advice of Watkins (2018), the pattern coefficients were the first focus in the analysis. According to Bandalos and Gerstner (2016) the practical usefulness of pattern coefficients ranges from 0.30 to 0.40; as a result, coefficients with an absolute value below 0.35 were suppressed. Items that fell below the 0.35 cut-off, items that loaded across more than one factor, or items that did not show unipolar loadings were considered for removal. Structure coefficients were also reviewed to evaluate consistency. Following the advice of Norman and Streiner (2014) the communalities table was examined and items with values less

than .50 were considered for removal. Items that failed to load on any factor or loaded outside of the expected pattern were investigated and considered for removal.

2. Reliability analysis (using Cronbach's Alpha) undertaken to determine how dimension reliability would change with the removal of individual items from the scale. The aim was to identify items whose removal resulted in higher dimension reliability; these items were considered for removal.

Practical item reduction procedures and inclusion and/or exclusion criteria included:

1. Determining NOSACQ-50 item readability utilising the Flesch-Kincaid Grade level, which was considered important for obtaining valid data in industries that have a higher risk of safety incidents (e.g., construction, manufacturing) with workers having lower educational requirements and/or who speak English as a second language. For reference, a Flesch-Kincaid Grade readability score of 10 requires the reader to have a Year 10 reading level to understand the text. A grade 8.0 reading level is recommended for most scales (Hall et al., 2010).
2. Safety climate researchers independently ranked the safety climate questions within each dimension from most to least important in terms of perceived usefulness for assessing work safety attitudes and behaviours. Items ranked in first, second, or third position were deemed most important; items that were not ranked most important by over 60% (a majority) of the researchers were considered for removal.
3. Work safety practitioners ranked the practical usefulness of items in each of the seven NOSACQ dimensions for assessing work safety in their particular organisation and industry, and also commented on the items and/or identified missing safety areas relevant for their industry. Items not ranked first, second, or third by over 50% of the practitioners were considered for removal. Qualitative responses from the participants were also analysed and utilised for determining item selection criteria.
4. Correlational analyses were conducted between the NOSACQ-50 items and five outcome variables from the CBI (Personal Stress, Work-Related Stress, Client-Related Stress) and the

SF-8 Health Survey (Physical Health and Mental Health). The purpose of these correlations was to identify items that were associated with both physical and mental health and wellbeing to ensure the selected items were practically relevant and that the brief measure remained an effective leading indicator of work safety stress and health related outcomes. Items that did not correlate significantly with at least four of the five outcome variables were considered for removal.

2.6 Results

2.6.1 Statistical Item Reduction Procedures

Table 1 provides the descriptive statistics for the DSW and hospitality worker well-being measures and for the NOSACQ-50 measure that was used for the statistical item reduction procedures. As can be seen there is a sufficient range of responses, without any floor or ceiling effects and thus the data is appropriate for item reduction methods.

Table 1
Descriptive statistics for the Copenhagen Burnout Inventory, SF-8 Health Survey, and NOSACQ-50 for the whole sample (N = 477)

Scales	Range	Mean (SD)
Copenhagen Burnout Inventory (CBI)		
Personal burnout	0-100	42.30 (19.74)
Work-related burnout	0-100	36.62 (20.92)
Client-related burnout	0-95.83	23.51 (20.19)
SF-8 Health Survey		
Physical Health Component Score	19.17-63.72	49.68 (8.56)
Mental Health Component Score	11.35-62.91	48.03 (10.83)
NOSACQ-50		
Management Safety Priority, Commitment and Competence	1.00-4.00	3.00 (0.56)
Management Safety Empowerment	1.00-4.00	2.89 (0.57)
Management Safety Justice	1.00-4.00	2.96 (0.59)
Workers' Safety Commitment	1.83-4.00	3.18 (0.44)
Workers' Safety Priority & Risk Non-Acceptance	1.28-4.00	2.97 (0.49)
Safety Communication, Learning, and Trust in Co-Worker Safety Competence	1.25-4.00	3.15 (0.47)
Workers' Trust in the Efficacy of Safety Systems	1.00-4.00	3.20 (0.46)

Note: CBI scale = 1-100; SF-8 scale = 1-100; NOSACQ-50 scale = 1-4. SF-8 Health Survey data was only available for DSWs.

2.6.1.1 Exploratory Factor Analysis (EFA)

Principal components analysis (N = 374) was employed on the 50-item NOSACQ. Bartlett's test of sphericity was significant (χ_2 (1225) =11127.97, p<.001) indicating that the correlation matrix was not random and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .95, above the suggested .50 cut-off (Norman & Streiner, 2014). Thus the data were suitable for use. Initial extraction identified eight factors with eigenvalues greater than one, although visual scree plot examination suggested either a three-factor (accounting for 47.77% of variance) or five-factor solution (accounting

for 54.12% of variance). In combination with parallel analysis it was determined that the three-factor solution best represented the data. The three factors (shown in Table 2) were categorised as representing (1) Management focussed safety climate; (2) Co-worker focussed safety climate; and (3) Worker Safety Priority and Risk Non-Acceptance. However, it is possible that extraction of this third factor was related to negative item wording with each of the items loading on this factor involving negative wording, although it is worth noting that not all negatively phrased NOSACQ items loaded accordingly. This possible explanation has some support in the research literature wherein various studies have examined the impact negatively worded questions can have on the dimensionality of survey measures (e.g., Chen & Jin, 2020; Molina et al., 2014; Suárez-Alvarez et al., 2018; Zhang et al., 2016). Despite not identifying the seven dimensions identified by Kines et al. (2011), criteria for retaining or removing items from the questionnaire were applied at the dimension level in order to maintain the conceptual structure underlying the original NOSACQ scale as recommended by Goetz et al. (2013), thereby allowing comparison between the original and shortened scale to determine the NOSACQ safety climate benchmarks.

In terms of criteria for retaining or removing items for a brief version, Table 2 shows that two items (items 3 and 5) loaded on more than one factor; both are management items addressing aspects of risk (e.g., item 5: *'Management accepts employees here taking risks when the work schedule is tight'*) and are negatively worded items. Fourteen items (4 management, 10 co-worker items) did not achieve the .50 communality criterion.

Table 2

Pattern Matrix and Communalities for the three-factor solution from Principal Components Analysis with an Oblique Rotation for the NOSACQ-50.

NOSACQ Items		Factor 1 (Eigenvalue = 18.06)	Factor 2 (Eigenvalue = 3.57)	Factor 3 (Eigenvalue = 2.26)	Communalities
Management items	1	0.59			**.55**
	2	0.68			**.55**
	3r	0.35		0.36	.46
	4	0.58			.36
	5r	0.25		0.43	.37
	6	0.80			**.69**
	7	0.80			**.61**
	8r	0.77			**.63**
	9r	0.73			**.68**
	10	0.67			**.63**
	11	0.76			**.68**
	12	0.75			**.55**
	13r	0.58			**.55**
	14	0.74			**.64**
	15r	0.64			.46
	16	0.74			**.57**
	17	0.70			**.54**
	18r	0.57			**.54**
	19	0.70			**.65**
	20	0.76			**.62**
	21r	0.63			**.54**
	22	0.72			**.64**
Co-worker items	23		0.59		.48
	24		0.58		.45
	25r		0.39		**.52**
	26r				.49
	27		0.68		**.54**

28r			.32
29r		0.64	.42
30r		0.68	.49
31r		0.68	**.54**
32r		0.60	**.62**
33	0.36		.24
34r		0.51	.29
35r		0.75	**.61**
36	0.70		**.59**
37	0.75		**.64**
38	0.74		**.70**
39	0.77		**.67**
40	0.78		**.71**
41r			.23
42	0.64		**.60**
43	0.50		**.59**
44			**.53**
45r		0.40	**.52**
46			**.58**
47r			**.58**
48	0.35		.49
49r			**.55**
50			**.55**

Note: Pattern coefficients < 0.35 omitted; Communalities ≥ .50 in bold; r indicates negatively worded (reversed scored) items.

2.6.1.2 Reliability Analysis

Cronbach's Alpha findings showed the internal consistency of the NOSACQ-50 dimensions was generally very good. As shown in Tables 3 and 4, there were only six items whose removal would result in higher dimension reliability, including two management items (items 5 and 18) and four co-worker items (items 26, 33, 34, and 41). These items were from five of the seven dimensions, with no items from the "Management safety empowerment" or the "Workers' trust in the efficacy of safety

systems" dimensions. Of the six identified items, five were negatively worded (items 5, 18, 26, 34, 41) and one could be considered 'reverse oriented', meaning a negative particle has been added to the sentence, although the item is still scored as positive (item 33, *'We who work here never accept risk-taking even if the work schedule is tight'*). It has been demonstrated in previous research that both negative wording, and reverse oriented items increase participant difficulty and can lead to issues with interpretation and reliability (van Sonderen et al., 2013; Swain et al., 2008). This further supports the removal of these items.

2.6.2 Practical Item Reduction Procedures

2.6.2.1 Flesch-Kincaid Grade Reading Levels

NOSACQ-50 reading levels ranged from 2.4 to 24.2 years (M = 10.52 years, SD = 4.99). The mean Flesch-Kincaid Grade of 10.52 exceeded the recommended grade 8 level so a further purpose of this analysis was to ensure the brief version reading level remained similar to the full NOSACQ. Higher reading grade levels were present for management items (M = 14.58 years, SD = 4.36) than co-worker items (M = 7.39 years, SD = 2.59). As shown in Tables 3 and 4, all but three co-worker items (items 40, 44, and 45) met the criterion of a reading grade of less than or equal to 10.5 years whereas all but three management items (items 5, 8, and 20) exceeded this criterion.

2.6.2.2 Safety Climate Researcher Rankings

Researcher agreement on importance rankings ranged from 0-100% for the NOSACQ items. There were two items (items 1 and 20), both management items, that were ranked as most important by all researchers. As indicated in Tables 3 and 4, seventeen of the 50 items were ranked by 60% of researchers as important (i.e., first, second or third) for assessing work safety attitudes and behaviours, including seven (32%) management items and 10 (36%) co-worker items.

2.6.2.3 Work Safety Practitioner Rankings

Practitioner agreement on importance rankings ranged from 0-86%. There was no single item that all 14 safety practitioners ranked as being most important (i.e., ranked first, second, or third by the practitioners), with item 1 the highest-ranking item. Twenty-one items were ranked by 50% of the safety practitioners as important (i.e., first, second or third) for assessing work safety attitudes and behaviours, including nine (41%) management items and 12 (43%) co-worker items (see Tables 3 and 4).

In terms of safety practitioner responses to the open-ended questions "Are there any comments you would like to make about your rankings of the above safety climate questions?" 79% of practitioners (n = 11) provided a response. Responses were grouped into two themes: a preference for positively worded questions (n = 7), and problematic wording of questions (n = 5). Both of these qualitative themes supported decisions to remove negatively worded (e.g., item 5) and reverse oriented (e.g., item 33) items, and preferentially retain positively worded items when suitable alternatives were available. Sixty-four percent of practitioners provided a response to the question "Are there any areas of safety that are important for the industry sector that you work in that were not included in the above list of safety items?". The majority of responses (n = 5) did not highlight any specific safety areas missing, but similar comments were grouped into two themes: items to assist with the identification of mental health issues (n = 2), and desire for benchmarking (n = 2).

2.6.2.4 Correlational Analyses

An examination of the correlations between the individual NOSACQ items and the health and wellbeing measures found the number of significant correlations ranged from 0 – 5 (M = 3.96). All management items correlated significantly with the five health and wellbeing measures except item 13, which did not correlate with the physical health measure. There were three co-worker items that did not correlate significantly with any of the health and wellbeing measures (items 41, 44, and 47)

and 16 (57%) co-worker items that did not meet the criterion of correlating significantly with four of the five health and wellbeing measures (see Tables 3 and 4).

2.6.3 Combining Item Reduction Procedures

Items that met a number of selection criteria (e.g., appropriate and unipolar factor loading, positive impact on dimension reliability, significant correlation with dependent outcome variables, selected as highly important by both researchers and practitioners, and appropriate readability) were considered for retention and are shown in Table 3. Given the study aim of developing a practical measure of work safety climate for monitoring purposes, significant attention was paid to the items deemed most important by safety practitioners as these were seen as the strongest indicators of practical content validity. There was also a specific focus on any items commented on by safety practitioners as problematic in their wording. This criterion was also employed when deciding on which items should be removed (see Table 4). An example of problematic wording identified by the safety practitioners was item 34 “We who work here consider that our work is unsuitable for cowards”. One safety practitioner commented: “I have worked for over a decade in heavy construction in Australia…I’ve honestly never heard anything phrased in terms of ‘cowardice’…it’s a truly odd phrasing/question”. Comments from safety practitioners also highlighted a preference for positively compared to negatively worded questions. Examples include: “Some statements may be better if put in the positive context…” and “…the fact that several of the sections had a group of "positive" and "negative" responses in the same section directed people (me) to naturally put the positive safety comments as a higher ranking than the negative ones”. This resulted in negatively worded questions that were the inverse of positively worded questions being considered for removal; for example, item 45 "We who work here consider that safety rounds/evaluations have no effect on safety” was removed in favour of item 48 “We who work here consider that safety rounds/evaluations help find serious hazards”, given that they were ranked similarly based on statistical and practical criteria, the only discernible difference being the wording.

However, some negatively worded questions were still included in the NOSACQ-24 if they displayed appropriate statistical strength, reliability, readability, and were ranked highly by both researchers and practitioners. An example of this is item 32, “We who work here break safety rules in order to complete work on time”, which although negatively worded, remains statistically acceptable and was ranked highly by 80% of researchers and 50% of practitioners. In these situations, the negatively worded questions were retained rather than attempting to reword them positively.

Table 3

Summary of the statistical and practical item reduction procedures contributing to NOSACQ item retention.

NOSACQ Item Number	Statistical item reduction procedures			Practical item reduction procedures			
	EFA Coefficient (≥ 0.35)	Commun-alities (≥ .50)	Removal Reduced Dimension Reliability	Readability (Flesch Kincaid Grade ≤ 10.5)	Researcher Selected (≥ 60%)	Practitioner Selected (≥ 50%)	Correlation with Outcome Variables (≥ 4/5)
Management items							
1	X	X	X		X	X	X
2	X	X	X				X
4	X		X			X	X
7	X	X	X		X		X
11	X	X	X			X	X
12	X	X	X			X	X
14	X	X	X		X		X
16	X	X	X		X	X	X
17	X	X	X		X	X	X
20	X	X	X	X	X	X	X
22	X	X	X			X	X
Co- worker items							
23	X		X	X	X	X	X
24	X		X	X		X	
27	X	X	X	X	X	X	X
30r			X	X	X	X	X
32r	X	X	X	X	X	X	X
35r		X	X	X	X		X
36	X	X	X	X	X	X	
39	X	X	X	X	X		

40	X	X	X				
43		X	X	X	X	X	X
46	X	X	X	X	X	X	X
48			X	X	X	X	
50	X	X	X	X		X	

Note: X indicates retention criterion met; r indicates negatively worded (reversed scored) items.

Table 4

Summary of the statistical and practical item reduction procedures contributing to NOSACQ item removal.

NOSACQ Item Number	Statistical item reduction procedures			Practical item reduction procedures			
	EFA Coefficient (<.35)	Communalities (<.50)	Removal Improved Dimension Reliability	Readability (Flesch Kincaid Grade >10.5)	Researcher Selected (<60%)	Practitioner Selected (<50%)	Correlation with Outcome Variables (<4/5)
Management items							
3r	X	X		X	X	X	
5r		X	X		X	X	
6				X	X	X	
8r					X	X	
9r				X	X	X	
10				X		X	
13r	X			X	X	X	
15r	X	X		X	X	X	
18r			X	X	X	X	
19				X	X		
21r				X	X	X	
Co- worker items							
25r	X				X	X	X
26r		X	X		X	X	X
28r	X	X			X	X	X
29r		X			X		
31r					X	X	
33		X	X		X		X
34r		X	X		X	X	X
37					X	X	

38						X	X	
41r		X	X			X	X	X
42	X					X	X	X
44					X	X	X	X
45r					X	X	X	X
47r						X	X	X
49r						X	X	X

Note: X indicates removal criterion met; r indicates negatively worded (reversed scored) items.

The difference between this study and others that have attempted to produce shortened composite measures is that once an item was deemed statistically appropriate based on the predetermined cut-offs, more practical item selection techniques were employed. The goal was not to select the most statistically relevant items, it was instead to select the most practically relevant items that were simultaneously statistically appropriate. This process led to seven items, six of which were co-worker items, being selected for the final version of the brief measure that did not fulfil all of the statistical criteria. For example, item 4 ("Management places safety before production") had one of the lower pattern matrix coefficients (although still statistically acceptable) when compared to other items within the same dimension. However, the item was deemed highly practically significant by nine of fourteen safety practitioners.

2.6.4 Comparison of Original and Brief Version

Following the application of the above criteria, a brief NOSACQ-24 version was compiled and is shown in Appendix. This process resulted in the original seven factors being represented with between three and four items compared to the six to nine items in the full NOSACQ-50. In addition to maintaining the dimension structure, the mean readability (Flesch-Kincaid Grade) requirements of the brief measure (~11 years) remained similar to the full NOSACQ (~10.5 years).

Table 5 shows the descriptive statistics for the seven dimensions of the 50 and 24-item NOSACQ versions. With regard to the reliability analysis of the brief version, six of the seven dimensions demonstrate acceptable reliability (>.70), with the seventh-dimension approaching acceptability at .69. Although the brief version showed decreases in almost all of the seven dimensions (excluding Workers' Safety Commitment) this was not unexpected. Under classical testing theory scale reliability is dependent on the number of items, thus, reducing the number of items in a dimension would reduce reliability (Streiner & Normal, 2014).

To assess whether the NOSACQ international benchmarking database could be utilised when employing the shortened NOSACQ-24, the mean scores of the seven original dimensions and the 24-item versions were compared using a paired samples t-tests. Results are shown in Table 5. Although two significant differences were found between the dimension means, there was not a difference in mean score above .07 (using 95% confidence intervals), and all seven dimensions would still be classified in the same NOSACQ safety climate interpretation ranges outlined in the method, supporting the use of existing benchmarking data with the brief NOSACQ-24.

Table 5

Descriptive statistics, Cronbach's alpha values for the seven dimensions of the 50 and 24-item NOSACQ versions and mean comparisons using paired samples t-tests.

NOSACQ Dimensions	50-item NOSACQ			24-item NOSACQ			Paired t-test
	Number of items	Mean (SD)	Cronbach's α	Number of items	Mean (SD)	Cronbach's α	p-value (two-tailed)
Management Safety Priority, Commitment, and Competence	9	3.00 (0.56)	.88	4	3.00 (0.62)	.80	.589
Management Safety Empowerment	7	2.89 (0.57)	.89	4	2.89 (0.60)	.85	.185
Management Safety Justice	6	2.96 (0.59)	.88	3	2.96 (0.61)	.82	.504
Workers' Safety Commitment	6	3.18 (0.44)	.73	3	3.20 (0.50)	.75	.111
Workers' Safety Priority and Risk Non-Acceptance	7	2.97 (0.49)	.75	3	2.99 (0.60)	.69	.095
Safety Communication, Learning, and Trust in Co-Worker Safety Competence	8	3.15 (0.47)	.89	4	3.22 (0.49)	.85	<.001
Workers' Trust in the Efficacy of Safety Systems	7	3.20 (0.46)	.84	3	3.23 (0.48)	.73	.002

Note: NOSACQ-50 scale = 1-4, NOSACQ-24 scale = 1-4.

Finally, the factor structure of the 24-item version was compared to the 50-item NOSACQ using principal components analysis with an oblique rotation. Bartlett's test of sphericity was significant (χ_2 (276) =4981.38, p<.001) indicating that the correlation matrix was not random, and the

KMO statistic (.95) was above the suggested .50 cut-off (Norman & Streiner, 2014). The analysis extracted three factors from the 24-item NOSACQ (accounting for 56% of variance), and these matched the factor structure of the three extracted from the 50-item NOSACQ. Thus, the item reduction had not altered the factor structure of the data which demonstrates the reduced version is measuring the same construct (safety climate) as the full measure. Similar to the factor structure of the full scale, all items within the third factor were negatively worded. This outcome is consistent with Roszkowski and Soven (2010) who reported that as few as two negatively worded questions can be defined as a separate factor, as well as the previously cited research that outlined the detrimental impact negatively worded questions can have on survey measures. Table 6 shows the pattern matrix for the reduced measure.

Table 6

Pattern Matrix Component Structure for 24-item NOSACQ.

NOSACQ Items		Factor 1 (Eigenvalue = 9.88)	Factor 2 (Eigenvalue = 2.32)	Factor 3 (Eigenvalue = 1.24)	Communalities
Management items	1	0.66			**.57**
	2	0.77			**.62**
	4	0.66			.39
	7	0.80			**.58**
	11	0.75			**.62**
	12	0.75			**.57**
	14	0.77			**.66**
	16	0.75			**.56**
	17	0.73			**.56**
	20	0.76			**.62**
	22	0.70			**.63**
Co-worker items	23		0.70		**.54**
	24		0.59		.42
	27		0.68		**.53**
	30r			0.74	**.56**
	32r			0.73	**.66**
	35r			0.76	**.64**
	36		0.81		**.59**
	39		0.82		**.63**
	40		0.71		**.64**
	43		0.54		**.56**
	46		0.53		.39
	48		0.61		**.50**
	50		0.69		.40

2.7 Discussion

Following the methodological guidelines of Goetz et al. (2013), results from this study support the NOSACQ-24 as a brief, practical measurement scale for work safety climate. Practitioner opinions suggest that the selected items will be relevant for a wide range of organisations, and their comments did not indicate any critical missing items for specific types of organisations. Further application in a wider range of organisations and with other relevant outcome variables is necessary to determine the extent to which this brief measure could be generalised.

Assuming that each question takes approximately the same time to answer, this brief version would reduce survey completion time by half. Estimated completion time for the full scale is 20 minutes, meaning the brief survey could be completed in 10 minutes. This short completion time should encourage regular usage for the purpose of monitoring safety climate, rather than simply responding to safety concerns as they become critical. Acknowledgement of emerging problem areas with regard to safety can lead to remedial action that prevents costly incidents and/or accidents. Interventions may relate to management, co-worker, or risk areas as per the dimension structure of the measure. While Pronovost and Sexton (2005) recommend annual safety climate surveys, a shorter time investment involved with the brief version could see bi-annual or even quarterly reviews of safety climate. This would allow assessments of safety climate trends across business periods, and also for the evaluation of remedial safety-specific interventions, serving as a 'pulse' for employee safety climate. Comparatively, the full scale measure could be employed annually as part of a larger, comprehensive safety assessment. In this sense the brief survey could provide an indication of employee engagement with, and perception of, safety policies and procedures through the business year, whereas the full survey may assess annual safety targets and provide input to broader safety management goals. The alignment of the brief measure with the more comprehensive 50-item measure further suggests that parts of the latter could also be utilised to provide more detailed information when targeting specific areas with safety interventions. Results further demonstrated the same benchmarked scores for both measures, suggesting that the NOSACQ international benchmarks

could be applied to either version. In research settings workplace safety climate is often measured as part of a larger assessment, thus the reduced measure supported in this study may benefit safety researchers by allowing for supplementary co-variate measures without the additional response burden cost.

This study highlights several advantages of combining both statistical and practical methods when it comes to measurement development and item reduction. For more general constructs such as work safety climate there are likely to be unique and context-specific facets relevant to different organisations. As a result, asking safety practitioners whether anything was missing from the measure was an important consideration to ensure the measure would remain widely applicable. This process also helped to highlight practical issues with the current measure in terms of item wording that was considered confusing or unsuitable for the target population. A further advantage of consulting with domain-specific practitioners for item reduction is that it can facilitate buy-in for the measure which may promote future use. Similarly, engaging practitioners in the survey design process may have the added benefit of shifting organisational focus upstream from retroactive outcomes to preventative, proactive measures (Davis et al., 2020). It has previously been mentioned that several measures of work safety climate exist, some with questionable validity or reliability, thus, collaborating with practitioners is an important step to bridging the gap between research and practice (Baker et al., 2015; Chang et al., 2015).

Utilising this new method for item reduction that extends beyond purely statistical methods did identify some potential issues. Readability was selected as a key practical component of the survey's usability and was intended to distinguish between items that performed similarly from a statistical perspective. According to Hall et al. (2010) items should have a mean readability score (measured by Flesch-Kincaid grade) of 8. However, in the case of the NOSACQ, all management level and several co-worker level items exceeded this threshold to begin with. Thus, readability measures were not useful in reducing the survey dimensions – particularly the management dimensions. As a

result, readability scores were used to ensure that the reduced measure remained similar to the full version in terms of required reading ability and therefore usability.

Ultimately this study demonstrates the importance of determining the purpose of a measure before attempting item reduction. In this study one aim of the research team was to ensure that the shortened NOSACQ would continue to serve as a leading indicator for work safety outcomes. Hence, it was important for selected items to correlate with health and wellbeing measures and thus a high criterion of correlating with 4 of the 5 measures was set. The cut-off criteria for the other methods (e.g., researcher and practitioner ratings of >60% and >50% respectively) were similarly arbitrary but were set to represent a majority consensus. Researchers who wish to replicate this item reduction approach should consider selection criteria based on the purpose a shortened measure will serve. Proposing definitive rules or recommendations for the selection of items that will constitute a brief version of an existing measure would be unwise, as the optimal criteria is likely to vary according to construct, target population, and measurement purpose.

This study included data from two types of organisations (both human service), and the use of two dependent outcome variables. Both the CBI and SF-8 were selected due to their established validity and practical relevance in research on using a work safety climate measure to remediate work safety issues (Kirby et al., 2014). However, a greater range of types of organisations and more dependent measures related to work safety are needed to better assess the usefulness of the NOSACQ-24 when compared to the original measure. Additionally, in EFA there is always a component of subjectivity regarding scree plot analysis and factor structuring (Watkins, 2018), ultimately the factors are hypothetical constructs that cannot be measured directly and are instead inferred.

Future research is needed to investigate the practical relevance of item reduction methods used in this study. The value of the brief measure for monitoring and remedial purposes needs to be demonstrated in terms of its capacity to identify emerging safety issues in different types of organisations and to assess outcomes of implemented remedial strategies to deal with those issues. Following the guidelines described by Goetz et al. (2013) future research should aim to validate the

shortened measure within an independent sample. Additionally, while this study followed a more comprehensive methodological process than usual for item reduction, the resulting 24-item measure should undergo further validation, potentially in the form of a Confirmatory Factor Analysis to assess the dimension structure. This may be particularly relevant given the potentially problematic impact of negatively worded questions in the survey.

2.7.1 Conclusion

This study aimed to develop a brief work safety monitoring measure to identify emerging safety issues before they become critical. The methods used enabled the development of a brief measure that retained key items in each factor of the comprehensive work safety measure on which it was based. Therefore, an identified issue might be further investigated using a relevant part of the comprehensive measure if required. Safety research will also benefit from this brief measure, particularly when multiple assessment measures are employed as part of a larger test battery.

The widespread monitoring use of a validated, brief measure for work safety climate may help to identify emerging work safety issues before they become critical, allowing the implementation of remedial strategies to prevent safety accidents and incidents that are costly to both individual workers and organisations. It may also help to develop a consensus concerning key practical issues in the development and maintenance of workplace safety. Its application as a monitoring tool could also assist in the benchmarking of safety climate standards and thereby contribute to a shared understanding of best work safety practice.

Chapter 3: The Validity and Measurement Equivalence of a Brief Safety Climate Questionnaire across Casual and Permanent Workers.

3.1 Statement of Authorship

Submitted Manuscript: Under review
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Denvar Summers, first author, PhD Candidate

This paper reports on original research conducted by Denvar Summers during the period of his Higher Degree by Research candidature and is not subject to any obligations of contractual agreements with a third party that would constrain its inclusion in this thesis. He is the primary author of this paper. He was responsible for the conception of this study, literature review, developing the research aims and hypotheses and data analyses; and wrote the original manuscript. Mr Summers was the first author and corresponding author for the manuscript and was primarily responsible for revisions to the paper. His overall percentage of contribution to the paper is 85%.

Dr Aspa Sarris, Dr Neil Kirby and Dr Julia Harries were the supervisors and/or contributors of the research program to which this manuscript belongs. They collaborated with Mr Denvar Summers on the development of the content and structure of the manuscript and assisted with editing and proof reading. Mr Summers was responsible for the conceptualisation of the research aims and hypotheses, literature review, statistical analysis and write-up of this manuscript. Their role was to discuss the feasibility of his research proposals, provide support and assistance when he encountered difficulties and to provide feedback and editing on manuscript drafts. They give permission for this paper to be incorporated in Mr Summers' submission for the degree of Doctor of Philosophy from the University of Adelaide.

Statement of Authorship

Title of Paper	The validity and measurement equivalence of a brief safety climate questionnaire across casual and permanent workers
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Principal Author

Name of Principal Author (Candidate)	Denvar Summers
Contribution to the Paper	Performed analyses on all samples, interpreted data, wrote manuscript and acted as corresponding author.
Overall percentage (%)	85%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature	Date 27/05/2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate to include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Aspa Sarris
Contribution to the Paper	Supervised development of work, helped with manuscript evaluation. As we are unable to reach Aspa Sarris at this time, principal supervisor Neil Kirby and co-supervisor Julia Harries have accepted the proposed Statement of Authorship and hence Neil Kirby will sign as outlined in the FAQs for HDR Submission with Publications
Signature	Date 7/6/2022

Name of Co-Author	Julia Harries
Contribution to the Paper	Helped in data interpretation, editing and evaluation of manuscript
Signature	Date 7/6/2022.

Please cut and paste additional co-author panels here as required.

3.2 Preamble

The previous study used a novel item reduction approach to derive a brief version of the NOSACQ that was both statistically grounded and practically useful. Designed to be a measure that could be used regularly by organisations to monitor safety climate and as a surveillance mechanism for identifying emerging safety concerns, it was essential that the brief NOSACQ version had sufficient validity to ensure that it was an effective safety climate measure and also that it maintained its correspondence with, and connection to, the full version of the NOSACQ.

Maintaining the dimensional structure of the original full version of the NOSACQ was critical to the development of the brief version to enable the full measure to be implemented when more comprehensive safety climate assessment was required using either all, or some, of the NOSACQ-50 dimensions. Yet another key reason for maintaining the three management and four co-worker safety climate dimension structure of the full NOSACQ was to enable organisations to use the extensive international benchmarking database of the NOSACQ to determine the extent that their assessed safety climate was satisfactory and/or requiring remediation based on findings from other similar industry types worldwide.

Thus, the second study aimed to examine the construct validity, external validity, concurrent validity, measurement equivalence, and benchmarking capabilities of the NOSACQ-24 measure developed in study one. In particular, the investigations involved ensuring congruence between the factor (dimension) structure of the brief version with the full version, examined through confirmatory factor analysis (CFA) across two samples of independent participants (either permanently or casually employed), to support the external and construct validity of the brief NOSACQ version. Concurrent validity of the NOSACQ-24 was examined through correlational analyses with associated outcome variables (burnout, mental and physical health). Benchmarking capability of the brief measure was also examined across four employee groups through paired samples t-tests. Measurement equivalence of the brief NOSACQ was examined across permanent and casual workers in order to assess if the measure could be applied to different employment groups.

This study was intended to expand on the initial development of the brief NOSACQ, and extend the assessment of the measure to a wider range of validity metrics. In doing so this study may also support the methodology employed in study one, demonstrating the effectiveness of incorporating practically focussed criteria for item selection when attempting to reduce an existing measure. This study may support the application of the brief safety climate measure in practical settings across a variety of workplaces and industry types.

3.3 Abstract

Background: Safety climate is an effective leading indicator of safety incidents and accidents. However, organisations frequently use safety climate measures only in times of crisis rather than for regular monitoring to identify and remediate safety issues before becoming critical. **Objective:** This study aimed to validate a 24-item version of the 50-item Nordic Occupational Safety Climate Questionnaire (NOSACQ-50) that was developed for use as a regular monitoring tool. **Method:** Analyses undertaken included confirmatory factor analysis (CFA) and assessments of construct validity, external validity, concurrent validity, measurement equivalence, and benchmarking capabilities. CFA included a combined sample of disability support workers and hospitality employees (N = 474) and examined the external and construct validity of the NOSACQ-24. Concurrent validity was assessed by comparing correlations between the 50-item and 24-item versions of the NOSACQ with health and wellbeing outcome variables. External validity of the NOSACQ-24 was established using an independent sample of students in casual employment (N = 122) and employees from a vocational education and training (VET) organisation (N = 53). Paired samples t-tests examined the safety climate scores for the 50-item and 24-item measures across all participant samples to evaluate the safety climate benchmarking capability of the NOSACQ-24. **Results:** The NOSACQ-24 demonstrated a comparable factor structure to the full NOSACQ-50 version. External, construct, and concurrent validity for the NOSACQ-24 were largely supported, as were measurement equivalence and benchmarking capabilities. **Conclusion:** Use of the NOSACQ-24 is supported, and future applications are discussed.

Key words: Nordic Occupational Safety Climate Questionnaire, Work Safety, Leading Indicator, Confirmatory Factor Analysis.

3.4 Introduction

Work safety in organisations needs to be constantly reviewed in order to effectively manage risks, both physical and psychological, associated with changing work practices and procedures (O'Neill, 2014). One of the most effective leading indicators of safety behaviours is work safety climate, defined as "shared perceptions with regard to safety policies, procedures and practices" (Zohar, 2011, p. 143). In general, a positive safety climate is associated with more positive safety behaviours and outcomes, with the influence of these shared perceptions being demonstrated over several meta-analytic studies (Beus et al., 2010; Christian et al., 2009; Clarke, 2006; Nahrgang et al., 2011).

The necessity for constantly reviewing and remediating work safety issues is highlighted by the costs associated with work safety incidents. At a global level the World Health Organization and International Labour Organization (2019) reported over 360,000 global workplace deaths due to injury. Additionally, at a national level Safe Work Australia (2021a) reported 194 deaths and 120,355 serious injury claims for the 2020-21 financial year, with a median time and financial cost of 6.6 weeks lost work and $13,500 AUD per claim. Not only do safety incidents incur substantial financial and personal costs for individuals, but organisations and communities also suffer the direct and indirect costs of workplace injuries. Direct workplace injury costs include financial compensation (e.g., medical expenses and rehabilitation) and the loss of production if work has to be halted. Indirect costs include the need for hiring and training of replacement workers, increased insurance premiums, reduced staff morale, and negative public image (Rikhardsson & Impgaard, 2004). The direct and indirect costs of workplace injuries and accidents highlight the importance of monitoring work safety climate to identify and remediate emerging safety issues as a basis for promoting effective safety practices from an organisational perspective (Haslam et al., 2016).

3.4.1 Safety Climate Measurement

The interest in assessing organisational safety climate has culminated in the development of numerous measures since the conceptualisation of the construct (Zohar, 1980), with authors such as

Beus et al. (2019) and Shea et al. (2021) reporting 67 and 49 distinct measures of safety climate, respectively. Despite many measures of work safety climate being developed, relatively few have been deemed satisfactory in terms of their statistical properties and psychometric content. A review of over 200 safety climate measures by Vu and De Cieri (2015) revealed that only 18 measures were considered to be appropriate. The number of items contained within these measures ranged from four to over one hundred (M = 42). The shorter measures are more time efficient but are often not adequately comprehensive to assess and identify critical work safety issues. However, the more comprehensive measures take longer to complete and previous research has found that the completion time is positively associated with response burden (Nielsen et al., 2016) and meta-analytic evidence suggests that response burden is negatively associated with response rates (Rolstad et al., 2011).

Work safety climate measures are often implemented in research studies with other related measures of occupational stress, burnout, health and wellbeing. Consequently, a shorter work safety climate measure that is sufficiently comprehensive but with a smaller response burden would facilitate the inclusion of other work-related safety constructs. Of particular importance for dealing with work safety issues, such a measure would also allow for repeated measurements to monitor safety climate to identify safety issues and to evaluate the effects of safety interventions designed to address those issues (Summers et al., 2022a). It would also allow for the regular assessment of safety trends over periods of time (Pronovost & Sexton, 2005). Lengthy safety climate measures may discourage organisations from implementing such regular assessments due to time and cost restraints.

In their study, Vu and De Cieri (2015) identified the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50; Kines et al., 2011) as being a satisfactory evidence-based measure of safety climate. The NOSACQ is a comprehensive measure comprising 50 items representing seven (three management and four co-worker) dimensions. The scale has consistently demonstrated reliability and validity, has been translated into over 40 languages, and has an extensive international

benchmarking database of 57,270 workers and 17,098 leaders. The NOSACQ-50 has also been used to assess and remediate critical work safety issues (Harries et al., 2020).

To develop a brief measure of work safety climate that would be sufficiently comprehensive but suitable for regular safety monitoring, Summers et al. (2022a) used a multifaceted approach to develop a brief NOSACQ-24 that retained the basic structure of the full version with sufficient items in each of the three management and four co-worker factors to identify work safety issues. Reducing the brief version to 24-items meant that, assuming approximately equal time for each item, it could be completed approximately 50% faster than the full version thus making it more suitable for monitoring purposes.

A brief version of a comprehensive norm-based work safety climate measure could allow for regular monitoring to ensure that an organisation's work safety climate is at an acceptable level with respect to benchmarking against similar organisations. If it retains the structure of the comprehensive measure with sufficient sample items from each factor it could also assist in identifying emerging work safety issues that could be remediated before they reach a critical point. More detailed assessment of a particular safety issue could also be obtained from the additional relevant items in the comprehensive version.

Summers et al. (2022a) reported the development of the NOSACQ-24, which was performed using a combination of exploratory factor analysis (EFA) and measures designed to improve its practical usefulness (such as readability assessment and recommendations from safety practitioners and researchers). EFA of the NOSACQ-24 identified three key dimensions, which were categorised as management focussed safety climate, co-worker focussed safety climate, and worker safety priority and risk non-acceptance, instead of the seven dimensions originally proposed by Kines et al. (2011). However, it is possible that the third dimension extracted from the EFA was a 'nuisance' factor that came as a result of negatively worded questions (Chyung et al., 2018). Nonetheless, while the EFA suggested a three-dimensional structure, the original seven dimensions were retained in the NOSACQ-24 to enable use of the associated safety climate dimension benchmarks of the NOSACQ-50. Thus, a

major aim of the present study was to conduct an assessment of model fit using a confirmatory factor analysis (CFA) approach to identify the most appropriate dimensional structure for NOSACQ analysis. This approach aligns with best practice recommendations for developing or refining safety climate measures, with Shea et al. (2021) stating:

> …scholars should go beyond the exploratory analysis (i.e., EFA) and incorporate confirmatory techniques such as CFA…there are benefits to approaching scale development by combining both techniques when developing a scale to capitalize on the strengths and minimize the weaknesses of each technique, which will lead to a more robust analysis (p.11).

Previous research has shown that the assessment of work safety climate varies according to whether employees are casual or permanent. For instance, Okoye and Aderibigbe (2014) compared the work safety climate experienced by casual and permanent construction workers from over 80 construction sites and demonstrated a significant difference between the groups, with permanent employees having more favourable perceptions of management commitment, workers' involvement, and safety education and training. Differential treatment of casual employees in terms of benefits, job conditions, and salaries was considered to be the cause of this disparity. If work safety climate measures can demonstrate significantly different work safety issues among casual employees compared with permanent employees, then the need to develop specific strategies to improve the work safety climate in largely casual workforces (e.g., occupations such as hospitality and retail) can be better investigated. The ability to identify work safety issues due to other working conditions such as those imposed during the COVID-19 pandemic would also be particularly useful. One consequence of dealing with the economic uncertainties caused by COVID-19 may be an increase in casual work opportunities (Stansfield, 2020), thereby increasing the need to monitor the work safety climate of these employees. Thus, another aim of the present study was to compare the measurement equivalence of the NOSACQ-24 with the full scale version using independent samples of casual and permanent employees.

The NOSACQ-24 was developed using a sample of disability support workers and hospitality workers who were largely employed in a permanent capacity. A further aim of the present study was to validate the measure using two independent samples of workers who differ from the original sample of workers in terms of either their employment characteristics or employment sector, a methodological approach recommended by Goetz et al. (2013) when shortening composite scales.

3.4.2 Research Aims

Thus, the overarching objective of assessing the validity of the NOSACQ-24 can be summarised in terms of five main aims: 1) To determine the most appropriate factor structure by which to assess the NOSACQ through a Confirmatory Factor Analysis (CFA) comparing the three and seven dimension structures; 2) To assess and compare the construct and external validity of both the 50-item and 24-item versions of the NOSACQ using CFA to assess model fit; 3) To assess the benchmarking capability of the NOSACQ-24 through dimension score comparisons with the 50-item version; 4) To assess the concurrent validity of the NOSACQ-24 in comparison with the NOSACQ-50 by examining correlational analyses of health and wellbeing outcome measures; and 5) To assess the measurement equivalence and external validity of both the 50- and 24-item NOSACQ versions within two independent samples of predominantly casual and permanent employees.

3.5 Materials and Method

3.5.1 Participants

There were four groups of participants in this study. The first two groups included 474 participants (male = 213, female = 260, 1 = not reported) and comprised 364 disability support workers (DSWs; 281 full-time, 61 part-time, 18 casual, 4 other [identified as being on workers compensation and working reduced hours]) and 110 hospitality employees (54 full-time, 34 part-time, 22 casual). The mean age of the DSWs was 49.15 years (SD = 10.89), and the mean age of the hospitality employees was 35.63 years (SD = 10.84). Responses from the DSW participants were collected using pen and paper methods, and responses from the hospitality participants were collected online. The

data from these first two groups were made available from a larger research study and were also used in the initial development of the NOSACQ-24 (Summers et al., 2022a). The focus of this study and previous research has been to develop a brief general safety climate measure and not a measure that reflected safety associated with a specific industry sector, therefore the DSW and hospitality worker responses were combined to represent a sample of Australian workers for the purpose of developing the brief measure. In addition to providing a sample that was not drawn from a single industry sector, combining these groups enhanced the statistical power and potential generalisability of the modelling undertaken due to the greater number and range of participants. The third group comprised 122 university students (33 male, 89 female) with a mean age of 20.58 years (SD = 4.28). The majority of students (n = 91) worked on a casual basis with the remaining 31 working on a part-time basis. Seventy two percent of participants identified their employment setting as either hospitality (39.3%), retail (31.1%), or both (1.6%). The remaining 27.9% of participants had their employment type categorised as "Other". Jobs within this category included cleaning services, social work, education, and fitness. The fourth group of participants comprised an independent sample of 53 employees from a vocational education and training (VET) organisation (17 male, 33 female, 1 other, 2 prefer not to say) with a mean age of 53.1 years (SD = 8.71). All participants in the fourth group worked on a permanent basis (e.g., full time or part time). Both student worker participants and VET participants completed the questionnaire online.

3.5.2 Measures

Nordic Occupational Safety Climate Questionnaire (NOSACQ-50): DSWs, hospitality employees, student employees, and VET employees rated the safety climate of their workplace using the 50-item NOSACQ. The NOSACQ measures seven safety climate dimensions:

1) Management Safety Priority, Commitment and Competence;
2) Management Safety Empowerment;
3) Management Safety Justice;

4) Workers' Safety Commitment;
5) Workers' Safety Priority and Risk Non-Acceptance;
6) Safety Communication, Learning, and Trust in Co-Worker Safety Competence; and
7) Workers' Trust in the Efficacy of Safety Systems.

The measure utilises a 4-point Likert response (Strongly Disagree; Disagree; Agree; Strongly Agree), eliminating the possibility of a neutral response. According to the NOSACQ official interpretation guide, a score of more than 3.30 indicates a good safety climate level allowing for maintaining and continuing developments. A score of 3.00 to 3.30 indicates a fairly good safety climate level with slight need of improvement. A score of 2.70 to 2.99 shows a fairly low safety climate level with need of improvement, and a score below 2.70 indicates a low safety climate level with great need of improvement. The full-scale employs both positively (n = 29) and negatively (n = 21) worded questions. The NOSACQ-50 has shown consistently reliable and valid results in past research (e.g., Marín et al., 2019), and has an international benchmarking database of 57,270 workers and 17,098 leaders. See Appendix for the full scale NOSACQ-50 and the annotated items included in the NOSACQ-24. The NOSACQ-24 was designed to maintain the seven-dimension structure, employs the same Likert response scale, and utilises an approximately equal distribution of items per dimension as the NOSACQ-50. See Summers et al. (2022a) for a comprehensive development overview of the NOSACQ-24.

Health and Wellbeing Outcome Measures: To compare the concurrent validity of the brief and full version of the NOSACQ, health and wellbeing outcome measures were assessed. The two self-report measures used were the Copenhagen Burnout Inventory (CBI; Kristensen et al., 2005) and the SF-8 Health Survey (Ware et al., 2000).

The 19-item CBI contains three scales that measure personal burnout, work-related burnout, and client-related burnout. Higher scores on the CBI scales represent higher levels of reported burnout. All three scales have demonstrated strong internal reliability, differentiate well between

occupational settings, and can predict future job outcomes, including job absence and intention to quit (Kristensen et al., 2005). CBI responses were available for the DSWs and hospitality employees.

The SF-8 Health Survey contains eight physical and mental health items covering general health, physical functioning, role physical, bodily pain, vitality, social functioning, mental health, and role emotional. SF-8 responses were only available for the DSWs. The SF-8 measures produce two composite scores, a general physical health score and a general mental health score, with higher scores representing better health. The measure has been shown to be effective in monitoring the health of large-scale populations in outcome studies (Yiengprugsawan et al., 2014).

3.5.3 Data Analysis

All analyses were conducted using SPSS Software Version 26 and SPSS AMOS Version 26. A priori power analysis was conducted using G*Power (3.1.9.7) to compute required sample sizes for analysis using a 0.80 power level and $\alpha = .05$ significant criterion to detect a medium effect size ($d = 0.3$) with analyses showing appropriate sample sizes for all planned analyses. Normality of measures was investigated visually and using z-score calculations of skewness and kurtosis. Due to skewed distribution (12 measures), bootstrapping (using the bias-corrected and accelerated method with 1000 iterations) was used to calculate confidence intervals for descriptive statistics and to confirm parametric findings. Research on Structural Equation Modelling (SEM) literature provides recommendations regarding required sample size for factor analysis (e.g., Bentler & Chou, 1987; Ding et al., 1995; Kline, 2005) with the majority of studies supporting the sample sizes of the groups of participants in this study as appropriate for CFA.

3.5.4 Confirmatory Factor Analysis Criteria

Guidelines provided by Schreiber et al. (2006) were used for establishing cut-off criteria for the fit indexes used in the CFA. For Chi-square a ratio of x^2 to degrees of freedom less than 2 or 3 is considered acceptable, with a lower ratio indicating a better fit. Akaike information criteria (AIC) is a useful criterion for undertaking model comparisons rather than for understanding the fit of a single

model, with smaller scores indicating better model fit. For the comparative fit index (CFI) it is recommended that scores greater than .95 indicate acceptable fit. Finally, for the root mean square error of approximation (RMSEA), scores less than .06 to .08 (with confidence intervals) are considered an acceptable fit of the data.

3.5.5 Ethics

Ethical approval for this project was obtained through the University of Adelaide: Human Research Ethics Subcommittee (Code number: 19/61).

3.6 Results

Table 7 provides the descriptive statistics for all groups' responses to the NOSACQ-50, and the wellbeing measures (for DSW and Hospitality employees) used for the statistical procedures. The table demonstrates a sufficient range of responses, without any floor or ceiling effects and thus the data are appropriate for the analyses performed.

Table 7

Descriptive statistics for the Copenhagen Burnout Inventory, SF-8 Health Survey, and NOSACQ-50 for all samples (DSW and Hospitality Employees=474; Student Employees = 122; VET = 53).

Scales	Range	DSW & Hospitality Employees Mean (SD)	Casual Student Employees Mean (SD)	VET Employees Mean (SD)
Copenhagen Burnout Inventory				
Personal burnout	0-100	42.30 (19.74)	NA	NA
Work-related burnout	0-100	36.62 (20.92)	NA	NA
Client-related burnout	0-95.83	23.51 (20.19)	NA	NA
SF-8 Health Survey[a]				
Physical Health Component Score	19.17-63.72	49.68 (8.56)	NA	NA
Mental Health Component Scores	11.35-62.91	48.03 (10.83)	NA	NA
NOSACQ-50				
Management Safety Priority, Commitment & Competence	1.00-4.00	3.00 (0.56)	3.11 (0.56)	2.90 (0.59)
Management Safety Empowerment	1.00-4.00	2.89 (0.57)	2.92 (0.51)	2.75 (0.57)
Management Safety Justice	1.00-4.00	2.96 (0.59)	3.06 (0.55)	2.86 (0.63)
Worker Safety Commitment	1.00-4.00	3.18 (0.44)	3.23 (0.47)	3.14 (0.48)
Workers' Safety Priority & Risk Non-Acceptance	1.00-4.00	2.97 (0.49)	2.92 (0.50)	3.05 (0.47)
Safety Communication, Learning, & Trust in Co-Worker Safety Competence	1.00-4.00	3.15 (0.47)	3.21 (0.41)	3.03 (0.49)
Workers' Trust in the Efficacy of Safety Systems	1.00-4.00	3.20 (0.46)	3.23 (0.46)	3.11 (0.49)

Note: CBI scale = 1-100, SF-8 scale = 1-100, NOSACQ-50 scale = 1-4.

[a]SF-8 Health Survey data were only available for DSWs; NA = Not Available.

3.6.1 CFA Assessment of Dimension Structure, Construct Validity, and External Validity

Confirmatory Factor Analysis (CFA) was performed using the combined NOSACQ responses from the DSW and Hospitality employees. Fit statistics were examined to determine the most appropriate factor structure for analysis of the NOSACQ data. The CFA fit statistics of four separate models were examined. The four models included: 24-item NOSACQ with seven dimensions, 50-item NOSACQ with seven dimensions, 24-item NOSACQ with three dimensions, and 50-item NOSACQ with three dimensions. Table 8 shows the fit statistics for each model tested. In CFA, a non-significant chi-square test indicates good model fit; however, as shown in Table 8, the Chi-square tests for all four models were significant. Ke-Hai and Wai (2016) note that the Chi-square statistic is heavily influenced by sample size and considering most SEM guidelines recommend a large sample size, this introduces an issue in that the larger the sample size, the more likely a statistically significant Chi-square will be obtained. Thus, other fit indices with alternative properties for measurement (e.g., CFI), and those that avoid issues of sample size (e.g., RMSEA; Hu & Bentler, 1998) were also examined.

Table 8
CFA fit statistics for each proposed model using NOSACQ responses from DSW and Hospitality Employees (N=474)

Model	Chi-Square	df	Chi-Square to df ratio	CFI	RMSEA [90% CI]	AIC
24-item 7 Dimensions	460.70 p = <.001	231	1.99	.96	.046 [.040-.052]	646.70
50-item 7 Dimensions	2738.11 p = <.001	1154	2.37	.87	.054 [.051-.056]	3080.11
24-item 3 Dimensions	647.62 p = <.001	253	2.56	.93	.057 [.052-.063]	789.62
50-item 3 Dimensions	3244.46 p = <.001	1172	2.77	.83	.061 [.058-.063]	3550.46

Note: df = Degrees of Freedom; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; AIC = Akaike Information Criterion.

The first point of examination was to determine whether a seven- or three-dimensional structure was most appropriate for analysis of the NOSACQ. When comparing the dimension structure between the NOSACQ models, it can be seen in Table 8 that all indices except for the CFI were within

the acceptable ranges specified by Schreiber et al. (2006). With regard to the CFI only the 24-item, seven-dimension model was within the acceptable range of greater than .95. However, overall the seven-dimension model structure for both the 24- and 50-item versions indicates better fit for the data across all fit indices when compared with the three-dimension models. To further support this conclusion, the AIC, which is a measure of model fit used for comparing models, was smaller in the seven-dimension model when compared to the three-dimension model for both the 50- and 24-item versions, indicating superior fit. This finding supports the original seven-dimension structure of the NOSACQ-50, and suggests that the NOSACQ-24 will most appropriately be analysed using this same structure. This result supports the construct validity of the NOSACQ-24, providing evidence that the NOSACQ-50 benchmarking data may be applicable to the 24-item measure. Furthermore, within the seven-dimension structure, the NOSACQ-24 demonstrates superior model fit indices when compared to the 50-item version. This supports the external validity of the NOSACQ-24 and suggests that conclusions drawn from the 24-item version will be equivalent to those drawn from the 50-item version. Figure 2 shows the superior 24-item seven-dimension NOSACQ modelled using the DSW and hospitality employee data.

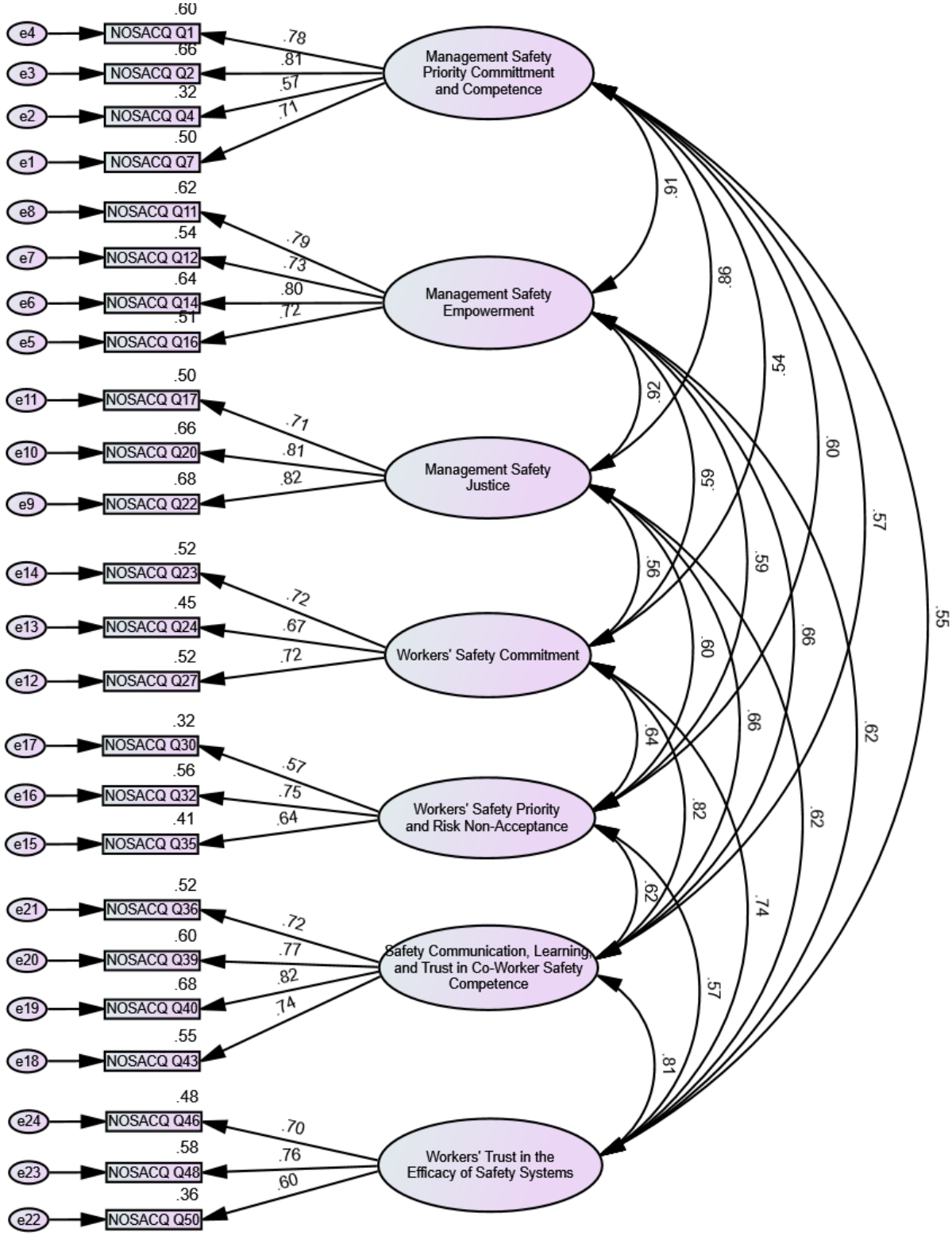

Figure 2: Confirmatory Factor Analysis path diagram (with standardised parameters) using DSW and Hospitality Employees (N = 474).
Note: NOSACQ Items 30, 32 and 35 are reverse scored.

3.6.2 Concurrent Validity Assessment

In order to support the validity of the NOSACQ-24, the measure needs to demonstrate appropriate concurrent validity when compared to the 50-item version. To address this, correlational analyses were performed examining the relationship between both 24-item and 50-item versions of the NOSACQ and the five burnout and health outcome variables obtained from the DSW employees and the three burnout variables for the hospitality employees. The results of these analyses are presented in Table 9.

Table 9

50- and 24-item NOSACQ dimension Pearson correlations with health and wellbeing outcome variables for the DSW and Hospitality Employees (N=474).

NOSACQ Dimension	Copenhagen Burnout Inventory			SF-8[a]	
	Personal Burnout	Work-Related Burnout	Client-Related Burnout	Physical Health Score	Mental Health Score
Management Safety Priority, Commitment & Competence					
50-item	-.38***	-.44***	-.35***	.29***	.35***
24-item	-.39***	-.43***	-.31***	.28***	.33***
Management Safety Empowerment					
50-item	-.40***	-.45***	-.34***	.25***	.35***
24-item	-.41***	-.45***	-.35***	.29***	.35***
Management Safety Justice					
50-item	-.38***	-.42***	-.34***	.28***	.30***
24-item	-.37***	-.40***	-.35***	.28***	.31***
Workers' Safety Commitment					
50-item	-.27***	-.27***	-.23***	.13*	.19***
24-item	-.24***	-.23***	-.18***	.10	.18***
Workers' Safety Priority & Risk Non-Acceptance					
50-item	-.33***	-.37***	-.38***	.15**	.31***
24-item	-.33***	-.36***	-.38***	.17**	.33***
Safety Communication, Learning, & Trust in Co-Worker Safety Competence					
50-item	-.29***	-.30***	-.23***	.13*	.18***
24-item	-.25***	-.26***	-.23***	.13*	.14**
Workers' Trust in the Efficacy of Safety Systems					
50-item	-.24***	-.24***	-.25***	.14*	.17**
24-item	-.23***	-.22***	-.23***	.17**	.16**

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

Note: [a] SF-8 correlations are for DSWs only.

From the correlation analyses it can be seen that all seven dimensions in both the 50-item and 24-item NOSACQ versions have small to medium significant correlations with all five outcome variables, with the exception of the NOSACQ-24 version of the "Workers' Safety Commitment" dimension, which did not significantly correlate with the SF-8 physical health score. Although the coefficient values of the two versions were similar, the NOSACQ-50 dimension reached statistical significance whereas the NOSACQ-24 dimension did not. It is worth noting that of all the outcome variables, general physical health typically had the weakest relationships with the NOSACQ dimensions for both NOSACQ versions. These results indicate that the NOSACQ-24 has comparable concurrent validity with the NOSACQ-50.

3.6.3 Assessment of Dimension Structure and External Validity within an Independent Sample

Goetz et al. (2013) proposed that six steps need to be followed when attempting to reduce items in an existing measurement scale: 1) Document the validity of the original measurement scale and the objective of its shortening; 2) Take the conceptual model into account; 3) Preserve content validity; 4) Preserve psychometric properties; 5) Document the reasons for item selection, and 6) Validate the short-form measure in an independent sample. Steps one through five were addressed in a previous study (Summers et al., 2022a). In this study the final step involving validating the short-form measurement scale using an independent sample was addressed. For this purpose, a CFA was performed on a sample of student workers who were predominantly casual employees. Fit statistics were determined for the same four models as from the DSW and hospitality employee data: 24-item NOSACQ with seven dimensions, 50-item NOSACQ with seven dimensions, 24-item NOSACQ with three dimensions, and 50-item NOSACQ with three dimensions. Table 5 shows the model fit statistics for each model tested.

Table 10
CFA fit statistics for each proposed NOSACQ model using student employees (N = 122).

Model	Chi-Square	df	Chi-Square to df ratio	CFI	RMSEA [90% CI]	AIC
24-item 7 dimensions	355.00 p = <.001	231	1.54	.91	.066 [.052-.79]	541.00
50-item 7 dimensions	1999.18 p = <.001	1154	1.73	.76	.077 [.071-.082]	2341.18
24-item 3 dimensions	450.09 p = <.001	253	1.78	.86	.079 [.067-.091]	592.09
50-item 3 dimensions	2228.42 p = <.001	1172	1.90	.70	.085 [.080-.091]	2534.42

Note: df = Degrees of Freedom; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; AIC = Akaike Information Criterion.

Results from the independent student sample replicate those from the DSW and Hospitality data in that the seven-dimension structure indicates a better fit for the data overall. However, while the CFI is greatest within the seven-dimension structure it did not meet the .95 cut-off criteria. Additionally, the NOSACQ-24 also indicates superior fit when compared to the NOSACQ-50 across all indices. A comparatively smaller AIC and chi-square to degrees of freedom ratio, and RMSEA within the acceptable range support this notion. Overall, these results provide additional support for the measurement structure, external and construct validity of the NOSACQ-24 by demonstrating it is generalisable across primarily casual employees. Figure 3 shows the superior 24-item seven-dimension NOSACQ modelled using the student employee data. It is worth noting that in this model, item number 12 "*Management encourages employees here to participate in decisions which affect their safety*" performs poorly compared to the DSW and Hospitality data modelled in Figure 2. This may be related to safety climate perception differences associated with being primarily casual employees as opposed to permanent employees. CFA was not undertaken using the VET employees due to insufficient sample size (Bentler & Chou, 1987; Ding et al., 1995; Kline, 2005).

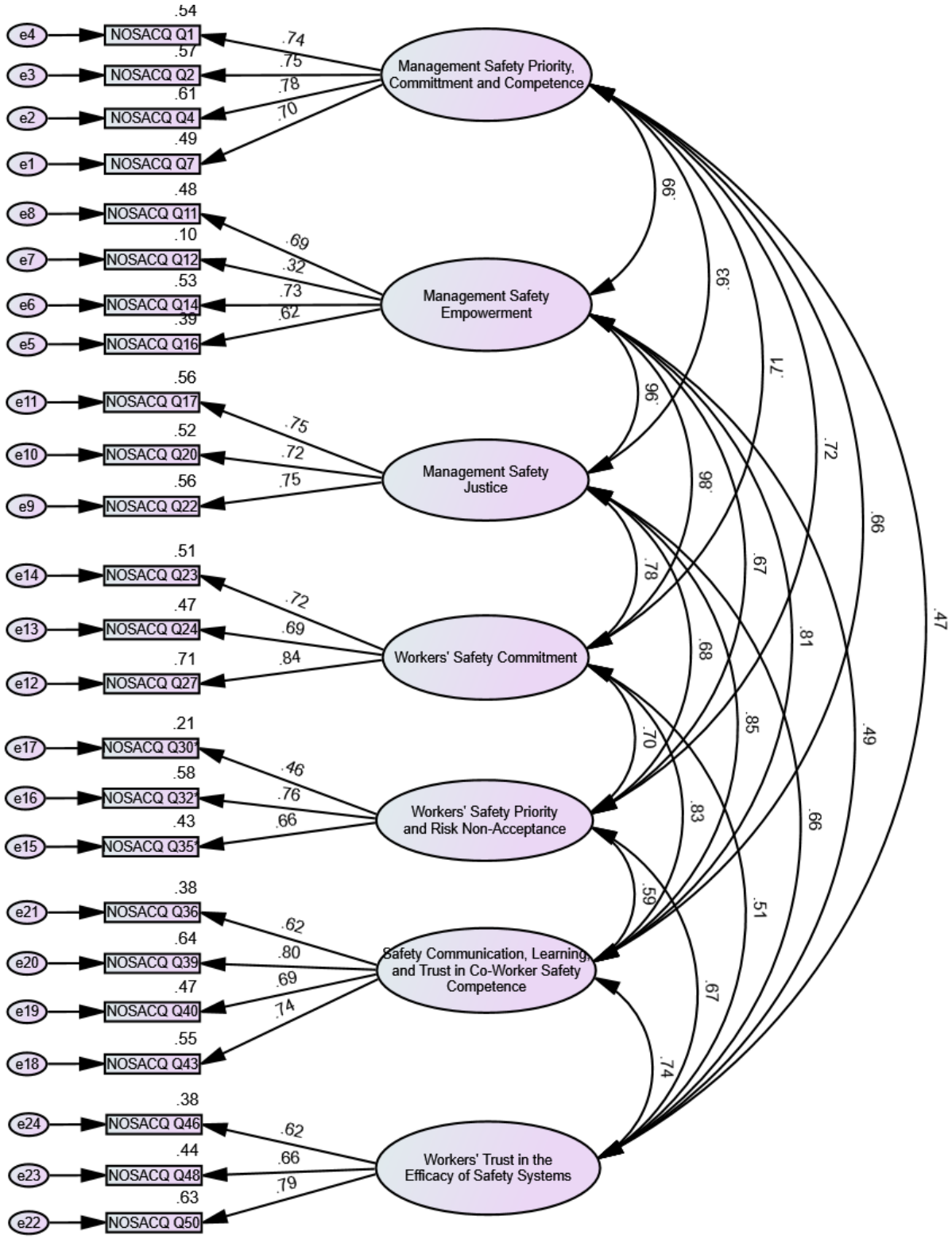

Figure 3: Confirmatory Factor Analysis path diagram (with standardised parameters) using student workers (N = 122)

Note: NOSACQ Items 30, 32 and 35 are reverse scored.

3.6.4 Measurement Equivalence and Benchmarking Capabilities of the NOSACQ-24

Measurement equivalence refers to an equality of performance on a measure regardless of group membership (Lee et al., 2014) and is an important part of validating new or abbreviated measures. To compare the mean dimension scores of both versions of the NOSACQ and across all available employees (DSW, Hospitality, Students, VET) a series of paired samples t-tests were performed. The results of these analyses can be seen in Table 11. Nine significant mean differences between the 24- and 50-item NOSACQ versions were obtained involving five of the NOSACQ dimensions, primarily co-worker dimensions. For two dimensions, Workers' Safety Commitment" and "Safety Communication, Learning, and Trust in Co-Worker Safety Competence", significant differences were demonstrated for three of the four work groups. Two significant mean differences were obtained for the "Workers' Trust in the Efficacy of Safety Systems" dimension, involving the DSW and Student employees. The remaining two dimensions had significant mean differences for one work group only; for the "Management Safety Empowerment" dimension a significant difference was demonstrated for the student employees and for the "Workers' Safety Priority and Risk Non-Acceptance" a significant difference was demonstrated for the hospitality employees. For the sample of permanent VET employees, no significant mean differences between dimension scores were identified.

Table 11

Paired Samples t-test comparing 50- and 24-item NOSACQ versions for the DSW, Hospitality, Student, and VET employees.

NOSACQ Dimension	NOSACQ Sample	50-item Mean (95% CI)	24-item Mean (95% CI)	*t* value	*p* value
Management Safety Priority, Commitment & Competence	*DSW*	2.91 (2.85-2.97)	2.91 (2.85-2.98)	-0.22	.833
	Hospitality	3.29 (3.20-3.37)	3.25 (3.15-3.35)	1.45	.161
	Student	3.11 (3.00-3.21)	3.11 (3.01-3.22)	-0.01	.990
	VET	2.91 (2.72-3.10)	2.90 (2.69-3.11)	0.35	.728
Management Safety Empowerment	*DSW*	2.82 (2.76-2.88)	2.80 (2.74-2.88)	1.41	.162
	Hospitality	3.12 (3.02-3.21)	3.11 (3.00-3.21)	0.28	.772
	Student	2.92 (2.82-3.01)	2.88 (2.79-2.98)	2.29	.024
	VET	2.77 (2.60-2.94)	2.75 (2.57-2.93)	0.81	.421
Management Safety Justice	*DSW*	2.85 (2.79-2.92)	2.85 (2.78-2.91)	0.43	.684
	Hospitality	3.28 (3.19-3.37)	3.27 (3.16-3.37)	0.64	.498
	Student	3.06 (2.96-3.16)	3.09 (2.99-3.18)	-1.48	.141
	VET	2.89 (2.66-3.06)	2.87 (2.69-3.06)	-0.59	.561
Workers' Safety Commitment	*DSW*	3.14 (3.10-3.19)	3.18 (3.12-3.23)	-2.06	.045
	Hospitality	3.30 (3.23-3.38)	3.20 (3.11-3.30)	2.28	.021
	Student	3.23 (3.15-3.32)	3.31 (3.22-3.40)	-3.32	.001

	VET	3.18 (3.04-3.31)	3.18 (3.05-3.31)	-0.12	.906
Workers' Safety Priority & Risk Non-Acceptance	*DSW*	2.90 (2.85-2.96)	2.92 (2.85-2.99)	-0.63	.518
	Hospitality	3.15 (3.07-3.23)	3.20 (3.11-3.30)	-2.45	.017
	Student	2.92 (2.83-3.01)	2.87 (2.77-2.98)	1.96	.052
	VET	3.07 (2.94-3.20)	3.09 (2.92-3.26)	-0.71	.482
Safety Communication, Learning, & Trust in Co-Worker Safety Competence	*DSW*	3.11 (3.06-3.16)	3.16 (3.11-3.22)	-6.63	.001
	Hospitality	3.27 (3.19-3.35)	3.36 (3.28-3.45)	-5.99	.001
	Student	3.21 (3.14-3.29)	3.32 (3.24-3.39)	-6.80	<.001
	VET	3.08 (2.94-3.21)	3.13 (2.99-3.26)	-1.93	.060
Workers' Trust in the Efficacy of Safety Systems	*DSW*	3.16 (3.10-3.21)	3.20 (3.14-3.25)	-3.49	.001
	Hospitality	3.33 (3.25-3.41)	3.33 (3.26-3.42)	-0.18	.842
	Student	3.23 (3.14-3.30)	3.28 (3.19-3.36)	-2.84	.005
	VET	3.13 (2.99-3.26)	3.16 (3.02-3.28)	-0.83	.413

Note: NOSACQ-50 scale = 1-4, NOSACQ-24 scale = 1-4. Degrees of Freedom for DSWs = 298, Hospitality employees = 103, Student employees = 120, VET employees = 53

Despite there being some statistically significant differences, the mean differences were all relatively small, with the largest mean score difference being 0.11 (for the student sample in "Safety Communication, Learning, and Trust in Co-Worker Safety Competence"). Perhaps more importantly, from a practical perspective all mean scores for the statistically different dimensions except three

would continue to be classified in the same benchmarking range according to the NOSACQ interpretation guidelines. “Workers’ Safety Commitment” would be benchmarked differently for the student employees (50-item mean = 3.23, 24-item mean = 3.31), and “Safety Communication, Learning, and Trust in Co-Worker Safety Competence” would be benchmarked differently for the hospitality (50-item mean = 3.27, 24-item mean = 3.36) and student (50-item mean = 3.21, 24-item mean = 3.32) employees. Overall, these results suggest that the existing benchmark data could continue to be applied to the 24-item NOSACQ developed by Summers et al. (2022a) across a range of participant groups; however, the findings also suggest the need for consideration of confidence intervals associated with each of the benchmarking criterion cut-off values when utilising the brief NOSACQ version to improve safety climate score interpretation.

3.7 Discussion

This study sought to further assess the validity of a brief, practical measure for workplace safety climate. The first aim of this study regarding the most appropriate factor structure by which to assess the NOSACQ-50 and NOSACQ-24 showed that the original seven dimensions described by Kines et al. (2011) demonstrate a markedly better fit for the data when compared to the three dimensions (management focussed safety climate, co-worker focussed safety climate, and worker safety priority and risk non-acceptance) identified in the analyses undertaken by Summers et al. (2022a). Support for the seven-dimension structure highlights the external and construct validity of the NOSACQ-24 and suggests that it can effectively provide a seven-dimension assessment of work safety climate. Similarly, these findings support assertions by Shea et al. (2021) that moving beyond purely exploratory analyses and combining confirmatory techniques into the analysis of safety climate measures is likely to yield superior measures.

Additionally, the second aim of this study was to compare goodness of fit for both the 50-item and 24- item versions of the NOSCAQ. While none of the examined models in this study would be considered a poor fit of the data, as all models had at least one acceptable measure of model fit, it is

worth noting that overall, the NOSACQ-24 had better goodness of fit compared to the NOSACQ-50. It is possible that some of the items that introduced unnecessary error to the 50-item version were removed while developing the NOSACQ-24, resulting in improved model fit. This provides support for the multi-faceted methodology employed by Summers et al. (2022) with regard to reducing existing measures of safety climate to enhance practicality.

A third aim of this study involved investigating the applicability of existing benchmarks for the individual dimensions of the NOSACQ (available through the NOSACQ-50 international database). The demonstrated validity and dimension structure of the NOSACQ-24 suggested the possibility that these benchmarks could also be applied to the NOSACQ-24. However, a series of paired samples t-tests across the four employee groups identified significant mean differences between some of the 50- and 24-item dimensions. Nonetheless, the fact that mean differences were very small suggests that from a practical perspective the benchmarking remained largely applicable to the NOSACQ-24. The use of a single cut-off score for benchmarking purposes means that for both versions, a work safety climate dimension score of 2.99 would be classified as a "fairly low safety climate level with need of improvement", which is unlikely to yield significant practical safety differences from a score of 3.01, although this score would be classified as "a fairly good safety climate level with slight need of improvement". A key goal of this research is to assist in bridging the gap between safety climate research and practice and thus for both measures it may be wise for safety practitioners to incorporate the confidence intervals into any practical benchmarking assessment of safety climate. In this way dimensions that may sit on the cusp of one benchmarking bracket or another can be classified appropriately according to the unique risk threshold of each organisation. For example, an organisation with a high risk of physical injury such as manufacturing, or psychological injury such as disability support work may wish to interpret a safety climate dimension score according to the lower end of the confidence interval scale.

The concurrent validity of the NOSACQ-24 was, for the most part, supported by similar significant correlations to those of the full NOSACQ-50 with measures of burnout, and mental and

physical health, thus satisfying a fourth aim of this study. While the relationships between work safety climate and burnout, physical health, and mental health are further endorsed in this study, thus adding to the NOSACQ's importance for identifying emerging work safety issues related to both the already established work safety accidents and incidents, and the physical and mental health of workers, further research is needed to identify other job-related performance, health and work satisfaction outcomes. A potential limitation of this study is the absence of typical work safety-related outcomes such as injury rates and compensation claims but these data were not available. Nevertheless, support for the relationship between safety climate and psychological health outcomes is of particular importance considering that psychological injury claims typically incur significantly larger return to work costs (Safe Work Australia, 2021c). Hence, there is a need for organisations to pursue safety climate interventions as a method for improving both physical and psychological health in the workplace. The fact that the measure of physical health typically had the weakest relationship with the safety climate variables across all dimensions for both measures may be due to comparatively lower physical requirements of the work performed in these types of employment. Future research would benefit from examining correlations between both versions of the NOSACQ and physical health outcome variables in a variety of work roles that involve greater physical requirements.

A final aim of this study was to examine the measurement equivalence and external validity of both versions of the NOSACQ across independent samples of predominantly casually employed participants and permanently employed participants. The results of this study ultimately support the measurement equivalence of the NOSACQ-24 for assessing organisational safety climate among casual or non-permanent employees. To the authors' knowledge this is the first study to have assessed the applicability of the NOSACQ across these types of employees and demonstrates that the measure is not limited only to larger organisations and permanent employees. One interesting finding from the CFA of the student worker data was the significantly reduced value of item 12 ("Management encourages employees here to participate in decisions which affect their safety") in the CFA model which may reflect the differential treatment of non-permanent employees by management reported

by Okoye and Aderibigbe (2014) and the need for management to encourage the participation of casual employees in decisions regarding safety. Thus, the results of this study support the use of the brief NOSACQ-24 and the NOSACQ-50 in samples of predominantly casual employees. Future assessments of work safety climate may need to take into account the rising numbers of non-permanent employees, particularly as the labour market shifts away from employment permanency and toward more casual and contract employment opportunities as a response to competitive pressures for flexibility, work from home arrangements, and improvements in information technology infrastructure (Edgell, 2012). From a theoretical perspective this may impact the methods by which safety climate assessments are developed and evaluated, and similarly from a practical perspective this is likely to impact the way safety climate results are interpreted. Effective safety interventions may differentially impact permanent or casual workers within the same organisation, requiring practitioners to adjust their strategies accordingly.

The measurement equivalence of the NOSACQ-24 was also supported within a smaller independent sample of workers from a different industry sector to those included in initial analyses of Summers et al. (2022a); that is, the group of permanent VET employees. Results of the paired-samples t-tests showed no significant differences between any of the NOSACQ dimensions for this sample, supporting the notion that the NOSACQ-24 could be employed as effectively as the full version to assess the level of organisational safety climate. The validity of the NOSACQ-24 and the reduced time to complete it supports its use for regular monitoring to identify and remediate emerging safety issues before they become critical.

From a theoretical perspective the results of this study support the combination of both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) when developing safety climate measures or refining existing ones (Shea et al., 2021). Where previous research identified a three factor solution for the NOSACQ-24 (Summers et al., 2022a) the confirmatory analyses in this study supported the original seven-factor conceptualisation as the strongest fit for the data. Traditionally using EFA and CFA on the same sample of participants is not considered valuable as EFA

extracts factors from a dataset and CFA subsequently serves to validate these factors. However, when reducing a scale EFA serves an important function to determine if the reduced number of items in a scale still results in the original number of extracted factors. Subsequently, CFA can then be employed to determine the validity of those extracted factors compared to the original measure, and to test the validity of the restrictions implied by the CFA (such as correlated residuals) that did not exist in the EFA (Ferrando et al., 2022). In the case of this study, the better fit of the NOSACQ-24 to the original seven-dimension structure suggests the measure should be interpreted according to these dimensions and not the three dimensions previously identified.

A possible limitation of this study is the size of the student sample, which may have impacted the confirmatory factor analysis results for casually employed workers. While the number of participants (N = 122) is appropriate according to the structural equation modelling literature, having a larger sample size would have been desirable. However, it was not possible to include participants from the VET organisation to improve analytical power as none of the VET employees were casually employed and doing so would have impacted the outcome of the measurement equivalence analysis. Although the student sample was useful in extending the application of work safety climate measures to casual and non-permanent employees, another possible limitation is that they were all employed in different organisations. Future research would benefit from examining the NOSACQ-24 and NOSACQ-50 within a single organisation that employs mostly casual and non-permanent employees. Future research also needs to assess the NOSACQ-24 in a wider range of organisations (e.g., mining, construction, education) and employment types (e.g., lone workers, sub-contractors) to ensure the measure is applicable as a general measure for organisation safety climate, and to assess if existing benchmarks can be applied. Additionally, future research may benefit from examining correlations between safety climate (using the NOSACQ-24) and injury rates in organisations that employ workers exposed to both low injury risk work (e.g., 'blunt end workers') and high injury risk work (e.g., 'sharp end workers') to determine potentially differential correlations between safety climate perceptions and injury rates, or differential values of specific items within the safety climate questionnaire (as with

item 12 across permanent and casual workers). While injury rates were not available in this study, previous research has linked safety climate to injury rates and accident involvement (Clarke, 2006). Hence, examining correlations between safety climate and injuries for workers exposed to different levels of risk within the same organisation will be crucial for understanding this relationship.

The additional evidence in this study regarding dimension structure, external validity, construct validity, concurrent validity, and measurement equivalence of the NOSACQ-24 further supports the item-reduction approach outlined by both Goetz et al. (2013), and the addition of a practice-focussed criterion for item selection proposed in a previous study by Summers et al. (2022a), which ultimately resulted in superior model fit indices. Given that this previous research identified a potential issue regarding negatively worded items and the impact they have on factor structure, future research may benefit from examining model fit indices in a version of the NOSACQ that contains only positively worded questions, particularly because one dimension of the NOSACQ, "Workers' Safety Priority and Risk Non-Acceptance", largely comprises (~85%) negatively worded questions.

3.8 Conclusion

This study sought to further validate the brief, practical work safety climate measure developed by Summers et al. (2022a). Confirmatory factor analysis was performed on an existing data set and an independent sample. Both models confirmed a superior fit of data for the NOSACQ-24 when compared to the NOSACQ-50. Analyses supported the external validity, construct validity, concurrent validity, and measurement equivalence of the NOSACQ-24. The validity and usefulness of the brief NOSACQ-24 for monitoring work safety climate and identifying and remediating work safety issues before they become critical will depend on further research concerning its relationship with important work safety related outcomes in different types of organisations and for different kinds of working conditions. It will also depend on the extent to which parts of the full version of the NOSACQ-50 are needed to understand safety issues identified by the brief NOSACQ-24 and the required strategies that need to be implemented to remediate them.

Chapter 4: Safety Climate across Worker and Job Characteristics: An Investigation of Safety Subcultures

4.1 Statement of Authorship

Submitted Manuscript: Under review
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Denvar Summers, first author, PhD Candidate

This paper reports on original research conducted by Denvar Summers during the period of his Higher Degree by Research candidature and is not subject to any obligations of contractual agreements with a third party that would constrain its inclusion in this thesis. He is the primary author of this paper. He was responsible for the conception of this study, literature review, developing the research aims and hypotheses and data analyses; and wrote the original manuscript. Mr Summers was the first author and corresponding author for the manuscript and was primarily responsible for revisions to the paper. His overall percentage of contribution to the paper is 85%.

Dr Neil Kirby and Dr Julia Harries were the supervisors and/or contributors of the research program to which this manuscript belongs. They collaborated with Mr Denvar Summers on the development of the content and structure of the manuscript and assisted with editing and proof reading. Mr Summers was responsible for the conceptualisation of the research aims and hypotheses, literature review, statistical analysis and write-up of this manuscript. Their role was to discuss the feasibility of his research proposals, provide support and assistance when he encountered difficulties and to provide feedback and editing on manuscript drafts. They give permission for this paper to be incorporated in Mr Summers' submission for the degree of Doctor of Philosophy from the University of Adelaide.

Statement of Authorship

Title of Paper	Safety climate across worker and job characteristics: An investigation of subcultures
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Principal Author

Name of Principal Author (Candidate)	Denvar Summers
Contribution to the Paper	Data collection, performed analyses on all samples, interpreted data, wrote manuscript, and acted as corresponding author.
Overall percentage (%)	85%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature	Date 27/05/2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Neil Kirby
Contribution to the Paper	Supervised development of work, helped in manuscript editing and evaluation.
Signature	Date 7/6/2022

Name of Co-Author	Julia Harries
Contribution to the Paper	Helped with data analysis and interpretation, manuscript editing and evaluation.
Signature	Date 7/6/2022.

Please cut and paste additional co-author panels here as required.

4.2 Preamble

The second study provided support for the validity of the NOSACQ-24 and showed that the existing NOSACQ benchmarks were generally applicable to use with the brief version, albeit the use of confidence intervals associated with the benchmark cut-off points were recommended. These validity findings support the use of the brief NOSACQ as an effective safety climate monitoring measure; however, to really be an effective measure of safety climate it is important that the brief measure has sufficient acuity to identify differences in safety climate perceptions amongst groups within the same organisation.

The presence of between group safety climate differences have implications for the way organisations address safety concerns, and failure to identify and respond to these differences in perceptions have consequences for the likely success of implemented safety interventions. Previous research has demonstrated that the NOSACQ-50 possesses sufficient acuity to identify between group differences in safety climate perceptions, thus it was important to investigate whether the NOSACQ-24 retained this capacity and could contribute towards the understanding of the nature of these differences.

The third study reported here extends the developments of the first and second study and examines the extent to which the brief NOSACQ can identify subcultural differences between employees within a single organisation. The sample included workers from a large vocational education and training (VET) organisation. Key demographics examined at the group (job) level included work-type, management function, employment status, and organisational differences (e.g., workplace location). Key demographics examined at the individual (worker) level included age and gender.

The study addressed the main aim of this thesis which is to determine the applicability and usefulness of a brief safety climate measure across various organisations. It also aimed to contribute to further understanding of the most effective way to examine safety climate assessments by examining results at key subcultural levels in order to more effectively target remedial interventions.

4.3 Abstract

Work safety climate has consistently been linked to safety outcomes and organisations should prioritise regular safety climate monitoring in order to identify emerging safety concerns. Whilst monitoring safety climate is important, several researchers have identified differences in safety climate perceptions between groups within the same organisation. These differences have important implications for the effectiveness of safety interventions. This study examined safety climate perception differences associated with individual (gender, age) and job (work-type, workplace location, management function, working situation, and employment status) factors within the same organisation. Participants (N = 549) from a vocational education and training (VET) organisation completed a brief version of the Nordic Occupational Safety Climate Questionnaire (NOSACQ) and differences were analysed with independent samples t-tests, one-way or two-way ANOVAS. Safety climate differences were identified associated with gender and several job factors including work-type, workplace location, management function, and employment status. Most comparisons also demonstrated implications for benchmarking classifications used to determine the need for safety interventions. Study results provide further validation for the recently developed brief NOSACQ-24 and support the existence of safety climate subcultures at this VET organisation. Safety climate assessments should take these subcultural factors into consideration when designing remedial strategies for safety issues.

Keywords: Safety Climate Assessment, Organisational Subculture, Accident Prevention

4.4 Introduction

Work safety climate is widely regarded as comprising employees' shared perceptions of management and workgroup policies, practices, and procedures as they relate to workplace safety (Zohar, 2011). A growing body of evidence exists supporting the relationship between work safety climate and work safety outcomes. Positive work safety climate has been linked to increases in safety participation (Beus et al., 2016), safety compliance (Barbaranelli et al., 2015), and safety motivation (Beus et al., 2016). Similarly, as a leading indicator of safety outcomes (as opposed to lagging indicators such as lost-time, fatality rates, or accident rates) work safety climate can be used to proactively assess safety risks and intervene to prevent them from reaching a critical level (Givehchi et al., 2017).

These associations highlight the importance of regularly monitoring work safety climate; however, frequently safety practitioners do not recognise the value of using safety climate tools to assess worker safety perceptions and to evaluate the effectiveness of safety interventions. Contributors to this have been reported to include "…poor instrument selection, ineffective questionnaire administration, flawed analysis of the results and failed follow-up" (Findley et al., 2007, p. 876). A further practical problem with many work safety climate measures is that in order to be comprehensive they are lengthy and, while useful for diagnosing a work safety crisis, their completion time represents a response burden and deterrent with regard to regular implementation for monitoring purposes.

To address the need for a comprehensive yet efficient safety climate measure that safety climate practitioners could implement regularly for monitoring purposes, Summers et al. (2022a) developed a brief version of the 50-item Nordic Occupational Safety Climate Questionnaire (NOSACQ-50; Kines et al., 2011) – an established safety climate tool that incorporates industry benchmarks to facilitate results analysis and the monitoring of changes associated with safety interventions. The NOSACQ was chosen as a desirable safety climate measure to shorten as it measures perceptions of both management and co-worker safety attitudes and behaviours, it has been translated into 40 languages, and has a regularly updated international database for benchmarking safety climate across

multiple industry sectors. The applicability of these safety climate benchmarks along with the construct, external, concurrent validity, and measurement equivalence of the brief NOSACQ-24 have also been previously demonstrated Summers et al. (2021). The findings thus far for this brief NOSACQ-24 version suggest it is a useful work safety climate tool and, due to its close alignment with the full NOSACQ-50 version, enables the more comprehensive measure to be used for more detailed analysis of safety issues identified by the brief measure if required.

4.4.1 Safety Climate Subcultures

The term subculture has often been used within the organisational culture literature, and some of the earliest research identified the potential role of subcultures within overall culture, with Turner (1978, p.101) stating "Each organisational unit or sub-unit will have developed its own distinctive sub-culture and its own version of rationality". At a theoretical level shared values, beliefs and assumptions may develop within organisations based on group or individual factors, and Schneider et al. (2013) proposed that examining safety through a micro lens (as opposed to a macro or macro-micro lens [Martin, 2002]) may reveal that participants occupy within-organisation subcultures "by function, by occupation, by gender, and so forth" (Schneider et al., 2013, p. 370). Previous research has identified safety climate differences amongst groups within the same organisation, suggesting the existence of specific safety climate subcultures. Hence, the term subculture in the context of this research relates to significant differential perceptions of safety climate based on organisational groups and /or groups based on individual level differences. Findley et al. (2007, p. 876) state that between-group work safety differences can lead to "competing priorities, miscommunication and lack of a cohesive safety climate" all of which can have implications for the effectiveness of implemented safety interventions. Within the safety research literature, perceptions of safety climate have been explored across subcultures associated with several variables concerned with both organisational groups and individual demographic groups. This research will be summarised in the following section. The groups selected for examination in this study using the brief

NOSACQ-24 are based on previous research using the NOSACQ-50 that identified differences between selected groups (Bergh, 2011; Bergh et al., 2013; Fargnoli & Lombardi, 2020; Forsell et al., 2017; Kjestveit et al., 2011). These include differences at the organisational (job) level such as work-type, management position, workplace location, employment status (e.g., permanent or casual), and at the individual demographic level such as age and gender.

4.4.1.1 Work-type and Safety

With regard to the influence of work-type differences across participants on safety climate perceptions there are several examples of this within the research literature. Lofquist et al. (2017) identified differences in interpretations of safety rules across three key subcultures identified by Schein (1996) – management, engineering, and operations, within the construction industry. Manning (2017) then expanded the subculture analysis to include a technical/quality level for food safety management. When focusing specifically on work safety, differential perceptions across work-types have been demonstrated between commercial airline pilots, engineers, cabin crew, and ground operations (Gao et al., 2015), registered nurses and nurse assistants (Danielsson et al., 2014), frontline nurses and physicians (Gambashidze et al., 2021), nuclear decommissioning and demolition employees such as managerial, administrative, foremen, and technical support staff (Findley et al., 2007), production, retail, and mine rescue employees (Stasila-Sieradzka et al., 2020), and construction and road maintenance employees (Lingard et al., 2009). The research suggests that there are multiple contributors to the presence of work-type subculture differences in safety perceptions, including exposure to hazards (Marín et al., 2011) and proximity to/use of dangerous equipment (Bergh et al., 2013). This suggests that a reliable measure of safety climate should be able to distinguish between groups performing job roles under different safety related conditions within an organisation.

4.4.1.2 Management Function and Safety

Perceptions of safety climate have also been shown to vary depending on the managerial functions of employees. Significant differences have been demonstrated between management level

and worker level employees within the construction industry (Chan et al., 2021; Gilkey et al., 2012), healthcare industry (Gambashidze et al., 2021; Kristensen et al., 2015; Peterson et al., 2016), aged care industry (Quach et al., 2019), and steel manufacturing industry (Prussia et al., 2003). In general, management level employees appraise safety climate more positively than worker level employees, and Prussia et al. (2003, p. 143) further noted that "When perceived safety climate is poor, managers believe employees are responsible and employees believe managers are responsible for workplace safety. However, as perceived safety climate improves, managers and employees converge in their perceptions of who is responsible for safety". This suggests that incongruence between employees based on whether they are involved in managerial functions or not may also be an indicator of poor work safety climate as not all employees are receiving the same messages with regard to safety.

In general, the research literature supports the notion that workers with managerial functions generally perceive safety climate more positively than non-management level workers. Differences in perspectives of safety between managers and workers are likely to have critical implications for the nature and prioritisation of safety interventions (e.g., associated with different perceptions of risk and trust in the safety systems), thus it is important that the safety climate measure used has sufficient acuity to identify such organisational subculture differences in safety perceptions, particularly given that change is generally authorised and resourced at the management level. Additionally, this highlights the importance of safety practitioners being able to consider both managerial and non-managerial level employees when using a measure of work safety climate to obtain the most accurate evaluation of work safety issues.

4.4.1.3 Employment Status and Safety

Employment status can refer to whether workers are employed on a full-time, part-time, or casual basis, and there have been fewer studies examining differences in safety perceptions across these groups, with varied results reported. With regard to organisational culture, of which safety climate is a component, Deem et al. (2015) found no differences in perceptions between full-time or

part-time employees. In terms of safety specifically, Huang et al. (2003) proposed that the occurrence of workplace injuries – an after-effect related to poor safety climate, adversely impacted job satisfaction in a similar way for both part-time and full-time workers, suggesting no between-group differences. In contrast, Gao et al. (2017) examined perceptions of safety climate across employment status and determined that sub-contractors (similar to casual workers) viewed safety climate more positively than main-contractor employees, partly due to more effective communication between the subcontractors and their compatriot supervisors, and partly due to local subcontractors having more related working experiences and knowledge of local safety regulations. More recently research has examined the impact of employment status on musculoskeletal complaints, which have been previously associated with poor safety climate (Golubovich et al., 2014). Bahk et al. (2021, p. 64) suggested that "Employees with musculoskeletal pains might be more likely to have precarious employment" due to inequalities in physical job demands and job autonomy. Similar to this, Okoye and Aderibigbe (2014) examined perceptions of safety climate across permanent (both part-time and full-time) and casual workers in the construction industry. Results indicated that casual workers had more negative perceptions of safety climate when compared to permanent workers, and the authors suggest that this may be due to a negative bias towards the organisation as a result of differential treatment by management across the two groups with regard to benefits, welfare packages, job conditions, and salary. Reports of safety perceptions of full-time and part-time workers tend to be similar throughout the research literature, leading some researchers to classify them together as permanent employees. However, the impact of employment status on perceptions of safety climate is less clear for casually employed workers, with some studies reporting more positive safety perceptions whereas others report more negative perceptions than permanent workers. Chiang (2009) suggested that as casual or subcontracting workers are often paid proportionately to the work produced, they may be more likely to neglect safety and hence have a more negative view of it when it impedes production. Additionally, research suggests that due to the more transient nature of casual employment, workers may tend to accept poorer safety standards (Guldenmund et al., 2013). These

results suggest that understanding the subcultural effect of employment status on safety may become increasingly important as the workforce becomes increasingly casualised.

4.4.1.4 Workplace and Safety

The impact of workplace location has been explored within the research literature with regard to safety, with mixed results also reported. Slip and fall-related injuries were examined across work locations by Bell et al. (2000) within an organisation in the coal mining industry. The researchers examined the risk of a safety incident occurring across three work locations: enclosed, outdoor/enclosed, and outdoor/not enclosed, and found that the risk of a safety incident was the same across the three locations. However, this study examined different locations within the same geographic work site. Other studies that have examined different locations across geographic work sites demonstrate different results. When examining the impact of local cultures on safety risk perceptions Owusu Danso et al. (2022) suggested that personal safety attitudes of site workers have a significant effect on their risk-taking behavioural intentions. Data were collected across multiple construction sites performing similar work within the same organisation in Ghana and the researchers revealed that four location-specific cultures (belief in God for protection, revering attitudes towards elders, valued opinions of family members, and having faith in God to overcome safety risks) mediated this relationship. Delikas et al. (2019) compared the safety climate perceptions of healthcare workers across 17 regular general practitioner offices and seven out-of-hours medical clinics (all within the same public healthcare system) in the Sogn and Fjordane county of Norway. Due to clustering of participant safety climate scores, work location was able to be determined based on responses, and high and low safety climate scores could be differentiated across the general practitioner and out-of-hours locations. Similar to this, Cheyne et al. (2002) demonstrated significant differences in perceptions of safety climate between two locations of a large multinational company within the same manufacturing sector. These combined results suggest perceptions of safety climate may differ across

workplace locations, and that unique interpretations and understanding of safety policies may differ at this subcultural level.

4.4.1.5 Age and Safety

Studies of injury rates and safety perceptions across age groups have provided mixed results. Muhammad and Marcham (2021) summarised work injury incidence rates per 10,000 people from the US Bureau of Labor Statistics and reported a significant effect of age. Their analyses revealed incidence rates were significantly higher for young workers aged 16-19 years, and older workers aged 45-54 years and 55-64 years. This suggests that differential basic assumptions, values, or beliefs across age groups may influence injury rates, which in turn can impact overall perceptions of safety. However, the nature of this relationship is not linear. Explanations for the incidence of injury across age groups within the research literature include suggestions that younger workers lack the experience and skills necessary for managing hazardous workplace situations (Nykänen et al., 2018) and that older workers may experience physical and cognitive decline (Ropes, 2013). With regard to perceptions of safety at work, Han et al. (2019) revealed that mid-career workers (i.e., aged 37-46 years) tend to underestimate safety risks from common hazardous encounters and suggested the need for continued safety refreshers within organisations. Contrastingly, Holden et al. (2009) examined three age groups of workers across four US Air Force ambulatory care facilities: younger than 31 years, 32-41 years, and 42-63 years, and revealed that the youngest age group had the lowest scores for both overall safety performance and teamwork climate, safety climate, perception of management, and job satisfaction. These differences remained even when controlling for professional group. In a study of construction workers Soilkovska et al. (2015) found a moderating effect of age when looking at the relationship between job satisfaction and safety climate. The researchers demonstrated that older partially satisfied employees perceived management as more committed to safety when compared to younger partially satisfied employees. In a structural equation modelling (SEM) study of older (35+ years) and younger (18-35 years) workers, Idress et al. (2017) found that workload and job satisfaction were

significant factors contributing to perception of safety in older workers, whereas organisational relationships, mental stress, and job security were significant factors for younger workers, indicating that the perception of safety is not shared between different age groups of workers, and potentially indicates subcultural differences. Additionally, Ajslev et al. (2017) used safety climate as an outcome variable and reported higher odds of experiencing an accident among young workers (18-24 years). Hence, the impact of age on perceived safety climate has yielded mixed results and warrants further investigation.

4.4.1.6 Gender and Safety

Gender differences in perception of safety between males and females have been widely reported, including perceptions of safety in urban environments (Mulvey, 2002), public transport (Ouali et al., 2020), and railway stations (Coppola & Silvestri, 2021), with females consistently rating perceptions of safety lower than men. Males have also consistently demonstrated more risky behaviours than females in activities such as driving a vehicle (e.g., Cordellieri et al., 2016). At an organisational level, Taka et al. (2016) examined the effect of gender on burnout (a known correlate with safety climate; Kirby et al., 2014) among university academics. The researchers reported a significant interaction between gender and perceptions of organisational climate, whereby perceived gender inequality enhanced personal and work-related burnout in females, but not males. Similarly, Han et al. (2019) examined demographic factors that influence safety perceptions within the construction industry and showed that females rated all eight presented safety scenarios as significantly more dangerous than males. Comparatively, male participants had higher levels of confidence with regard to correctly evaluating the severity of an identified threat. Among cleaning staff gender differences have also been demonstrated, whereby symptoms of safety risks such as exposure to chemicals were more prevalent among females but reporting of these risks were lower when compared to males (Lee et al., 2021). In contrast to the previous research, when examining perceptions of safety among frontline physicians and nurses, Gambashidze et al. (2021) found a very

limited direct effect of gender. However, gender was shown to have an indirect effect on perceptions of safety through significant positive effects on both profession (i.e., work-type) and managerial function, consistent with males being more likely to be physicians and hold managerial positions, with both of these groups reporting more positive perceptions of safety. Thus, examinations of gender differences with regard to perceptions of safety may also need to include consideration of these types of interactions. These studies ultimately demonstrate mixed results at the individual level for perceptions of safety across males and females in the workplace, and suggest further investigation is warranted.

4.4.2 Research Aims

Considering previous research using the NOSACQ-50 has identified safety climate differences across various demographic subcultures, and broader safety perceptions and outcomes have been demonstrated across these groups, the primary goal of this study is to determine if the subcultural demographic differences previously identified using the NOSACQ-50 can also be identified using the brief NOSACQ-24. Accordingly, these safety climate differences will be examined across both the individual (age, gender) and workgroup levels (work-type, managerial function, employment status, workplace location). The identification of subcultural differences in work safety climate within a single organisation will provide further validation of the brief NOSACQ-24 through alignment with the original 50-item measure, and may assist in advancing safety management theory through the identification of specific group or individual factors that differentially impact perceptions of work safety climate, and its practical application in being able to target different interventions for different groups to remediate identified work safety issues before they become critical.

4.5 Materials and Method

4.5.1 Participants

Participants in this study were employed at a large Australian vocational education and training (VET) organisation. A total of 549 employees responded to the safety climate questions in the

survey via the online Qualtrics platform. Two thousand participants were invited to complete the survey, without having to provide their names, resulting in an organisational participation rate of 27.5%. Participants who provided their gender information in the survey comprised 147 males (26.8 %), 316 females (57.6 %), with 86 (15.7%) not reported. The larger proportion of females to males is representative of the organisation as a whole. Some participants did not respond to all demographic questions and thus there is missing data across the various demographic questions as evident in Table 12, which shows the demographic information of participants.

Participants reported that they worked in either a management position (e.g., supervisor, line manager, senior manager/director, executive) or team member role (i.e., no supervisory/managerial responsibilities). Participants worked across seven different work locations. Location 1 represents a metropolitan location and Locations 2-7 represent regional locations. Participants were also grouped into three key employment types: weekly paid which included job roles involving government services, metal trades, and childcare/crèche services; professional services which included administration, technical and operational roles such as IT and customer service; and education services which involved teaching and assessment of students. The only variable where gender varied proportionally was for employment type where more females worked in professional services compared to males who tended to be in education roles.

Table 12

Age, Age Category, Employment Status, Employment Type, Management Position, Work Location, and Working Situation of participants.

	Males (n=147)	Females (n=316)	All participants including gender not reported (N=549)
Age			
Mean (SD)	52.58 years (9.09)	50.83 years (9.44)	51.24 years (9.38)
Range	25-70 years	25-73 years	25 – 73 years
Age Category			
25-34 years	4 (2.7%)	16 (5.1%)	22 (4%)
35-44 years	29 (19.7%)	69 (21.8%)	102 (18.6%)
45-54 years	44 (29.9%)	93 (29.4%)	141 (25.7%)
55-64 years	47 (32%)	86 (27.2%)	135 (24.6%)
65-74 years	8 (5.4%)	10 (3.2%)	18 (3.3%)
Not Reported	15 (10.3%)	42 (13.3%)	131 (23.8%)
Employment status			
Permanent	142 (96.6%)	299 (94.6%)	469 (85.4%)
Casual	5 (3.4%)	16 (5.1%)	21 (3.8%)
Not Reported	-	1 (0.3%)	59 (10.8%)
Employment type			
Weekly paid	11 (7.5%)	21 (6.6%)	33 (6%)
Professional services	42 (28.6%)	139 (44%)	191 (34.8%)
Education	92 (62.6%)	153 (48.4%)	262 (47.7%)
Not Reported	2 (1.3%)	3 (1%)	63 (11.5%)
Management position			
Yes	29 (19.7%)	61 (19.3%)	98 (17.9%)
No	116 (78.9%)	249 (78.8%)	383 (69.8%)
Not Reported	2 (1.4%)	6 (1.9%)	68 (12.3%)
Work location			

Location 1[a]	109 (74.2%)	219 (69.3%)	352 (64.1%)
Location 2 [b]	3 (2%)	20 (6.3%)	24 (4.4%)
Location 3 [b]	6 (4.1%)	23 (7.3%)	29 (5.3%)
Location 4 [b]	4 (2.7%)	5 (1.6%)	10 (1.8%)
Location 5 [b]	15 (10.2%)	29 (9.2%)	45 (8.2%)
Location 6 [b]	7 (4.8%)	13 (4.1%)	21 (3.8%)
Location 7 [b]	3 (2%)	1 (0.3%)	4 (0.7%)
Metropolitan Total	109 (74.1%)	219 (70.6%)	352 (64.1%)
Regional Total	38 (25.9%)	91 (29.4%)	133 (24.2%)
Not Reported	-	6 (1.9%)	64 (11.7%)
Working situation			
On campus only	89 (60.5%)	197 (62.4%)	306 (55.8%)
Only at home	1 (0.7%)	8 (2.5%)	9 (1.6%)
Blended (campus and at home)	50 (34%)	99 (31.3%)	156 (28.4%)
Not Reported	7 (4.8%)	12 (3.8%)	78 (14.2%)

[a] Metropolitan location [b] Regional location

4.5.2 Ethics

Ethical approval for this research was obtained through the University of Adelaide Human Research Ethics Subcommittee (Code number: 19/61)

4.5.3 Method

Participants were invited to partake in a workplace safety survey through their organisation's internal newsletter and intranet. Participants were assured that their responses would be confidential and that only group results would be reported. Responses were collected using the online Qualtrics platform. The survey collected demographic and workplace information, as well as perceptions of safety climate. It is important to note that the responses were gathered during the time of the COVID-19 global pandemic, and thus general responses on perceptions of safety at work may be lower than what would be typical for the organisation.

4.5.4 Measures

Brief Nordic Occupational Safety Climate Questionnaire (NOSACQ): All participants rated the safety climate of their workplace using the brief NOSACQ-24 developed and validated by Summers et al. (2021; 2022a). The measure assesses the same seven safety climate dimensions as the full NOSACQ, three management-focussed and four worker-focussed:

1) Management Safety Priority, Commitment and Competence;
2) Management Safety Empowerment;
3) Management Safety Justice;
4) Workers' Safety Commitment;
5) Workers' Safety Priority and Risk Non-Acceptance;
6) Safety Communication, Learning, and Trust in Co-Worker Safety Competence; and
7) Workers' Trust in the Efficacy of Safety Systems.

The NOSACQ-24 employs the same 4-point Likert response scale as the NOSACQ-50, eliminating the possibility of a neutral response. Previous research by the authors has validated the use of the NOSACQ-24 across several samples, including a sample of VET employees involved in this study. Summers et al. (2021) found no significant differences in dimension mean scores between VET participants who used the 50-item or 24-item version of the NOSACQ. The NOSACQ provides benchmarks for assessing the safety climate of organisations and these have been established as suitable for use with the brief NOSACQ-24 version (Summers et al., 2022a). NOSACQ benchmarks recommend that mean dimension scores of 3.30 or more indicate a good safety climate, 3.00-3.29 indicates a fairly good safety climate with slight need for improvement, 2.70-2.99 indicates a fairly low level of safety climate with need for improvement, and scores below 2.70 indicate a low safety climate with great need for improvement. It is important to note the difference between the level of a safety climate dimension score and the strength of a safety climate dimension score. As mentioned, the level often reflects where a dimension would be benchmarked. Comparatively, the strength of a safety climate score relates to the intra-unit standard deviation of safety climate scores, with smaller standard deviations representing greater strength of a dimension (Tawfik et al., 2019). As such, the focus of this study is primarily the safety climate level. As per the NOSACQ interpretation guidelines for calculating dimension means "only answered items will be entered into the calculation, if someone answers less than 50% of items in a dimension, ignore and do not include in the total mean" (The National Research Centre for Work Environment, 2022a). As a result of this, due to some missing responses the total number of reported participant responses per safety climate dimension varies from 531 – 549.

4.6 Results

A priori power analysis was conducted using G*Power (3.1.9.7) to compute required sample sizes using a 0.80 power level and $\alpha = .05$ significance criterion to detect a medium effect size ($d = 0.3$) and all sample sizes were adequate for analyses undertaken. Normality of measures was investigated

visually and using z-score calculations of skewness and kurtosis. Due to kurtotic distribution (two measures) bootstrapping (using the bias-corrected and accelerated method with 1000 iterations) was used for all analyses of safety climate dependent variables. Mean differences associated with subcultures were examined using independent samples t-tests and ANOVA with post-hoc analyses utilising LSD when Levene's test was non-significant and Games-Howell when Levene's test was significant. Table 13 shows the descriptive statistics for the NOSACQ safety climate scores of all participants and the NOSACQ Cronbach Alpha values, which were acceptable for each of the seven NOSACQ dimensions.

Table 13
Descriptive statistics and Cronbach's Alpha for the seven NOSACQ-24 safety climate dimensions.

NOSACQ Safety Climate Dimension	Responses (N)	Range	Cronbach's Alpha	Mean (SD)
Management Safety Priority, Commitment & Competence	549	1.00-4.00	.87	2.87 (0.63)
Management Safety Empowerment	546	1.00-4.00	.90	2.76 (0.63)
Management Safety Justice	539	1.00-4.00	.89	2.93 (0.59)
Worker Safety Commitment	544	1.00-4.00	.81	3.08 (0.52)
Workers' Safety Priority & Risk Non-Acceptance	538	1.00-4.00	.73	2.96 (0.58)
Safety Communication, Learning, & Trust in Co-Worker Safety Competence	533	1.00-4.00	.85	3.12 (0.48)
Workers' Trust in the Efficacy of Safety Systems	531	1.00-4.00	.76	3.15 (0.48)

Note: NOSACQ-24 scale = 1-4.

4.6.1 Safety Climate Subcultures at the Job Characteristics Level

4.6.1.1 Management Position

Independent samples t-tests were employed to examine differences in perceptions of safety climate between participants in a management position and participants in a team level position

(having no supervisory responsibilities) for each of the seven safety climate dimensions. Management level employees rated all seven dimensions of safety climate as higher than team member level employees; however, this was only statistically significant for one dimension. Perceptions of "Management Safety Justice" were significantly higher for management level employees (*M* = 3.07 [BCa 95% CI 2.94 – 3.19], *SD* = 0.66) when compared to team member level employees (*M* = 2.92 [BCa 95% CI 2.86 – 2.99], *SD* = 0.56), *t*(467) = 2.22, p = .044, Cohen's *d* = .254. This indicates a small effect of management position on perceptions of Management Safety Justice within the organisation. From a practical perspective the safety climate means for the groups would be classified differently according to the NOSACQ benchmarking interpretation guidelines. Management level safety climate would be classified as representing a "fairly good safety climate with slight need for improvement" whereas the team member safety climate would be classified as "fairly low safety climate with need for improvement".

4.6.1.2 Workplace Location

The effect of workplace location on perceptions of safety climate on the seven dimensions was examined using one-way ANOVAs. A significant effect was revealed for one dimension: Workers' Trust in the Efficacy of Safety Systems. Levene's test for homogeneity of variance was non-significant (*p* = .854) so post-hoc analyses using the LSD criterion for significance were examined. Significant differences in perceptions of safety climate for this dimension were found between participants at Location 2 and Locations 1, 3 and 5, with those at Location 2 reporting higher perceptions of the safety climate dimension than the other three locations as shown in Table 14. As also indicated in Table 14, safety climate benchmarking interpretation was also found to differ across these groups. Additionally, significant differences were identified between participants at Location 3 and Locations 4 and 7, with those at Location 3 reporting lower perceptions of the safety climate dimension than the other two locations. Again, these locations would be classified differently from a practical perspective as well.

Regional locations were then grouped together in order to compare overall differences in safety climate perceptions between regional and metropolitan workers. To examine these differences independent samples t-tests were used. Across all seven dimensions regional workers rated safety climate more positively than metropolitan workers; however, this was only statistically significant for the dimension "Workers' Safety Commitment". Regional workers (*M* = 3.19 [3.11 – 3.28 BCa 95% CI], *SD* = 0.49) rated this dimension significantly higher than Metropolitan workers (*M* = 3.06 [3.01 – 3.12 BCa 95% CI], *SD* = 0.52), *t*(469) = -2.43, *p* = .017, Cohen's *d* =.251. This represents a small effect of workplace location on perceptions of Worker's Safety Commitment but would not change the classification of safety climate benchmarks according to the interpretation guidelines as the safety climate for both location types would be classified as "fairly good safety climate with slight need for improvement".

Table 14

One-Way Analysis of Variance, Means with Bias-Corrected and Accelerated 95% Confidence Intervals, Standard Deviations, NOSACQ Safety Climate Benchmarking Classifications, and LSD Post-Hoc Analysis of the Workers' Trust in the Efficacy of Safety Systems Safety Climate Dimension Scores across Workplace Locations.

NOSCAQ Safety Climate Dimension	*F* (df)	*p*	Location Mean (SD) [BCa 95% CI] NOSACQ Benchmark Classification		*p*
Workers' Trust in the Efficacy of Safety Systems	2.51 (6, 464)	.021	Location 2[b] 3.37 (0.47) [3.17 – 3.57] G	Location 1[a] 3.15 (0.49) [3.09 – 3.20] FG	.027
				Location 3[b] 2.99 (0.54) [2.78 – 3.19] FL	.004
				Location 5[b] 3.09 (0.53) [2.93 – 3.25] FL	.022
			Location 3[b] 2.99 (0.54) [2.78 – 3.19] FL	Location 4[b] 3.40 (0.47) [3.07 – 3.73] G	.022
				Location 7[b] 3.58 (0.50) [2.79 – 4.38] G	.024

[a] Metropolitan location [b] Regional location

Note. L = low safety climate with need for improvement, FL = fairly low safety climate with need for improvement, FG = fairly good safety climate with slight need for improvement

4.6.1.3 Work-Type

Participants were classified as working in one of three different work-types: weekly paid, professional services, and education services. One-way ANOVAs revealed a significant effect of work-type for the three management-focussed safety climate dimensions: Management Safety Priority, Commitment and Competence; Management Safety Empowerment; and Management Safety Justice.

Levene's Test of homogeneity of variances was significant for all three dimensions (p <.001, p = .002, p <.001, respectively), hence Games-Howell post-hoc testing was examined. Results showed that education services employees rated these three dimensions of safety climate as significantly poorer than the other two work-type groups. Table 15 shows the results of the analyses for these three dimensions. The table further demonstrates that the three work-type groups would also differ from a practical perspective with regard to safety climate benchmarking classifications.

Table 15

One-Way Analysis of Variance, Means with Bias-Corrected and Accelerated 95% Confidence Intervals, Standard Deviations, NOSACQ Safety Climate Benchmarking Classifications, and Games-Howell Post-Hoc Analysis of Safety Climate Dimension Scores Across Work-Types.

NOSACQ Safety Climate Dimension	*F* (df)	*p*	Work-Type Mean (SD) [BCa 95% CI] NOSACQ Benchmark Classification		*p*
Management Safety Priority, Commitment and Competence	16.70 (2, 483)	<.001	Education 2.72 (0.69) [2.64 – 2.81] FL	Professional Services 3.04 (0.52) [2.97 – 3.11] FG	<.001
				Weekly Paid 3.07 (0.54) [2.88 – 3.26] FG	.004
Management Safety Empowerment	12.84 (2, 480)	<.001	Education 2.63 (0.67) [2.55 – 2.72] L	Professional Services 2.89 (0.54) [2.82 – 2.97] FL	<.001
				Weekly Paid 3.02 (0.55) [2.82 – 3.21] FG	.002
Management Safety Justice	10.41 (2, 473)	<.001	Education 2.83 (0.66) [2.75 – 2.91] FL	Professional Services 3.06 (0.50) [2.99 – 3.12] FG	<.001
				Weekly Paid 3.15 (0.39) [3.01 – 3.29] FG	<.001

Note. L = low safety climate with need for improvement, FL = fairly low safety climate with need for improvement, FG = fairly good safety climate with slight need for improvement

4.6.1.4 Employment Status

Independent samples t-tests were employed to examine differences in safety climate dimension scores for permanent and casual workers. Casual workers reported higher safety climate scores for all seven dimensions; however, this was only statistically significant for two dimensions - Management Safety Priority, Commitment, and Competence and Workers' Trust in the Efficacy of Safety Systems. Table 16 shows the results of the analyses for these two dimensions. For both dimensions the safety climate perceptions of permanent and casual workers would be classified differently from a practical perspective.

Table 16

Means with Bias-Corrected and Accelerated 95% Confidence Intervals, Standard Deviations, NOSACQ Safety Climate Benchmarking Classifications, Independent Samples t-test, and Cohen's d Effect Size for Safety Climate Dimension Scores across Permanent and Casual Workers.

Safety Climate Dimension	Permanent Mean (SD) [BCa 95% CI] NOSACQ Benchmark Classification	Casual Mean (SD) [BCa 95% CI] NOSACQ Benchmark Classification	*t* (df)	*p*	Cohen's *d*
Management Safety Priority, Commitment, and Competence	2.87 (0.63) [2.81 – 2.94] FL	3.13 (0.53) [2.91 – 3.36] FG	-1.84 (473)	.034	.410
Workers' Trust in the Efficacy of Safety Systems	3.14 (0.49) [3.09 – 3.18] FG	3.36 (0.47) [3.15 – 3.56] G	-1.99 (473)	.033	.443

Note: NOSACQ-24 scale = 1-4. FL = fairly low safety climate with need for improvement, FG = fairly good safety climate with slight need for improvement, G = good safety climate.

4.6.1.5 Working Situation

The effect of working situation (i.e., work only on campus, work only at home, work a blended combination of on campus and at home) on perceptions of safety climate was explored using one-way ANOVAs. Although employees working in a blended situation consistently rated the management level safety climate dimensions most positively, and employees working only on

campus consistently rated the co-worker level safety climate dimensions most positively, there were no significant effects of working situation across any of the seven safety climate dimensions.

4.6.2 Safety Climate Subcultures at the Individual Level

4.6.2.1 Gender

Differences in safety climate perceptions across gender groups were examined using independent samples t-tests, comparing participants who identified as male or female. For all seven of the dimensions, females rated safety climate more positively than males, but these differences were only significant for the three management level safety climate dimensions: Management Safety Priority, Commitment and Competence; Management Safety Empowerment; and Management Safety Justice. Table 17 shows the results of the analyses for the three management dimensions and indicates a small effect of gender. From a safety climate benchmarking perspective, there were also practical differences between males and females for the dimension Management Safety Justice.

Table 17

Means with Bias-Corrected and Accelerated 95% Confidence Intervals, Standard Deviations, Independent Samples t-test, and Cohen's d Effect Size for Safety Climate Dimension Scores across Male and Female Workers.

Safety Climate Dimension	Male Mean (SD) [BCa 95% CI] NOSACQ Benchmark Classification	Female Mean (SD) [BCa 95% CI] NOSACQ Benchmark Classification	*t* (df)	*p*	Cohen's *d*
Management Safety Priority, Commitment and Competence	2.80 (0.66) [2.68 – 2.90] FL	2.96 (0.60) [2.89 – 3.04] FL	-2.70 (448)	.010	.273
Management Safety Empowerment	2.70 (0.63) [2.59 – 2.80] FL	2.85 (0.61) [2.77 – 2.92] FL	-2.38 (448)	.020	.240
Management Safety Justice	2.88 (0.58) [2.78 – 2.97] FL	3.02 (0.56) [2.96 – 3.09] FG	-2.48 (448)	.011	.250

Note: NOSACQ-24 scale = 1-4. FL = fairly low safety climate with need for improvement, FG = fairly good safety climate with slight need for improvement.

4.6.2.2 Age

One-way ANOVAs were employed to examine the effect of age on perceptions of safety climate. Despite there being a wide range of ages involved in the study, there were no significant effects of age categories across any of the seven safety climate dimensions.

4.6.3 Gender Interaction Effects

As previous safety climate research has demonstrated a relationship between gender, work-type and management position (Gambashidze et al., 2021), two-way ANOVAs were performed to assess any interaction effects. With regard to gender and work-type there were no significant interaction effects for any of the seven safety climate dimensions. However, management position and gender did yield significant interaction effects for two safety climate dimensions.

With regard to Management Safety Justice, a significant interaction effect of management position and gender was found such that male employees in a management position (*M* = 3.23 [3.02

– 3.43 BCa 95% CI], *SD* = 0.73) rated this dimension significantly more positively than male employees in a team member position (*M* = 2.80 [2.70 – 2.90 BCa 95% CI], *SD* = 0.52), *F*(1, 443) = 6.167, *p* = .013. η_p^2 = .014.

For the dimension Workers' Safety Priority and Risk Non-Acceptance a similar significant interaction effect of management position and gender was also found. Males in a management position (*M* = 3.22 [3.01 – 3.42 BCa 95% CI], *SD* = 0.70) also rated this dimension significantly more positively than males in a team member position (*M* = 2.87 [2.77 – 2.97 BCa 95% CI], *SD* = 0.55), *F*(1, 450) = 5.944, *p* = .015, η_p^2 = .013.

Interaction effects were also examined for work-type and gender, employment status and gender, workplace location and gender, age and gender, and work-type and employment status. No significant interaction effects were found for these analyses.

4.7 Discussion

This study sought to determine if the practical usefulness of a brief 24-item version of the NOSACQ could be enhanced by being able to identify safety climate subcultural differences among vocational education and training (VET) employees. Consistent with previous research associated with work safety climate subcultures identified using the NOSACQ-50, the brief version similarly identified between-group differences for this sample of VET employees. Analyses indicated that between-group differences existed across managerial function, work-type, workplace location, employment status, and gender. In most cases the significant differences tended to be more for management level rather than worker level dimensions. The reliability of these results may be affected by the number of comparisons made and the fact that significant differences were relatively small even though they did, in some cases, result in different benchmarking classifications of work safety climate. However, the ability to identify differences between these subcultural groups is a key strength of the NOSACQ-50 and the present results suggest that the capacity to identify such differences has been maintained for

the brief NOSACQ-24 developed by Summers et al. (2022a), with these findings further validating the brief measure for use in research and practical settings.

In this VET sample, safety climate was rated more positively among participants with a managerial function compared to those without, which aligns with similar findings in the literature (Gilkey et al., 2012; Gambashidze et al., 2021; Kristensen et al., 2015; Peterson et al., 2016; Quach et al., 2019). From a practical perspective this highlights the need to assess all levels of employees when measuring work safety climate. If only managerial or non-managerial employees are surveyed organisations may base safety-related decisions on inaccurate and misleading data. At the theoretical level the incongruence of safety perceptions between managerial and non-managerial employees may indicate that information regarding safety is not effectively being communicated to all levels of employees, potentially resulting in unique interpretations of safety policies and procedures.

Safety climate differences were demonstrated across work-types, supporting the importance of safety practitioners examining differences in perceptions of safety climate across various work-types, and suggesting that these groups of employees may develop their own interpretation of safety climate at both management and worker levels. This aligns with broader organisational culture theory (e.g., Schein, 1996) and suggests that subcultural differences can influence perceptions of safety climate. Additionally, these results yield practically significant applications, particularly when considering implementing safety change programs. By understanding the differences in safety climate perceptions between work-types practitioners may more accurately identify work safety issues requiring remediation and target interventions accordingly.

Casual employees working for this VET organisation were shown to perceive safety climate more positively than permanent employees, and this finding adds to the mixed results currently reported within the research literature. Several possible theoretical explanations have been proposed for this difference between groups. Firstly, casual employees may spend less time in the work environment, hence may be less likely to become a part of the workplace community, and therefore the culture of the work group or organisation (Bergquist & Pawlak, 2008). This might lead such

employees to have a less informed view of the work safety climate and a consequent tendency, without evidence to the contrary, to assume a positive view of it. Alternatively, previous research in the adult education sector has suggested that casual workers are concerned about the insecurity of their employment (Gottschalk & McEachern, 2010). It is therefore possible that casual workers would respond more positively to questions about the organisation in the hope of keeping their casual work and perhaps attaining permanency. However, the mixed results reported in the research literature suggest that more research is needed to determine the factors that influence casual workers' safety climate responses.

Consistent with the research literature, workplace location was shown to effect perceptions of safety climate across individual locations with respect to "Workers' Trust in the Efficacy of Safety Systems", and for broader groups (e.g., metropolitan and regional workers) with respect to "Workers' Safety Commitment". In terms of the safety climate benchmarking, differences exist across individual locations for this organisation and would be classified differently from a practical perspective, whereas broader metropolitan and regional location differences would not, which may suggest organisations should examine unique workplace locations when interpreting safety climate results. Different workplace locations within the same organisation that have different work experiences may develop their own shared perceptions and understanding of how safety is valued. This further supports the assertion by Brondino et al. (2012) that from both a theoretical and practical perspective safety climate should be examined at a subcultural level.

In contrast with previous literature, females in this study were shown to have more positive perceptions of safety climate when compared with males although this effect size would be considered small. It is possible that the larger comparative percentage of males who worked in an education role contributed to this because they are exposed to more hazardous teaching environments (e.g., teaching trade skills such as metal working) and thus have a more negative perception of safety climate. However no significant interaction effect was identified for gender and work-type. Nevertheless, these findings confirm that gender should be examined when investigating

work safety climate, and safety management strategies may be enhanced at the practical level by examining safety climate at this level and applying interventions accordingly.

Similar to Gambashidze et al. (2021) a significant interaction effect was identified for gender and managerial function; however, no interaction was found for gender and work-type. Although approximately an equal proportion of males (19.7%) and females (19.3%) held managerial positions within the organisation, the effect of gender on work safety climate perceptions was only evident for males. Both Management Safety Justice and Workers' Safety Priority and Risk Non-Acceptance dimensions were perceived significantly more positively by males with a managerial function. It is possible that males in non-managerial positions work in roles with greater exposure to safety threats (e.g., within a workshop) compared to males in a managerial position, and hence the risk tolerance for these workers may be comparatively lower, resulting in more negative responses.

Of the variables investigated in this study, the only non-significant group differences identified were for age and working situation (e.g., only on campus, only at home, blended). The findings regarding age do not align with previous research that has shown significant age differences in safety perceptions and safety incidents (e.g., Holden et al., 2009; Muhammad & Marcham, 2021). Data on frequency of safety incidents were not available in this study so it was not possible to determine whether certain age brackets were more prone to safety incidents (as in previous studies) despite sharing similar perceptions of safety climate. The fact the NOSACQ-24 did not show differences in safety climate perceptions between age groups may be due to the limited number of participants in both the highest and lowest age brackets in this study compared with previous studies. Previous research that has demonstrated differences between age groups using the NOSACQ-50 (Kjestveit et al., 2011), has primarily focussed on participants in either the youngest (e.g., 18-30 years) or oldest (e.g., 65+ years) age brackets. The sample of participants in the present study had very few employees in either of these age brackets, with no participants reporting their age as under 25 years, only seven employees reporting their age as 30 years or younger, and 18 reporting their age as older than 65

years. This more limited age range may have impacted the analysis of age-related perceptions of work safety climate.

To the authors' knowledge this is the first study to have examined perceptions of work safety climate across different work situation arrangements, which in this study included all work undertaken on campus, working at home only, or working a blended combination of on campus and at home. As the COVID-19 global pandemic continues it is possible that in the foreseeable future blended working arrangements will continue to increase in prevalence. Numerous safety concerns associated with working from home have been identified including physical hazards (e.g., physical strain injuries from ergonomically improper workstations, fatigue and eye strain injury from poor lighting, tripping hazards from communal walkways), but also psychosocial hazards (e.g., due to family or domestic violence). Although the results of this study suggest that in blended working environments perceptions of safety climate do not decrease significantly so that workers can still benefit from the advantages of a blended arrangement, the small numbers involved in this study indicate that this is a topic for further research.

Given that several of the subcultural work safety climate differences identified in this study would be classified differently according to the NOSACQ benchmarking interpretation guide, this suggests that meaningful management- and worker-focussed differences in safety perceptions can exist in the reporting of safety climate when examined across these levels. This has implications for both research and practice. From a research perspective, future analyses of safety climate using the NOSACQ-50 or brief NOSACQ-24 should compare differences in manager and worker safety climate dimensions between demographic subcultures identified in this study, such as differences between males and females, managerial functions, workplace locations, employment status, and work-types. While differences in age brackets were not identified in this study, this may also be a topic for future research, as the finding of no differences in the present study may be due to its limited age range and potentially the absence of any very young workers (i.e., under 25 years). Measures of safety climate may also benefit from examining differences between other demographic groups in order to further

the theoretical understanding of how and why safety climate differs within organisations. It will also be important for future research to examine interactions in order to determine which factors are most influential and whether there are combined effects of particular factors. As demonstrated within this research males in a non-managerial position rated some management- and worker-focussed safety climate dimensions lower than males in a managerial position. However, this difference was not demonstrated for females which suggests that there may be differential impacts of factors like gender on employee perceptions of safety climate in different job roles.

The theoretical implication of the results in this study supports the conceptualisation of work safety climate as existing at different levels in various organisational groups and subcultures (Schneider et al., 2013). By examining perceptions of safety climate (as a reflection of safety culture) through the micro lens (Martin, 2000), specific within-organisation work safety climate subcultures were identified. These subcultural differences at the micro level may interact with macro level influences such as organisational culture and national culture to differentially impact work safety in organisations. This further supports the statement by Schneider et al. (2013) that more multilevel research is needed on factors influencing the formation and maintenance of organisational culture (as reflected through organisational climate).

From a practical perspective examining the differences in the work safety climate dimensions between groups and subcultures within an organisation may help to shape more cost effective safety solutions by appropriately targeting different safety interventions to specific groups and subcultures rather than the entire organisation. The use of a brief work safety climate measure suitable for regular monitoring as part of a broader safety management strategy, can help to identify and remediate emerging safety issues in particular groups or subcultures before they become critical and result in costly safety incidents or accidents (Summers et al., 2022a). Assessing group and subculture differences will also address some of the concerns raised by Findley et al. (2007) regarding the practical use of safety climate measures, reducing misleading general assessments of safety climate and ineffectively targeted interventions.

4.7.1 Limitations and Future Directions

A limitation of this study is that data were collected amidst the COVID-19 global pandemic, which may have differentially impacted perceptions of safety amongst those participants who could work from home and who may have consequently felt safer than those who went to work with colleagues. Additionally, awareness of COVID-19 may have heightened participants' awareness of unsafe or unhygienic COVID-related practices and could have further negatively influenced safety climate perceptions. Future studies will need to continue the examination of the differences in working arrangements, particularly if working from home arrangements continue after COVID-related issues at work have been minimised. Similarly, given the proportionally low number of participants in this study who were working in a blended arrangement and only at home, this too may serve as an area for future research. Discrepancies in sample sizes between groups were also a limitation, although they were accounted for using bootstrapping and appropriate post-hoc testing based on equality of variance metrics. The fact that data in this study came from a single organisation limits the generalisability of these findings. Future research is needed to explore differences in perceptions of safety climate between groups and subcultures in a range of different types of organisations.

4.7.2 Conclusion

This study demonstrated significant statistical and practical differences in perceptions of work safety climate dimensions across various organisational and demographic groups within a single vocational education and training organisation. Results of this study support previous recommendations that safety climate in organisations needs to be appropriately analysed in terms of different work safety climate dimensions and different organisational and individual factors to highlight the value of such measures. This study further supports and extends the practical use of the brief NOSACQ-24 (Summers et al., 2021; 2022a) as a valid and reliable tool for regularly monitoring safety climate to identify emerging work safety issues not only in a whole organisation but also within groups or subcultures of an organisation so that remedial interventions can be targeted to deal with

particular group or subculture safety issues before they become critical, thus contributing to the prevention of accidents and incidents that are costly both financially and in human terms.

Chapter 5: A Brief Supplementary Measure of Organisational Change Capability Factors to Accompany Work Safety Climate Assessments and Facilitate Remedial Interventions

5.1 Statement of Authorship

Submitted Manuscript: Under review
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This paper reports on original research conducted by Denvar Summers during the period of his Higher Degree by Research candidature and is not subject to any obligations of contractual agreements with a third party that would constrain its inclusion in this thesis. He is the primary author of this paper. He was responsible for the conception of this study, literature review, developing the research aims and hypotheses and data analyses; and wrote the original manuscript. Mr Summers was the first author and corresponding author for the manuscript and was primarily responsible for revisions to the paper. His overall percentage of contribution to the paper is 85%.

Dr Neil Kirby and Dr Julia Harries were the supervisors and/or contributors of the research program to which this manuscript belongs. They collaborated with Mr Denvar Summers on the development of the content and structure of the manuscript and assisted with editing and proof reading. Mr Summers was responsible for the conceptualisation of the research aims and hypotheses, literature review, statistical analysis and write-up of this manuscript. Their role was to discuss the feasibility of his research proposals, provide support and assistance when he encountered difficulties and to provide feedback and editing on manuscript drafts. They give permission for this paper to be incorporated in Mr Summers' submission for the degree of Doctor of Philosophy from the University of Adelaide.

Statement of Authorship

Title of Paper	A BRIEF SUPPLEMENTARY MEASURE OF ORGANISATIONAL CHANGE CAPABILITY FACTORS TO ACCOMPANY WORK SAFETY CLIMATE ASSESSMENTS AND FACILITATE REMEDIAL INTERVENTIONS
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Principal Author

Name of Principal Author (Candidate)	Denvar Summers
Contribution to the Paper	Data collection, performed analyses on all samples, interpreted data, wrote manuscript, and acted as corresponding author.
Overall percentage (%)	85%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature	Date 27/05/2022

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Neil Kirby
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Please cut and paste additional co-author panels here as required.

5.2 Preamble

The previous three studies reported in this thesis addressed the development and validation of a brief version of the NOSACQ that was brief enough to be used for regular work safety climate monitoring but that retained sufficient detail to be able to inform interventions to remediate safety concerns. However, the research literature has shown that while change initiatives in organisations occur frequently, most either fail altogether or fail to achieve the intended objective. Successful implementation of organisational change initiatives requires consideration of -- what is termed in this thesis -- as the *change capability* of an organisation.

Although there are many factors that might contribute to an organisation's change capability, this fourth study is concerned with the possibility of developing a brief measure of key factors that affect change capability that could be used in conjunction with the NOSACQ-24. This final study examines the development and validation of a brief 4-item supplementary measure for change capability that assesses worker perceptions of: (1) the overall capability of the organisation to change, (2) top management overt support for changes, (3) organisational use champions of change to facilitate change, and (4) worker engagement and buy-in.

This study reports on the scale development approach for this brief change capability measure and uses factor analyses, reliability assessments, correlations with predicted outcome measures, and thematic analysis of qualitative responses from the participants from the VET organisation outlined in study three in order to validate the measure. Organisational subculture perspectives of change capability were also examined using the key demographic groups outlined in study three.

This study aimed to advance the research aims of this thesis by allowing researchers and practitioners to shift focus from assessing and analysing work safety climate, to remediating identified concerns successfully. A post-intervention change capability assessment was planned with the partner organisation to determine the effectiveness of the measure in a practical setting, however this was not able to proceed as a result of the COVID-19 global pandemic.

5.3 Abstract

This study was concerned with the development of a brief organisational change capability measure designed to accompany a brief work safety climate measure in order to facilitate required interventions for identified work safety issues. Four critical factors were identified and assessed: overall change capability, overt top management support, use of “champions of change”, and worker buy-in. Participants included 485 employees from an Australian vocational education and training organisation who completed measures assessing work safety climate, wellbeing, and change capability. Qualitative comments were requested to provide additional context-specific information, to assess the validity of the measure, and to provide practically useful information to improve change capability. Results indicate appropriate reliability statistics and significant correlations with expected outcome variables (safety climate and mental wellbeing). Exploratory factor analysis suggested a unidimensional model of change capability. The brief change capability measure was further able to discriminate between group and individual demographic differences including gender, work type, and employment status. Preliminary support was provided for the brief organisational change capability measure as a useful adjunct to the previously developed brief work safety climate measure in order to enhance the success of implemented remedial interventions for work safety climate issues. Future directions for research are discussed.

Keywords: Change Management, Critical Change Factors, Work Safety, Wellbeing.

5.4 Introduction

Comprehensive measures of work safety climate, such as the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50; Kines et al., 2011), have been used successfully to identify safety issues in the workplace that require remediation. A study in an Australian government disability organisation by Kirby et al. (2014) used the NOSACQ-50 to identify critical safety issues as a basis for determining and implementing selected remedial interventions. The study reported successful outcomes of these interventions in terms of relevant improvements in mental health, physical health, and three forms of burnout (personal, work-related, client-related). As was the case in the disability organisation study, comprehensive work safety climate measures like the 50-item version of the NOSACQ are most often used when safety issues have reached a critical point, either in terms of accidents or safety related incidents. From a practical perspective it would be preferable for such safety issues to be identified as they begin to emerge rather than after they have reached a critical point. However, a problem with comprehensive measures like the NOSACQ-50 is that due to their length they are time consuming to complete, making them less suited to regular monitoring of emerging work safety issues (Givehchi et al., 2017). To address this problem Summers et al. (2021; 2022a) have developed and validated a brief version of the NOSACQ-50, comprising 24 items and retaining the diagnostic capability and practical usefulness of its three management- and four worker-focussed dimensions.

Critical to the successful implementation of the recommended interventions in the previously mentioned government disability organisation study Kirby et al. (2014) were change related factors that have been identified in the research literature; in particular, overt management support for the interventions, the appointment of “champions of change” responsible for implementing the interventions, and buy-in from workers based on their contribution and participation in selecting interventions most likely to be effective.

Successfully implementing needed organisational changes is challenging but necessary for organisations to remain safe, effective, and competitive in ever-changing circumstances. Researchers

have estimated that 46% of organisations are undergoing three or more complex changes at any one time (Bareil et al., 2007). However, it has also been reported that 70% of organisational change initiatives fail (Hallencreutz & Turner, 2011; Vakola, 2013), and of those determined successful, 75% fail to achieve their original goal (Hallencreutz & Turner, 2011; Nikolaou et al., 2007). Similarly, recent research indicates that executive level employees believe only one in three organisational change interventions are successful (Stouten et al., 2018). With respect to work safety, these results suggest that even if needed changes in the work safety can be identified using a work safety climate measure, successful implementation of remedial interventions is likely to be a major challenge for organisations.

Based on the low levels of success with change initiatives, researchers have suggested that organisations may benefit from assessing factors influencing the level of readiness for change, in order to improve core competencies required to manage change (Vakola, 2013; Vaishnavi & Suresh, 2019). This concept together with its opposite of resistance to change have their foundation in Lewin's (1947) model of unfreezing, changing, and freezing, which argues that any change strategy will have forces that attempt to encourage or resist change. In addition to readiness for change, it has also been argued that "an organisation that needs to change but do *[sic]* not know how to manage it properly, is unlikely to obtain the necessary support to be successful" (Borges & Quintas, 2020, p. 679). Readiness for change and the ability to manage it can be considered part of what the present authors term "change capability" which involves being able to successfully implement organisational change.

Although there are many factors which might contribute to an organisation's change capability the present study is concerned with the possibility of developing a brief measure of key factors affecting this capability that could be used in conjunction with a brief version of the NOSACQ that has been developed to be suitable for monitoring purposes (Summers et al., 2021; 2022a). Thus, a brief change capability measure might be used when the brief work safety climate measure identifies an emerging work safety issue that requires remediation. This would help to ensure that the necessary steps can be taken for the successful implementation of required changes to improve work safety. However, depending on how often the work safety climate is monitored an organisation might also

find it useful to examine change capability on a regular basis as this would be applicable to any continuing organisational changes that need to be made.

As already indicated in previous research (Kirby et al., 2014), three key factors identified from the research literature as contributing to effective change were successfully employed: overt top management support; the designation of "champions of change"; and worker empowerment and buy-in to the change process. As such, these factors might contribute to an effective brief measure of overall change capability. Additionally, a brief measure for change capability may benefit from a question concerning an organisation's overall capacity to successfully implement change. Responses to such a question may reflect consideration of any other important factors relevant to the organisation's capacity to implement changes. As such, research concerning overall capability for change, and the three specific change capability factors will be briefly reviewed.

5.4.1 Overall Change Capability

Kaper et al. (2021) reported that a critical factor for successful change implementation was a culture of innovation that focussed on quality improvement, with change capability being supported by an understanding that the proposed change is necessary and appropriate (Chênevert et al., 2019; Holt et al., 2007; Neves, 2009; Oreg et al., 2018; Vaishnavi & Suresh, 2019). Change initiatives will garner more support among employees if the organisation's culture has been influenced by past changes that have been successfully implemented (Borges & Quintas, 2020; Fuchs & Prouska, 2014; Jansen et al., 2016; Stouten et al., 2018; Vakola, 2013). As highlighted by Bordina et al. (2011) negative past experiences with change can increase resistance to future change attempts. Chrusciel and Field (2006) also assessed success factors in dealing with organisational change and indicated that employee perceptions of their organisation's ability to manage change was crucial for successful implementation. Therefore, assessing how employees perceive the overall effectiveness of procedural improvements in their organisation based on their previous experience is critical to understanding whether future changes will be accepted or resisted.

5.4.2 Top Management Support

The involvement of senior management in change processes is critical for successful outcomes, particularly when it comes to communication from management about how changes are going to occur, and why they are necessary. This sentiment is widely supported throughout the research literature across a variety of industries (Ahmad et al., 2019; Borges & Quintas, 2020; Guidetti et al., 2018; Larkin & Larkin, 1994; McCrae et al., 2014; Stouten et al., 2018; Tanner & Otto, 2016; Vakola, 2013; Vosse & Aliyu, 2018). It has been reported from a review of a number of studies that proper communication and provision of information from management can reduce resistant behaviours by up to 43% (Stouten et al., 2018). Similarly, change, as it is being implemented, needs to have continuing overt support by top management for the change to be successful. This may include appropriate communications about issues that become relevant or factors such as appropriate resourcing and/or the provision of adequate training (Choi & Ruona, 2011; Heyden et al., 2016; Kaper et al., 2021; Khalid & Janjua, 2021; Kirrane et al., 2017; Lee et al., 2018; Lines et al., 2015; Tanner & Otto, 2016; Vakola & Wilson, 2004). Some researchers have argued that top management support is the single most important factor in managing the success of a change project (Young & Jordan, 2008; Young & Poon, 2013). Hence, assessing how employees perceive support from top management with regard to organisational change is essential when examining change capability.

5.4.3 Champions of Change

"Champions of change" is a term referring to individuals being selected to promote and manage organisational change. These individuals act as a driving force that encourages collaboration and deals with any difficulties with the planned change. Champions of change can be individuals or committees designated by top management to be responsible for ensuring the success of a particular change. Hendy and Barlow (2012, p. 349) state that champions of change reflect "a personal commitment…as opposed to emphasising the expertise of seniority" and as such most will have relevant knowledge of the inner workings and internal networks of their organisation, with the

delegated authority to assist in the delivery of successful change (Birkinshaw et al., 2008). Champions of change are authorised to ensure appropriate resources are provided to achieve change, to unlock barriers to change by liaising with senior management and staff, to create and maintain a positive group consensus regarding proposed changes and how they are to be implemented, and to provide support to managers and co-workers who may have concerns regarding different stages of the change process (Chênevert et al., 2019; Chruschiel & Field, 2006; Fuchs & Prouska, 2014; Guidetti et al., 2018; Jansen et al., 2016; Kaper et al., 2021; Lawrence & Callan, 2011; Lines et al., 2015; Pettigrew et al., 1992; Shea, 2021; Shoemaker et al., 2013; Stouten et al., 2018). Combined, these factors assist champions of change to contribute to the successful implementation of organisational change and highlight the critical role that they play in reducing any initial resistance or emerging resistance that may affect the willing participation of relevant managers and staff in the change process.

5.4.4 Worker Buy-In

Empowering workers to take an active role in change processes is another factor that is considered critical to successful change programs. Often buy-in is developed through participatory and consultative approaches whereby workers are given the opportunity to provide relevant information, suggestions for, and selection of, appropriate interventions and change processes. Directly involving workers in the change process has been shown to increase buy-in, support for the change, employee commitment, empowerment, and decrease change related cynicism, all of which are essential for achieving successful change initiatives (Bordina et al., 2011; Borges & Quintas, 2020; Campbell, 2020; Choi & Ruona, 2011; Chrusciel & Field, 2006; Fuchs & Prouska, 2014; Holt et al., 2007; Jansen et al., 2016; Kaper et al., 2021; McCrae et al., 2014; Neves, 2009; Onyeneke & Abe, 2021; Shoemaker et al., 2013; Stouten et al., 2018; Vakola, 2013). Thus, an assessment of buy-in from all key stakeholders including workers is crucial when preparing for organisational change, and when attempting to reduce resistance and promote positive involvement in a change process. Hence, worker buy-in is a key component of change capability.

5.4.5 Study Aims

Currently there exist several measures for change readiness (Holt et al., 2007; Shea et al., 2014), however as previously discussed, readiness for change and capability for change are arguably two distinct concepts. Where change readiness measures focus on the extent to which employees and organisations are psychologically prepared and motivated to implement a particular change (Shea et al., 2014), a measure of change capability moves beyond this to assess the use of factors that determine whether any change can be successfully implemented. An organisation may be prepared and ready for change; however, this is different to having the capability to enact that change. Hence, the first aim of this study is concerned with highlighting the development process for a brief measure of change capability, consisting of the four identified critical factors for facilitating successful change within organisations. This process includes the scale development approach, examining the dimensionality of the measure using exploratory factor analysis (EFA), assessing inter-item correlation, and Cronbach alpha reliability analyses.

The development of the brief measure of change capability was part of a larger study that used a brief version of the NOSACQ together with a measure of mental wellbeing to assess the ongoing work safety climate at a large Vocational and Education Training (VET) organisation and to identify any emerging safety issues that might need remediation. Related research evidence suggests that responses to the change capability statements would be likely to correlate positively with a measure of mental wellbeing. While the research literature examining change readiness and mental wellbeing is limited, a study by Geerligs et al. (2021) showed that participants who reported higher scores for change readiness also reported greater confidence in overcoming anticipated barriers. Increased change capability is likely to share this relationship and may act to decrease known negative mental wellbeing symptoms such as apathy. General worker concerns about change have also been related to increased employee burnout and reduced employee engagement (Guideti et al., 2017) – both known symptoms of poor mental wellbeing.

Similarly, while relevant research literature is scarce, it is expected that there would be a positive correlation between the brief change capability measure and work safety climate. Given that safety climate reflects employee perceptions regarding how safety is valued within their organisation, the capability to successfully enact change is likely to be positively associated with overall safety climate as this may be consistent with ensuring that safety is a priority for remediation when required. To ensure that safety climate is and remains positive, it might be expected that top management would be more likely to support safety initiatives, designated individuals or groups would be more likely to be assigned to support safety initiatives, and workers would be more likely to be consulted regarding necessary safety changes. Benn et al. (2012) examined hospital safety climate in a longitudinal study and proposed that supporting critical change implementation factors may be an effective method for developing organisational and patient safety climate. Thus, research provides some support for a positive relationship between change capability, mental wellbeing, and work safety climate. Accordingly, a second aim of this study is to assess the concurrent validity of the brief change capability measure by examining its relationship with expected outcome variables (in this case, safety climate and mental wellbeing).

Previous research (Summers et al., 2022b) has suggested the ability to identify differences between organisational subcultures is an important component of workplace assessments. From a practical perspective the ability to identify perceptual differences between individuals or groups from within the same organisation allows for more accurate targeting of remedial interventions. From the perspective of measurement validity, organisational subcultures are likely to perceive change capability differently given the different experiences groups have with their organisation, particularly within larger organisations. Hence, if a brief measure of change capability is able to discriminate between subcultures within the same organisation this may provide support for known-groups validity. Thus, a third aim of this study is to further assess the validity and practical usefulness of the brief change capability measure by examining the ability to distinguish between responses from various subcultural groups (e.g., gender, work type, managerial function, employment status).

A fourth and final goal of this study is to examine the qualitative responses of participants with regard to both change capability and broader safety in the workplace. If responses from participants align with the key factors identified: overall change capability, top management support, use of champions of change, and worker buy-in, then the construct validity of using such factors to assess change capability would be supported. From a practical perspective, qualitative responses may also provide directions for future change initiatives or areas of development within the organisation related to change capability.

To briefly summarise, the goals of this study are as follows: (1) to highlight the development process of a brief change capability measure, including assessments of dimensionality, inter-item correlations, and internal consistency; (2) to examine the concurrent validity of the brief change capability measure through correlational analyses with predicted outcome variables; (3) to determine if the brief change capability measure is able to distinguish between organisational subcultural groups; and (4) to assess if the qualitative comments provided by participants align with the four identified change capability factors in order to further validate and support the importance of these factors.

Such a measure of change capability would be beneficial for both researchers and practitioners by providing additional information and areas of development with regard to effective remediation of safety concerns once they have been identified. Although primarily designed in this study to be used in conjunction with a brief 24 item monitoring version of the NOSACQ-50, the use of a brief change capability measure might be extended to any appropriate organisational change. With respect to work safety, while it might only be used when an emerging safety issue has been identified, an organisation might decide to use it with the brief work safety climate measure or other pulse surveys for monitoring purposes to ensure that the organisation remains change capable.

5.5 Materials and Method

5.5.1 Participants

Participants were employed at a large Vocational Education and Training (VET) organisation. A total of 485 employees responded to the change capability statements in the survey which were part of a larger work health and safety survey that included the use of a brief version of the NOSACQ and a measure of mental wellbeing. Responses were collected via the online Qualtrics platform. The larger survey was undertaken in order to generate a baseline of safety climate and mental wellbeing within the VET organisation and to assess if any remedial interventions would be necessary. Approximately 2000 employees were invited to complete the survey, resulting in an organisational participation rate of 24.25%. The mean age of participants was 51.17 years (SD = 9.36) with a range of 25-73 years. The sample of participants was 64.1% female, 29.9% male, with 6% not providing this information. The majority of participants were employed on a permanent full-time or part-time basis (95.7%) with the remaining participants employed on a casual basis (4.3%). Consistent with most contemporary organisations, the VET organisation had previously undergone significant changes and was currently going through changes, including restructuring and with regard to working arrangements that would have provided participants with opportunities to observe the implementation of changes in the organisation.

In terms of job functions 20.2% of participants had managerial responsibilities in their work (e.g., Executive, Senior Manager, Line Manager, Supervisor), and the remaining 79.8% of participants had no managerial responsibilities. Participants were employed across three distinct work types as categorised by the VET organisation: weekly paid workers (7%) which included job roles involving custodial services, metal trades, and childcare/crèche services; professional services (39.4%) which included administration, technical and operational roles such as IT and customer service; and education services (53.6%) which involved teaching and assessment of students.

Data were collected approximately eight months into the COVID-19 global pandemic, and as a result, working situations had been divided into three categories: working only on campus (63.4%), only at home (1.8%), and blended, meaning a mixture of days at home and on campus (34.8%). Work locations were divided into either metropolitan (72.5%) or regional (27.5%).

5.5.2 Ethics

Participants were informed that their responses would be confidential and that only group results would be reported. The study was approved by management of the VET organisation and by the University of Adelaide research ethics committee (Code number: 19/61).

5.5.3 Method

Workers were invited to participate in a workplace health and safety survey by the organisation's Health and Safety unit through their internal newsletter and intranet. Reponses were collected using the online Qualtrics platform. The surveys collected demographic and workplace information, as well as perceptions of safety climate (both quantitative and qualitative), mental wellbeing (quantitative only), and change capability (both quantitative and qualitative).

5.5.4 Measures

5.5.4.1 Change Capability

In order to assess the four factors of change capability proposed in this study, four statements were developed by the authors. Only one statement was developed to represent each critical factor of change capability to ensure the measure remained as brief as possible and to enhance its usefulness as a monitoring tool. Staff members from the VET Health and Safety team reviewed the questions and confirmed they were likely to be easily understood and answered by members of the workforce. All statements were introduced with the words "Please select one response that best reflects your organisation's current abilities regarding the following statements", in order to gain an assessment of current attitudes concerning the change capability factors. Participants were asked to respond using

a four-point Likert-type response where 1 = “Needs considerable improvement”, 2 = “Needs some improvement”, 3 = “Satisfactory”, and 4 = “Is well done”, leaving no option for a neutral response. The decision to remove a neutral response option comes from the determination that change capability is not something that can be neutral, and the nature of the construct is either positive or negative. If participants selected “needs considerable improvement” or “needs some improvement” as a response option, they were then asked to explain their decision through an open-ended qualitative response.

The first statement assessed the organisation’s overall capacity to successfully implement organisational changes. Participants were asked to respond to the statement: “This organisation effectively makes needed improvements to its processes and procedures”. This statement enabled participants to include in their assessment any factors specific to change capability that might affect the organisation’s ability to implement organisational changes successfully.

The second statement assessed top management’s overt encouragement and support for implementing an organisational change. Participants were asked to respond to the statement: “Top management effectively communicates to everyone its encouragement and support for the implementation of changes to improve the organisation”.

The third statement assessed whether champions of change were appointed to guide a change process and maintain its outcomes. Participants were asked to respond to the statement: “This organisation appoints specific individuals or teams responsible for ensuring required changes are implemented and maintained effectively”.

The fourth statement assessed worker buy-in with respect to organisational change. Participants were asked to respond to the statement: “Workers are consulted and involved in the design and implementation of changes to improve the organisation”.

Although the change capability statements were designed to accompany a work safety climate assessment, the choice of wording was intentionally generalised so that the statements can apply to any organisational change experienced by participants.

5.5.4.2 Brief Nordic Safety Climate Questionnaire (NOSACQ)

The brief NOSACQ-24 was developed and validated in previous research (Summers et al., 2021; 2022a; 2022b) and assesses each of the seven safety climate dimensions of the full measure; three of which are management-focussed dimensions: (1) Management Safety Priority, Commitment and Competence; (2) Management Safety Empowerment; (3) Management Safety Justice, and four of which are worker-focussed dimensions: (4) Workers' Safety Commitment; (5) Workers' Safety Priority and Risk Non-Acceptance; (6) Safety Communication, Learning, and Trust in Co-Worker Safety Competence; (7) Workers' Trust in the Efficacy of Safety Systems. The brief measure employs the same 4-point Likert response scale as the full measure (1= Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree) and has no option for a neutral response. It was used in the present study to provide the VET organisation with an assessment of work safety climate and to further validate the use of this brief measure across different types of organisations. Previous research (Summers et al., 2021) has also indicated that the brief version of the NOSACQ can be used with existing benchmarks of the full NOSACQ-50.

5.5.4.3 Short Warwick Edinburgh Mental Wellbeing Scale

Participants were asked to complete the Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS; NHS Health Scotland, University of Warwick and University of Edinburgh, 2008). The measure employs a 5-point Likert response scale (1 = None of the time, 2 = Rarely, 3 = Some of the time, 4 = Often, 5 = All of the time) and contains seven positively worded questions related to mental wellbeing (e.g., 'I've been feeling optimistic about the future'). Participants are asked to select the response that best describes their experiences over the last two weeks. Scores from participants are then summed and transformed into metric scores using a conversion table provided by the developers. The SWEMWBS has been validated for use in the general population (Ng Fat et al., 2017).

5.5.4.4 Qualitative Questions

The survey also included qualitative questions about both work health, safety, and change capability measures. At the end of the brief work safety climate questionnaire participants were asked "Are there any additional comments you would like to make about your answers to the safety in the workplace questions?". Following each of the change capability statements participants were presented with the statement "If you have selected 'needs considerable improvement' or 'needs some improvement' please explain your decision". There were three reasons for only asking qualitative questions of participants who responded negatively to the change capability questions. A theoretical reason was to provide supporting validating evidence for these ratings. One practical reason was to obtain useful information to identify issues of concern and thereby determine what needed to be done to improve the change capability ratings. These responses could provide practitioners with context-specific remedial actions to consider. A second practical reason was to reduce the time required to complete and analyse the brief change capability measure thus enhancing its practical usefulness as a monitoring measure.

Latent thematic analyses using the methods described by Braun and Clarke (2006) were performed on the qualitative data from participants in order to determine if responses would align with the described factors contributing to change capability (overall change capability, top management support, champions of change, worker buy-in). Hence, the qualitative codes were already pre-determined and participant responses were mapped onto these. Given the goal of this study was to develop a brief measure for change capability, this method was deemed most appropriate. Qualitative data were analysed separately for those comments related to the question asked following the brief work safety climate measure and for those related to the responses for questions in the brief change capability measure. However, responses to the survey questions concerning workplace safety were only analysed for this study if they related to the change capability factors, consequently thematic content associated with safety issues unrelated to change capability are not reported here.

5.5.5 Data Analysis

A priori power analysis was conducted using G*Power (3.1) to compute required sample sizes using a 0.80 power level and $\alpha = .05$ significance criterion to detect a medium effect size ($d = 0.3$), with results showing appropriate sample sizes for all planned analyses. This study employed a mixed-methods approach to assess the reliability and validity of the proposed change capability measure. Exploratory factor analysis (EFA), correlational analyses with dependent variables (work safety climate and mental wellbeing), and assessments of differences between demographic groups of participants comprise the quantitative analyses. Normality of measures was investigated visually and using z-score calculations of skewness and kurtosis. All measures were considered normally distributed. All analyses were conducted using SPSS Software Version 28. Latent thematic analysis to determine how participant responses fit the four key factors contributing to change capability comprise the qualitative analyses.

5.6 Results

The results concerning the work safety study of the VET organisation have previously been reported in Summers et al. (2022b). The results reported here will be only those from each of the measures and questions that are relevant to the change capability measure.

Table 18 demonstrates the descriptive statistics for participant responses to the change capability measure. The mean scores for each change capability factor are shown together with the SDs and the percentages of responses for each of the four ratings for each statement. It can be seen that mean responses for all four statements were between a rating of “needs some improvement” and “satisfactory” and the relatively small SDs indicate general consistency in responding. However, it can also be seen that the mean for worker buy-in was the lowest mean rating and it also had the largest percentages of responses indicating a need for considerable improvement or some improvement and the lowest percentage for “is well done”.

Table 18

Means, Standard Deviations and Percentages of Responses from the VET Workers for the Change Capability Questions (N = 485).

Change Capability Factor	Mean (SD)	Improvement Ratings			
		Needs considerable improvement	Needs some improvement	Satisfactory	Is well done
Overall Capability	2.59 (0.84)	12.4%	26.8%	50.1%	10.7%
Top Management Support	2.65 (0.84)	12.4%	21%	55.5%	11.1%
Champions of Change	2.79 (0.74)	6%	22%	59%	13%
Worker Buy-In	2.38 (0.83)	17.7%	30.9%	46.8%	4.5%

Note: Change capability scale = 1-4.

5.6.1 Change Capability Inter-Correlations and Reliability Assessment

In order to confirm the four factors selected to assess change capability are related, a Pearson correlation analysis was performed. The correlation matrix for this analysis is shown in Table 19. All four factors correlated significantly with one another, ranging from moderate to strong correlations. The correlation values suggest that while reasonably homogeneous, the four factors of change capability are not identical to one another. This provides support for the conceptualisation of the change capability measure and suggests the four items are assessing different aspects of the same construct (Cohen & Swerdlik, 2005). While top management support and champions of change correlated most strongly with overall capability; interestingly, worker buy-in had a stronger correlation with top management support. This may be due to worker buy-in being largely enabled and initiated at the top management level and hence employee perceptions of the level of consultation regarding

change may be more closely aligned with perceptions of top management rather than broader organisational change capability.

Table 19
Correlations for VET Worker Responses to Change Capability Factors (N=485).

Change Capability Factor	1	2	3	4
1. Overall Capability	-			
2. Top Management Support	.71***	-		
3. Champions of Change	.69***	.68***	-	
4. Worker Buy-In	.59***	.65***	.59***	-

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

Internal consistency of the change capability measure was then investigated. Internal consistency is a form of reliability and reflects the extent to which items within a scale measure components of the same construct. Cronbach's alpha is commonly used to estimate the internal consistency of a measure, and values greater than .70 are considered acceptable (Hays & Revicki, 2005). Cronbach's alpha was calculated for the change capability construct and was .88 indicating an appropriate level of internal consistency for the scale. Additionally, the alpha score for the scale would not increase with the removal of any of the four items, which provides support for the change capability measure conceptualisation.

5.6.2 Change Capability Exploratory Factor Analysis

The factor structure of the change capability measure was investigated using exploratory factor analysis (EFA) with a principal components analysis approach in order to confirm a single factor structure for the change capability measure. Watkins (2018) asserts that a minimum of three measured variables are needed to perform EFA, indicating the change capability measure can be appropriately assessed in this manner. Additionally, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for the four items in the change capability measure was equal to .83 indicating that factor

analysis could plausibly be performed. Sample size in this study is appropriate based on various recommendations in the literature including a minimum of 100-150 participants (Tabachnik & Fidell, 2001), or a minimum of 200 participants (Kline, 2005).

Principal components analysis with oblique rotation (assuming any identified factors were likely to be correlated) was performed on the scale. Bartlett's test of sphericity was significant (p = <.001) rejecting the null hypothesis that the correlation matrix is an identity matrix. Communalities are reported in Table 20 with no items falling below .50 which would otherwise warrant removal from the scale (Norman & Streiner, 2014). Analysis yielded a one-factor solution accounting for 73.80% of the variance explained. Visual scree plot analysis was performed to confirm these findings. Results of the factor analysis suggest that all four factors are loading onto a single dimension, which provides support for the conceptualisation of change capability.

Table 20

Component Matrix and Communalities for the One-Factor Solution from Principal Components Analysis with an Oblique Rotation for the Change Capability Measure using VET Workers.

Change Capability Factor	Factor 1 (Eigenvalue = 2.95)	Communalities
Overall Change Capability	.871	.758
Top Management Support	.886	.784
Champions of Change	.860	.740
Worker Buy-In	.818	.669

5.6.3 Change Capability Correlation with Work Safety Climate

Based on limited previous research (e.g., Benn et al., 2012) it was hypothesised that the seven safety climate dimensions of the brief NOSACQ-24 would be positively associated with the four change capability dimensions of this study. In order to assess this relationship, and by extension assess the concurrent validity of the change capability measure, Pearson correlation analyses were performed.

Results of this analysis are shown in Table 21. As predicted all four change capability factors significantly correlated with the safety climate dimensions. The results demonstrate moderate-strong correlations between the change capability items and all three management-focussed safety climate dimensions, and small-moderate correlations between the change capability items and all four of the worker-focussed safety climate dimensions. This is perhaps unsurprising considering change capability is largely driven by management.

Table 21

NOSACQ Dimension Descriptive Statistics and Correlations with Change Capability Factors for VET employees.

NOSACQ Safety Climate Dimensions	*N*	*M* (*SD*)	Change Capability Factors			
			Overall Capability	Top Management Support	Champions of Change	Worker Buy-In
Management Safety Priority, Commitment and Competence	485	2.87 (0.65)	.62***	.61***	.62***	.52***
Management Safety Empowerment	482	2.77 (0.64)	.63***	.65***	.63***	.58***
Management Safety Justice	478	2.94 (0.61)	.57***	.56***	.56***	.47***
Workers' Safety Commitment	484	3.09 (0.52)	.34***	.36***	.37***	.29***
Workers' Safety Priority and Risk Non-Acceptance	484	2.97 (0.58)	.36***	.33***	.32***	.30***
Safety Communication, Learning, and Trust in Co-Worker Safety Competence	485	3.13 (0.49)	.38***	.37***	.35***	.28***
Workers' Trust in the Efficacy of Safety Systems	485	3.15 (0.50)	.33***	.35***	.31***	.26***

Note: NOSACQ-24 scale = 1-4. *p<.05, **p<.01, ***p<.001

5.6.4 Change Capability Correlation with Mental Wellbeing

Based on previous research (e.g., Geerling et al., 2021; Guidetti et al., 2018) it was predicted that mental wellbeing and change capability would be positively related. Evidence of such a relationship would support the concurrent validity of the change capability measure. To assess this

relationship Pearson correlation analyses were performed. Overall change capability ($r(471) = .38$, p = <.001), top management support ($r(471) = .36$, p = <.001), champions of change ($r(471) = .33$, p = <.001), and worker buy-in ($r(471) = .42$, p = <.001) all correlated significantly with the SWEMWBS (transformed $M = 21.54$, $SD = 4.54$). All four correlations would be considered moderate, with worker buy-in demonstrating the strongest relationship with mental wellbeing.

5.6.5 Differences across Demographics

Previous research by the authors Summers et al. (2022b) has indicated the importance of assessing outcome variables across individual and work-related demographics in order to identify potential subcultures within the same organisation. At a theoretical level the ability to discriminate between organisational subcultures may provide support for known-groups validity. From a practical perspective the usefulness of distinguishing between such demographics is that organisations can more effectively and economically tailor interventions to where they are most needed in the pre-implementation phase of the change cycle. To assess this for the change capability measure, participant responses were examined across gender, age, managerial function, employment status, work type, work location, and working situation. Table 22 shows the means, standard deviations and number of responses in each of the four response categories for each of these variables. Due to some missing responses in the data collected the total number of participant responses for the demographic information ranges from 400-462. Table 23 shows the percentage of demographic group improvement responses to each of the change capability statements where significant differences were identified.

Table 22

Means and standard deviations for the change capability questions across the demographic groups.

Demographic variables	*n*	Change Capability Factors			
		Overall Capability Mean (SD)	Top Management Support Mean (SD)	Champions of Change Mean (SD)	Worker Buy-In Mean (SD)
Gender					
Male	139	2.51 (0.85)	2.51 (0.88)	2.74 (0.72)	2.33 (0.85)
Female	298	2.67 (0.79)	2.76 (0.79)	2.86 (0.72)	2.46 (0.79)
Age					
24-34 years	20	2.45 (0.83)	2.65 (0.75)	2.75 (0.79)	2.55 (0.83)
35-44 years	85	2.71 (0.87)	2.76 (0.88)	2.93 (0.78)	2.55 (0.81)
45-54 years	129	2.68 (0.84)	2.75 (0.78)	2.87 (0.74)	2.47 (0.77)
55-64 years	144	2.51 (0.83)	2.58 (0.85)	2.75 (0.70)	2.36 (0.83)
65-74 years	22	2.68 (0.72)	2.73 (0.77)	2.77 (0.69)	2.41 (0.73)
Managerial Function					
Yes	92	2.68 (0.85)	2.77 (0.76)	2.85 (0.74)	2.52 (0.72)
No	363	2.57 (0.81)	2.63 (0.84)	2.79 (0.73)	2.35 (0.84)
Employment status					
Permanent	442	2.57 (0.84)	2.63 (0.84)	2.79 (0.75)	2.35 (0.83)
Casual	20	2.95 (0.83)	3.10 (0.71)	3.05 (0.51)	2.85 (0.67)
Work type					
Weekly paid	32	2.94 (0.67)	3.00 (0.50)	3.06 (0.50)	2.78 (0.55)
Professional services	181	2.77 (0.77)	2.78 (0.78)	2.97 (0.70)	2.46 (0.80)

Education	246	2.40 (0.88)	2.50 (0.89)	2.62 (0.77)	2.24 (0.86)
Work location					
Metropolitan	332	2.55 (0.87)	2.62 (0.85)	2.77 (0.76)	2.36 (0.83)
Regional	126	2.68 (0.79)	2.71 (0.85)	2.87 (0.71)	2.40 (0.85)
Working Situation					
Only on campus	282	2.57 (0.84)	2.64 (0.83)	2.75 (0.76)	2.38 (0.83)
Blended	155	2.67 (0.80)	2.73 (0.82)	2.90 (0.68)	2.44 (0.80)

Note. Due to the low number of responses (n = 8) participants working only at home were removed from the working situation analysis.

Table 23

Percentages of Responses from the VET Workers for the Change Capability Questions across Demographic groups where significant differences were identified.

	Overall Capability				Top Management Support				Champions of Change				Worker Buy-In			
	Capability ratings (%) [a]				Capability ratings (%)				Capability ratings (%)				Capability ratings (%)			
	NCI	NI	S	WD	NCI	NI	S	WD	NCI	NI	S	WD	NCI	NI	S	WD
Gender																
Male	16.5%	22.3%	54%	7.2%	18%	19.4%	54.7%	7.9%	5%	25.2%	59%	10.8%	20.1%	29.5%	46%	4.3%
Female	8.1%	29.9%	48.7%	13.4%	8.4%	21.8%	56%	13.8%	4.7%	20.1%	59.4%	15.8%	13.4%	33.2%	48%	5.4%
Employment status																
Permanent	12.7%	28.1%	49.1%	10.2%	12.7%	22.9%	53.6%	10.9%	5.9%	23.3%	57.2%	13.6%	18.3%	32.6%	44.6%	4.5%
Casual	5%	20%	50%	25%	5%	5%	65%	25%	0%	10%	75%	15%	5%	15%	70%	10%
Work type																
Weekly paid	3.1%	15.6%	65.6%	15.6%	3.1%	9.4%	71.9%	15.6%	0%	9.4%	75%	15.6%	0%	28.1%	65.6%	6.3%
Professional services	7.2%	22.1%	57.5%	13.3%	9.4%	15.5%	63%	12.2%	4.4%	12.7%	64.1%	18.8%	14.4%	29.8%	50.8%	5%
Education	17.9%	32.9%	40.7%	8.5%	16.3%	28.5%	44.7%	10.6%	7.7%	32.1%	50.4%	9.8%	23.2%	33.7%	38.6%	4.5%

Note. [a] NCI = Needs considerable improvement, NI = Needs some improvement, S = Satisfactory, WD = Is well done

5.6.5.1 Gender

To assess the difference between males and females with regard to responses to the change capability questions, independent samples t-tests were employed. It can be seen in Table 22 that female participants rated all four change capability factors more positively than male participants. However, this was only statistically significant for responses to the question regarding top management's overt encouragement and support for implementing an organisational change, $t(246.53) = -2.58$, $p = .010$, Cohen's $d = -.28$. Table 23 also demonstrates that for the factor of top management overt support for change far fewer female employees responded with "needs considerable improvement" compared to males.

5.6.5.2 Age

Table 22 shows that participants aged 35-44 years rated all four factors of change capability more positively when compared to participants in other age brackets. However, one-way ANOVA revealed no statistically significant differences.

5.6.5.3 Managerial Function

It can be seen in Table 22 that participants with a managerial function responded more positively than participants without a managerial function to each of the four change capability items; however, t-test analyses revealed no statistically significant differences.

5.6.5.4 Employment Status

It can be seen in Table 22 that participants employed on a casual basis responded more positively to all four items of change capability when compared to participants employed on a permanent basis. The differences were statistically significant for overall change capability, $t(460) = -1.99$, $p = .047$, Cohen's $d = .46$; top management overt support for changes, $t(21.42) = -2.86$, $p = .009$, Cohen's $d = .57$; use of champions of change, $t(22.86) = -2.22$, $p = .037$, Cohen's $d = .36$; and worker

buy-in, $t(21.71) = -3.21$, $p = .004$, Cohen's $d = .60$. Despite the small degrees of freedom for three analyses due to significant Levene's test for equality of variances, results indicate a small to medium effect of employment status on perceptions of use of champions of change, and medium effects for employment status on perceptions of overall change capability, top management support, and worker buy-in. The results in Table 23 support this and demonstrate that proportionally fewer casual workers responded with "needs considerable improvement" or "needs some improvement" to all four change capability statements.

5.6.5.5 Work Type

It can be seen in Table 22 that participants who worked in education roles within this VET organisation rated all four change capability items most negatively, followed by professional services participants, with weekly paid participants rating all four items most positively. Results of a one-way ANOVA examining these differences are presented in Table 24. The mean differences between education employees and both professional services and weekly paid workers were significant for all four change capability factors based on the results of one-way ANOVAs. Similarly, professional services workers rated worker buy-in significantly lower than weekly paid workers. Post-hoc Games-Howell testing was employed due to Levene's tests of homogeneity of variance yielding significant results for all items. According to eta-squared interpretation guidelines, participant work type was shown to have a small to medium effect on perceptions of top management support and worker buy-in, and a medium effect on perceptions of overall change capability and perceptions of use of champions of change. Table 23 further demonstrates the markedly higher percentage of education employees who responded with "needs considerable improvement" or "needs some improvement" to all four change capability statements when compared to professional services and weekly paid work types.

Table 24

One-Way Analysis of Variance (ANOVA), Eta-squared Effect Size, and Games-Howell Post-Hoc Analysis of Change Capability Scores across Work Types.

Change Capability Factor	ANOVA *F* (df)	ANOVA *p*	η^2	Work Type Group		Games-Howell *p*
Overall Change Capability	13.72 (2, 456)	<.001	.057	Education	Professional Services	<.001
					Weekly Paid	<.001
Top Management Support	9.24 (2, 456)	<.001	.039	Education	Professional Services	<.001
					Weekly Paid	.002
Champions of Change	14.54 (2, 456)	<.001	.060	Education	Professional Services	<.001
					Weekly Paid	<.001
Worker Buy-in	8.14 (2, 456)	<.001	.034	Education	Professional Services	<.001
					Weekly Paid	.018
				Professional Services	Weekly Paid	.020

Note: Change capability scale = 1-4.

5.6.5.6 Work Location

As demonstrated in Table 22 regionally located workers rated all four items assessing change capability more positively than metropolitan located workers. However, t-test analyses revealed no significant differences.

5.6.5.7 Working Situation

Due to the small number of participants (n = 8) who only worked at home these data were removed from the analysis. As a result, differences in perceptions of critical change capability items between participants working only on campus and participants working in a blended arrangement were examined using independent samples t-tests. It can be seen in Table 22 that participants working in a blended arrangement rated all critical items of change capability more positively than participants working only on campus. However, none of these differences were statistically significant.

5.6.6 Interaction Effects

A series of two-way ANOVAs were performed to assess any interaction effects for any of the four change capability factors. Based on significant main effects, interaction effects were examined for gender and employment status, gender and work-type, and employment status and work-type. A significant interaction was identified for gender and employment status with regard to perceptions of overall capability, top management support, and champions of change.

For overall capability a significant interaction effect of gender and work-type was found such that female employees in the weekly paid category (M = 3.15 [2.80 – 3.50 95% CI], SD = 0.59) rated overall capability more positively than male employees in the weekly paid category (M = 2.55 [2.07 – 3.02 95% CI], SD = 0.69); male employees in the professional services category (M = 2.93 [2.68 – 3.17 95% CI], SD = 0.66) rated overall capability more positively than female employees in the professional services category (M = 2.76 [2.63 – 2.90 95% CI], SD = 0.77); and female employees in the education category (M = 2.53 [2.40 – 2.67 95% CI], SD = 0.84) rated overall capability more positively than males in the education category (M = 2.33 [2.16 – 2.50 95% CI], SD = 0.90), $F(5, 426) = 3.46$, $p = .032$, $\eta_p^2 = .016$.

For top management support a significant interaction effect of gender and work-type was also demonstrated. Male employees in the weekly paid (M = 2.73 [2.25 – 3.21 95% CI], SD = 0.65) and education (M = 2.31 [2.14 – 2.49 95% CI], SD = 0.87) categories rated top management support more

negatively than female employees in the weekly paid (M = 3.15 [2.80 – 3.51 95% CI], SD = 0.59) and education (M = 2.65 [2.52 – 2.79 95% CI], SD = 0.86) categories, $F(5, 426) = 3.15$, $p = .044$, $\eta_p^2 = .015$.

Similarly, for champions of change a significant interaction effect of gender and work-type was found. Females employed in the weekly paid category (M = 3.20 [2.89 – 3.51 95% CI], SD = 0.41) rated champions of change more positively than males employed in the weekly paid category (M = 2.73 [2.25 – 3.21 95% CI], SD = 0.60); males employed in the professional services category (M = 3.20 [2.98 – 3.42 95% CI], SD = 0.56) rated champions of change more positively than females employed in the professional services category (M = 2.94 [2.82 – 3.06 95% CI], SD = 0.70); and females employed in the education category (M = 2.74 [2.63 – 2.86 95% CI], SD = 0.77) rated champions of change more positively than males employed in the education category (M = 2.53 [2.39 – 2.68 95% CI], SD = 0.70), $F(5, 426) = 5.12$, $p = .006$, $\eta_p^2 = .024$.

Interaction effects were also examined for managerial function and gender, managerial function and age, managerial function and employment status, managerial function and work-type, managerial function and working situation, managerial function and work location, and managerial function and working situation. No significant interactions were found for these analyses.

5.6.7 Latent Thematic Analysis

In order to support the construct validity of the change capability items, latent thematic analysis was performed on the qualitative data. Participant responses were coded with respect to their relevance to the four items: overall change capability, top management support, use of champions of change, and worker buy-in. Results of the thematic analysis will be discussed first in terms of the qualitative comments made in response to each of the change capability items. Qualitative comments associated with the work safety questionnaire will then be discussed.

5.6.7.1 Change Capability Items

Of the 190 participants who responded “needs considerable improvement” or “needs some improvement” to the overall change capability question, 21 provided qualitative responses. Of the

162 participants who responded “needs considerable improvement” or “needs some improvement” to the top management support question, 20 provided qualitative responses. For champions of change only 11 participants responded to the qualitative questions from a total of 136 who responded to the statement with either “needs considerable improvement” or “needs some improvement”. With regard to worker buy-in 236 participants responded with either “needs considerable improvement” or “needs some improvement”, and 26 of these participants provided qualitative feedback.

Qualitative responses to each individual statement were coded depending on their relevance to their respective factor. Despite the relatively small number of responses, most comments for each of the four factors (90% for overall change capability, 95.2% for top management support, 90.9% for champions of change and 90.9% for worker buy-in) referred to the specific factor thus providing some additional support for the construct validity of the four critical change capability factors. Additionally, many responses provided suggestions for potential improvements to the current situation experienced by workers in regard to the change capability areas. This supports the practical usefulness of these qualitative comments for improving the change capability of the organisation. Table 25 shows examples of the latent thematic analysis responses to the change capability statements.

Table 25

Latent thematic analysis of participant responses to each change capability statement for participants who provided "needs considerable improvement" or "needs some improvement" responses.

Theme	Supporting Extract Examples
Overall Capability	"…if there are projects that might cost money for equipment or time, it is often years before it can be fixed." (Participant #60) "Need for meetings where Management outlines about changes and procedures." (Participant #71) "The processes need to be made more clear regarding who to contact and how to escalate when an unsatisfactory response is met." (Participant #31)
Top Management Support	"Communication from top management is poor at best and not transparent at best." (Participant #27) "Communication comes through emails which is not an effective way to deliver. Management should deal with these directly with teams." (Participant #40) "Very little communication about changes." (Participant #41) "No face to face from senior management." (Participant #46) "There currently seems to be a lack of direction and communication (Leadership) coming from top management regarding the massive changes our organisation is undergoing." (Participant #77)
Champions of Change	"I didn't know they appointed any one." (Participant #76) "We have a WHS group but they are not visible on day to day basis other than general emails relating to topics such as fire danger days." (Participant #32) "This needs to be made more available to staff however due to the workloads there is little time to voluntarily add this to our duties

	despite its importance" (Participant #31)
Worker Buy-In	"It seems as though most decisions are made without consulting workers." (Participant #29)
	"Staff changes and reductions have lowered the ability for staff consultation or representation." (Participant #42)
	"Consultation can be a 'tick the box' affair at times." (Participant #77)
	"Never consulted, so when things do happen we are always the last to know." (Participant #91)

5.6.7.2 Work Safety Items

Qualitative responses were examined for the question at the end of the brief work safety climate measure: "Are there any additional comments you would like to make about your answers to the safety in the workplace questions?" in order to determine if any content related to the four change capability factors. Of the 137 responses to the question, 31 related to overall capability, 22 statements related to top management support, two responses related to champions of change, and six responses related to worker buy-in. These responses again provide additional support for the construct validity of the developed items as they relate to an organisation's change capability. Table 26 demonstrates the latent thematic analysis of responses to the question.

Table 26

Change capability latent thematic analysis of participant responses to the brief work safety climate qualitative question "Are there any additional comments you would like to make about your answers to the safety in the workplace questions?"

Theme	Supporting Extracts
Overall Capability	"Someone has to be seriously injured before action is taken…We have issues and they took YEARS to be rectified" (Participant #65)
	"We have been outlining high risk works and the need for [removed for confidentiality] produced by private industry to suit our class practical assessments. This has been minuted in workgroup meetings since 2017 with ZERO action thus far!" (Participant #82)
	"The system for reporting hazards and near misses is clunky and discourages reporting of those small things that later become big things" (Participant #93)
	"Safety hazards that were identified more than ten years ago are still in campus." (Participant #227)
Top Management Support	"Management engage in magical thinking where they want staff to be and act in a safe manner but provide little to no meaningful material support to do so." (Participant #9)
	"Management are only interested in their own KPI targets" (Participant #81)
	"Management and HR are happy to sit behind their policy, but make no effort to police it" (Participant #167)
	"Any safety concerns and incidents take a long time to be acknowledged and WHS management don't communicate well when there has been an incident on how it's been managed." (Participant #226)
	"Though issues are raised, they are treated with lip service. However when something goes wrong the management look to

	put the blame on the worker." (Participant #411)
Champions of Change	I don't even know who the safety rep or safety manager is. (Participant #269)
	We are expected to report to campus coordinators with no authority to deal with issues (Participant #322)
Worker Buy-In	"Staff consultation has been lacking in recent years" (Participant #42)
	"There is more emphasis on achieving time frames rather than meaningful discussion and input from staff who have to use the safety procedures." (Participant #104)
	"There is no consultation with [removed for confidentiality]. No one seems to know what is going on." (Participant #339)
	"Whilst every precaution is taken to ensure everyone's safety by management at times I feel that the work groups are not always heard in the decision making." (Participant #452)

Thus, the combination of quantitative and qualitative analyses in this study provides initial support for the design and use of all four factors of change capability (overall change capability, top management support, use of champions of change, and worker buy-in) as critically important for successfully implementing change within this VET organisation.

5.7 Discussion

The primary purpose of the present study was to develop and validate a brief measure of change capability that could be applied by practitioners to identify key factors affecting change capability that may need remediation before implementing interventions to improve an organisation's work safety climate. The measure was designed to be brief so that it could accompany the brief version

of the NOSACQ work safety climate measure for monitoring purposes. However, the measure assesses general change-related factors that are applicable to the success of any organisational change program. The general nature of the measure also makes it suitable for researchers who might want a brief measure of change capability to accompany a battery of other related organisational measures.

The four items of the brief measure were found to load appropriately onto a single dimension (change capability) through exploratory factor analysis (EFA). Internal reliability statistics (Cronbach's alpha) were acceptable, concurrent validity was supported through correlation with expected variables such as the work safety climate measure and a measure of mental wellbeing, and construct validity was supported through thematic analysis of qualitative responses from participants. The positive relationship between work climate and change capability aligns with the previous literature (Benn et al., 2012). Change capability was more strongly associated with management-focussed safety climate dimensions than worker-focussed dimensions which is consistent with the significant role management plays in organisational change initiatives. The positive relationship between factors within the change capability construct and the measure of mental wellbeing is also consistent with previous research (Geerlings et al., 2021; Guidetti et al., 2018). Unlike its relationship with safety climate, worker buy-in had the strongest relationship with mental wellbeing. This would be consistent with higher levels of worker buy-in being associated with greater feelings of control on the part of workers, which in turn relates to more positive mental wellbeing.

In terms of practical usefulness, the measure was able to discriminate between individual and work-level demographic differences in ratings for the change capability items. It was evident that male workers rated top management support significantly lower than did female workers. This gender effect on perceptions of top management is consistent with recent research demonstrating that females typically rate job satisfaction higher than males (Huang & Gamble, 2015), which may in turn result in more positive perceptions of management. Additionally, this difference in perceptions of management may come from females having typically lower expectations of a workplace than males

(Clark, 1997). However, as demonstrated by the results of the interaction analyses, this significant difference was only applicable for participants employed in the weekly paid and education categories.

Casual workers were found to rate all four change capability factors more positively than did permanent workers. This finding is inconsistent with some previous research on casual workers which indicates they experience reduced training, access to human resource communications, opportunities to voice concerns or collaborate with co-workers, and consultation about workplace changes when compared to permanent workers (Lowry, 2001). The finding instead supports the assertion that casual workers may have greater job insecurity (Gottschalk & McEachern), therefore being more likely to respond positively to questions about the organisation in the hope of retaining their casual contracts or moving into a permanent position. Previous research by the authors (Summers et al., 2022b) also identified casual workers as responding more positively than permanent workers with regard to perceptions of work safety climate. Alternatively, casual workers may have less experience with organisational changes and therefore may be less inclined to suggest these processes require improvements.

Importantly, the change capability measure was able to distinguish between perceptions of change capability within work types from a single organisation, providing preliminary support for known-groups validity. Education workers rated all four statements regarding change capability significantly more negatively than professional services and weekly paid workers. These results are consistent with the responses to the safety climate questionnaire utilised in this study and reported by Summers et al. (2022b), where education workers rated all three management-focussed safety climate dimensions significantly more negatively than both professional services and weekly paid workers. Results of the interaction analyses further indicated that perceptions of overall capability, top management support, and champions of change can differ across work-types based on the gender of participants. The ability to discriminate between work types is particularly important for change practitioners in order to effectively distribute resources and accurately target remedial action for where it is most required. For example, results of this study suggest education employees require the

most attention with regard to improving perceptions of change capability. By identifying this area of development change practitioners may be able to tailor specific remedial interventions, such as designating regular blocks of time for receiving feedback from education staff in order to enhance worker buy-in to changes, or by developing management communication capabilities before the implementation of a change that will impact education workers to enhance perceptions of top management support. The ability to identify specific areas of development with a brief measure that can be regularly implemented is particularly relevant for change practitioners that may be limited by available resourcing. Similarly, the ability to discriminate between work types within a single organisation may allow change practitioners to focus on specific development goals rather than organisation-wide approaches. The identification of significant interaction effects between gender and work-type regarding perceptions of overall capability, top management support, and champions of change is also beneficial information for change practitioners. For example, for this VET organisation, the mean scores for perceptions of overall change capability and use of champions of change indicate that female workers responded more positively to these questions. However, the interaction analyses demonstrated that this was not the case for professional services workers, with males rating these factors of change capability more positively than females. By considering differences both between and within organisational subcultures in the pre-implementation stage of the change cycle, practitioners may ultimately enhance the effectiveness of change initiatives.

Workers with a managerial function tended to rate all the change capability factors more positively than those with non-managerial functions but these differences were not statistically significant. Previous research indicates managerial staff typically respond more positively than non-managerial staff on a variety of workplace measures, such as safety climate (Chan et al., 2021; Kristensen et al., 2015; Prussia et al., 2003) and a significant difference of this kind was also found in the responses to the safety climate survey in this study (Summers et al., 2022b). Similarly, no significant differences in perceptions of change capability were identified between participants based on age or workplace location.

There were an insufficient number of participants who were working only at home to be included in the analyses. Those working in a blended arrangement of partly at home and partly at work tended to rate each of the change capability factors more positively although none of the differences were statistically significant compared to the ratings provided by those who worked only on campus. However, it may become increasingly important to monitor possible differences between these kinds of working arrangements as working from home and blended arrangements become more common due to the COVID-19 global pandemic. Many organisations have responded to the pandemic with more flexible working arrangements, and some have argued that the benefits of flexible working arrangements such as improved work-life balance, convenience and comfort, and more efficient use of office space facilities are likely to persist in a post-COVID world (Arquisola et al., 2021). If these kinds of working arrangements become permanent after the pandemic, there may be implications for implementing organisational changes that differentially impact these groups.

The use of a mixed-methods approach incorporating opportunities to provide qualitative responses to each of the four rated change capability statements provided support for the construct validity of each of the identified factors critical to change capability. Despite the relatively small number of participants who provided qualitative feedback, specific comments related to the need to improve overall change capability, overt top management support, use of champions of change, and promotion of worker buy-in. This similarly suggests that ratings of those factors were based on an assessment of their role in change capability. In particular, the qualitative comments on the overall change capability factor supported the addition of this general factors as comments made with relation to overall capability included factors other than the three specific change factors for the measure; for example, previous experience with change.

These qualitative comments were also of practical importance in so far as they highlighted particular aspects of each of the factors that needed to be remediated. For example, with respect to top management support, comments indicated a need to enhance face to face communication rather than relying on emails or other internal communications. Similarly, with respect to champions of

change comments suggested a need to improve the visibility of employees designated to these roles, as some participants were not aware they existed. With respect to worker buy-in, comments suggested a need to improve consultation with workers in order to garner their input and support for the changes.

While analysis of open-ended questions can be time consuming, this study provides support for the use of these types of questions in the pre-implementation phase of change management. The context-specific information that can be drawn from an analysis of qualitative responses can provide change managers with unique insights into the perceptions of workers regarding change that can be used to shape strategies that workers are more likely to endorse and less likely to resist. Additionally, despite the relatively low number of responses to qualitative questions in this study, if suggestions from workers are included into future change initiatives, and these are appropriately communicated to workers, then the number of responses are likely to increase over time and with future measurements. Given both the brief change capability measure and brief safety climate measure were designed to be as practically useful as possible, and to encourage regular monitoring, if used effectively these measures may assist practitioners in increasing the success rate of safety-related or other organisational changes.

It should be noted that the four change capability factors in this study are not independent, as demonstrated by significant inter-correlations. However, at a practical level they are also likely to impact one another. For example, if top management do not overtly support a change initiative with appropriate resourcing and encouragement, then workers are unlikely to buy in to the change as they may feel the longevity of the change is threatened by budgetary or staffing limitations. Similarly, if designated champions of change are not identified and communicated to staff members, or if they are not provided with the resourcing or authority to remove barriers to change, then worker buy-in is also likely to be negatively affected. Past experiences of change, whether positive or negative, may also affect perceptions of more than one change capability factor and these experiences are likely to inform qualitative comments on each of the four change capability factors.

Considering the aim of this study was to develop and validate a brief measure for change capability that can be applied within organisations, the results of the safety climate and mental wellbeing measures were not discussed beyond the correlations with the change capability measure. However, it is worth noting that if either or both of these measures indicated a need for remedial action, the results of the change capability measure and supplementary qualitative comments would provide significant practical value with regard to implementing effective and targeted solutions.

The results of organisational change initiatives can take years to complete (Stouten et al., 2018). Hence, a brief measure of change capability can be useful not only when changes need to be implemented but also to monitor change capability to ensure that it is maintained during change processes and between change interventions. The brief change capability measure could therefore be used in conjunction with the brief work safety measure developed by Summers et al. (2022b) to monitor both emerging work safety issues and emerging change capability problems before either become critical. Ultimately, by assessing change capability alongside other workplace measures (such as work safety climate) organisations can take steps to remedying the consistently reported low success rates for change initiatives (Hallencreutz & Turner, 2011; Vakola, 2013).

5.8 Future Research

Future research is needed to determine the extent to which the brief change capability measure can be used to improve the implementation of required work safety interventions and other types of organisational changes. Additionally, while exploratory factor analysis (EFA) provided preliminary support for a unidimensional model of change capability, future research should move beyond this to include confirmatory approaches such as Rasch analysis or confirmatory factor analysis (CFA). Future refinements to the measure could include adding response categories of “don’t know” and/or “unsure” to capture the views of more recently employed participants who may not have sufficient knowledge of past change processes and their degree of success. This would help to determine the cause of participant non-responses in the measure. It would also be useful to obtain

demographic information from participants about how long they have been employed in the organisation to assess the extent to which a knowledge of the organisation's previous change initiatives determines perceptions of the organisation's change capability. How many organisational changes participants have been involved in is also likely to be important when determining the usefulness of the data obtained from qualitative questions associated with each of the change capability factors and future research could address this.

Future research should also aim to further assess the validity of the measure with regard to its relationship with related measures of organisational climate/culture and more specifically existing change measures such as readiness for change; for example, the Organizational Readiness for Implementing Change measure (ORIC; Shea et al., 2014).

Consideration might be given to whether it would be worth adding additional critical change factor questions based on further analysis of qualitative responses and the research literature; for example, the extent to which professional standards of behaviour inform change interventions or a rating and comment on the most and/or least successful intervention that the participants remember. Comments on previously successful interventions may be an important component for developing buy-in from top management level employees as they would provide an indication of positive aspects of the organisation, rather than focussing solely on the negative. The response burden caused by an additional one or two change statements could be offset by reducing the number of qualitative comments following the change capability statements to just one final comment, as is the case with the brief work safety climate measure, by asking participants to comment on any change capability factor that needed substantial improvement or some improvement. To provide both positive feedback as well as any negative feedback, two qualitative comments might be used; the first, to ask participants what is working well with respect to change in the organisation, and the second to address needed improvements including those related to the four change capability factors. Presenting the feedback about what is working well to management might help to gain positive consideration of the need for improvements.

Consideration might also be given to developing a more comprehensive measure of change capability that could be used to provide more specific information regarding areas of development for organisational change capability. If the brief change capability measure is able to identify emerging areas for development through regular monitoring, then a more comprehensive measure may be able to focus on these areas and provide additional information; for example, after a change of Chief Executive Officer, or following a large-scale restructure. In this respect, a more comprehensive measure of change capability could be used in the same way as the full 50-item NOSACQ-50 can be used to provide more comprehensive information about certain emerging work safety climate domain issues if identified as necessary using the 24-item NOSACQ-24. An alternative to a more comprehensive measure might be the development of a format for focus groups involving key stakeholders to discuss the results from the change capability measure and initiate actions based on the results.

5.9 Limitations

A potential limitation of this study is that no measure of employment length was collected. As such, the researchers were unable to determine if responses to the survey had come from participants with limited exposure to change initiatives. In this case participants may have based their responses on limited information when providing their ratings. Given that such participants might be inclined to guess that change capability would be satisfactory or might not wish to report negatively about an organisation they recently joined, this may have positively inflated responses. Another potential limitation of this study is that the sample of participants limits the potential for incorporating organisational-level processes as this research involves single-source individual data. Future research would benefit from evaluating organisational-level differences with regard to change capability.

In this study no analysis of previous change initiatives was undertaken to identify existing change strategies employed by the organisation's leadership. Qualitative responses indicated that previous experience with change was likely to impact assessments of an organisation's change

capability; however, without assessing the perceived effectiveness of previous change strategies employed by the organisation in this study this effect could not be appropriately examined.

5.10 Conclusion

A brief change capability measure such as the one developed in this study could assist in advancing both the research and practical implementation of change initiatives. Researchers may benefit from a measure that is only four items in length and could thus be employed as part of a larger assessment or battery of measures without substantially increasing the response burden placed on participants. Change practitioners may benefit from knowledge of critical change capability factors and their relative need for improvement before starting costly and time-consuming change initiatives. Timely remediation to ensure change capability will help to increase the likelihood of successfully implementing organisational changes and reduce the high proportion of failed change efforts reported in the research literature.

Chapter 6: Discussion and Research Conclusions

6.1 Thesis Aims

The primary aim of this thesis was to develop a brief and practical multi-level measure for work safety climate that is reliable, valid, and applicable across different types of organisations. It was designed for monitoring purposes so that emerging safety issues could be identified and remediated through appropriate interventions before they become critical, thus reducing the likelihood of safety related accidents and incidents that are costly in both human and financial terms. For this purpose, it differed from existing comprehensive measures of work safety climate, which are often deemed too time consuming for monitoring purposes and instead tend to be only used in the case of a safety crisis. This brief work safety climate measure also differed from other brief work safety climate measures through the attempt to retain sufficient diagnostic capabilities that would allow for identification of specific safety issues requiring remediation, rather than providing an overall assessment of work safety climate as most brief measures do.

Following advice in the relevant research literature, the brief work safety climate measure was developed from an existing comprehensive measure with established reliability, validity and proven practical usefulness. The comprehensive measure used for this purpose was the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50; Kines et al., 2011), which was developed across all five Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden) and now has a large international database with norms that can be used to evaluate an organisation's work safety climate. The NOSACQ is divided into three management-focussed and four worker-focussed dimensions for diagnostic purposes and the development of the brief version of this measure retained these dimensions, with reduced items in each in an attempt to maintain the measure's diagnostic capability.

In addition to standard techniques used to develop and assess the reliability and validity of the brief work safety climate measure, the research also focussed on techniques designed to enhance practical usefulness, including having safety practitioners rank order items in terms of their practical relevance to the types of organisations and industries with which they were familiar, and ensuring

that the reading requirements of items is appropriate for workers in organisations and industries with limited education and for those from culturally and linguistically diverse backgrounds. Focus then shifted to assessing the validity and applicability of the measure across organisations, as well as the ability to apply benchmarking criteria from the more comprehensive measure from which the brief measure was derived.

Due to research evidence highlighting the poor success rates of many organisational attempts to implement change programs, a final study attempted to develop a brief supplementary measure of change capability that was also suitable for monitoring purposes, either with a brief work safety climate measure or by itself. Such a measure was primarily designed to assess if an organisation is capable of successfully implementing required interventions based on emerging safety issues identified by the monitoring use of the brief work safety climate measure. This was done because, fundamental to the usefulness of a brief work safety climate measure from an organisational perspective, is the ability to implement required interventions in a timely and successful way. In doing so, organisations can prevent emerging safety issues from becoming critical and leading to a greater likelihood of accidents and/or incidents.

Part of the development of these two brief measures involved considering key gaps and areas of concern within the safety climate and change implementation research literatures. This involved for the brief work safety climate measure the examination of the safety climate literature, the state of safety climate measurement, and item reduction practices, and for the brief change capability measure factors associated with the successful implementation of change initiatives. The theoretical and practical implications of this thesis, its overall strengths, potential limitations, and suggestions for future research are considered and will be discussed following a brief summary of the four completed studies.

6.2 Review of Studies

This thesis includes four studies of cross-sectional designs. The studies covered the life-cycle of measurement design from initial development and reliability analysis (study one), validation (study two), implementation and further validation (study three), with study four incorporating all of these.

Participants across the studies included disability support workers (studies one and two), hospitality workers (studies one and two), casually employed workers primarily from hospitality and retail industries (study two), and vocational education and training workers (studies two, three and four).

Data collection for all four studies included online and hard copy multiple-item surveys. Studies one and four also included various qualitative open-ended questions in order to ascertain a better understanding of the factors examined.

6.2.1 Study One

Study one, entitled “The development of a brief and practical work safety climate measure” explored cross-sectional data from a safety study of disability support workers and hospitality workers. The aim of study one was to use accepted item reduction methods to derive a brief multi-level work safety climate measure from an existing reliable, valid and practically useful comprehensive measure of work safety climate. These accepted methods were augmented with some additional methods for item reduction that used practically focussed criteria in order to enhance the monitoring capabilities of the brief work safety climate measure in applied settings.

This study was the first to explore these practical methods for item reduction and contributed to both the safety climate and item reduction literature by highlighting the effectiveness of incorporating practical criteria when reducing existing measures (in this case, practitioner opinions and readability); an item reduction area that had previously received minimal attention.

6.2.2 Study Two

Study two, entitled “The validity and measurement equivalence of a brief safety climate questionnaire across casual and permanent workers” examined the most appropriate factor structure and the validity for the brief multi-level safety climate measure developed in study one. This involved an independent sample of casual Australian workers compared with permanent workers to assess the measurement equivalence of the brief safety climate measure. The benchmarking capabilities and statistical differences in work safety climate scores were also examined using the brief measure across four samples of participants including disability support workers, hospitality workers, casually employed workers from various types of primarily retail and hospitality organisations, and employees from a vocational education and training organisation.

Model fit analyses indicated that the brief safety climate measure yielded superior fit indices from these samples of participants when compared to the original comprehensive measure. Additionally, the original seven-dimension structure demonstrated superior fit indices when compared to the three dimension structure suggested by the exploratory factor analysis undertaken in study one. All examined areas of validity were largely supported, as well as measurement equivalence across casual and permanent workers, and benchmarking capabilities. Study two extended the results of study one and demonstrated that the developed brief measure could be applied in practical settings.

6.2.3 Study Three

The third study was entitled “Safety climate across worker and job characteristics: An investigation of safety subcultures”. The aim of this study was to further examine the validity of the brief work safety climate measure developed in study one and validated in study two by examining the extent to which it was capable of assessing different safety climate subcultures in a large organisation based on group and individual factors. A demonstrated strength of the comprehensive

NOSACQ-50 is the ability to distinguish between organisational groups, hence a goal of study three was to investigate if the brief measure retained this diagnostic ability.

The results of study three demonstrated the practical usefulness of the brief safety climate measure in identifying subcultural differences across group and individual demographics. This study contributed to the safety climate literature by highlighting the importance of examining subcultural differences when assessing safety climate in so far as organisation-wide mean scores may not accurately reflect important differences in safety perceptions or identify different areas for safety development as part of a more refined approach to monitoring safety climate.

6.2.4 Study Four

Study four, entitled "A brief supplementary measure of organisational change capability factors to accompany work safety climate assessments and facilitate remedial interventions" examined the development of a brief 4-item supplementary change capability measure of critical change factors for successfully implementing required organisational safety changes. The four items assessed four important change related factors identified in the research literature: overall change capability, overt top management support, use of champions of change, and worker buy-in. The development of this measure was prompted by the very low success rates of implemented organisational changes reported in the research literature, the absence of any existing brief change capability measure of this kind, and the successful use of the three specific factors for implementing safety interventions employed in the disability support worker study used as a basis for study one. Such a measure would complement the brief work safety climate measure for monitoring purposes by providing practitioners with additional information to enhance their organisation's capacity for successful implementation of necessary remedial changes identified by the brief work safety climate measure.

Study four examined correlations between the four change capability factors, their correlations with the seven dimensions of the brief safety climate measure, and their correlations with

a measure of mental wellbeing to provide preliminary support for the validity of the change capability measure. Support for the construct validity of the change capability measure was also assessed through examination of open-ended qualitative responses from those participants who indicated a considerable or slight need for improvement in relation to each change capability factor. Qualitative responses related to the brief work safety climate measure were also analysed to determine if there were themes that aligned with the proposed critical success factors for change capability.

Results indicated appropriate internal consistency, unidimensionality, and support for validity of the brief measure of change capability. Similar to study three, the measure was able to distinguish between change capability perceptions of different organisational subculture groups. This study further adds to the safety research literature by highlighting the usefulness of assessing change capability, including the use of open-ended qualitative responses to identify needed improvements to change capability factors. In doing so, researchers and practitioners may enhance the likelihood of successfully implementing required work safety interventions. Monitoring change capability as well as work safety climate can add important contextual information that could be utilised by management to enhance change capability and increase the likelihood of successful safety related changes.

6.3 Theoretical and Practical Implications

Work safety climate is widely regarded as an effective leading indicator for safety outcomes (Zohar, 2010) and is a construct of theoretical interest for researchers and of practical use for applied psychologists, human resource managers, and safety practitioners in order to assess and improve the work safety climate of those who work in organisations. Safety climate has been assessed across a variety of organisations and industry types, and meta-analytic evidence has consistently demonstrated a relationship between positive safety climate and positive safety outcomes (Clarke, 2006; Christian et al., 2009; Beus et al., 2010; Nahrgang et al., 2011). Over 200 publicly available measure of work safety climate exist; however, only a minority are considered to be acceptable

measures of the construct (Vu & De Cieri, 2015a). Many comprehensive measures of work safety climate have been used to diagnose existing safety crises and many brief measures have been developed to provide an overall measure that is suitable for research purposes (e.g., Ajslev et al., 2017; 2018). This thesis has argued that in order to be most effective as a leading indicator, regular monitoring of work safety climate needs to be promoted. This requires a brief measure of work safety climate that retains diagnostic capability but reduces the response burden associated with longer survey measures that makes them unsuitable for monitoring purposes (Nielsen et al., 2016).

This thesis utilised a novel combination of classic test theory and practically focussed criteria to reduce an existing comprehensive, reliable and valid measure of work safety climate (i.e., the 50-item, seven dimension NOSACQ-50; Kines et al., 2011). The brief safety climate measure presented in this thesis would enable regular monitoring so that organisations could identify and remediate emerging safety concerns before they reach the critical stage of an accident or incident. Regular monitoring would also assist in ensuring that a positive work safety climate is maintained once it has been established. Following the item reduction guidelines set by Goetz et al. (2013) a brief NOSACQ-24 covering the seven key dimensions of the 50-item comprehensive measure was produced, assessed for reliability, validity, measurement equivalence, and practical benchmarking capabilities.

A first major contribution of this thesis is the novel approach taken to reduce the required number of items in a brief version of an existing comprehensive safety climate measure. Whereas traditionally item reduction practices have relied either primarily on classic test theory or item response theory, the approach employed in this thesis maintained the existing criteria for statistical acceptability, but also incorporated criteria to ensure the practical usefulness of the measure. The support for this method demonstrated throughout the thesis contributes to the existing literature on item reduction for brief practical measures.

A second major contribution of this thesis is the focus on reducing an existing comprehensive measure of safety climate, rather than developing a new brief measure. This aligns with the suggestions of safety climate researchers (e.g., Singh & Verma, 2020) and contributes to refining the

conceptual clarity of safety climate measurement (Shea et al., 2021). The refinement or item reduction of existing safety climate measures for practical purposes is not commonly researched, particularly when compared to the development of new safety climate measures; a gap that this thesis has addressed. This methodology further enables the more comprehensive full measure or specific parts of it to be employed when the need is identified.

A third major contribution of this thesis, at both a theoretical and practical level is the ability of a brief work safety climate measure to identify different safety subcultures that should be examined by researchers for refining the concept of work safety climate and by practitioners when undertaking work safety climate assessments that have different remedial implications for different subcultures within an organisation. Both statistically significant differences and differences in benchmarking positions were identified by the brief work safety climate measure used in this thesis across group and individual levels within a large organisation. While researchers have proposed and established the existence of subcultures previously (Schein, 1996; Zohar, 2000) the capacity to identify the range of potential work safety climate subcultures covered in this thesis contributes to the potential practical use of a brief work safety climate measure.

A fourth major contribution of this thesis was the development of a brief supplementary change capability measure to examine critical success factors for organisational change initiatives. Where the brief safety climate measure allows for monitoring of safety climate over time and for the assessment of changes associated with remedial actions, the measure of critical change capability factors provides safety climate researchers and practitioners with necessary information to facilitate the successful implementation of required interventions for emerging work safety issues before they reach a critical stage. An assessment of general critical change capability factors may also help researchers and practitioners to reduce the high failure rate of different types of organisational change initiatives reported in the research literature.

The theoretical and practical implications of these contributions will be discussed in more detail in the following sections.

6.3.1 Novel Item Reduction Approach

The first aim of this thesis was to develop a brief measure of work safety climate from an existing validated and comprehensive measure. This was achieved through novel means by combining classical test theory, factor analysis, and practically focussed criteria. Studies one and two highlight the development and validation of a brief 24-item safety climate measure, using the 50-item Nordic Occupational Safety Climate Survey (NOSACQ-50; Kines et al., 2011) as a foundation.

The unique combination of methods employed for item selection contribute significantly to both theory and practice. By investigating the opinions of safety practitioners from various types of organisations and industries, key areas of practical importance were able to be identified and included in the selection criteria. Had only statistical methods been utilised a number of these items would have been flagged for removal, indicating that the most statistically valuable items in any scale may not be the most practically relevant. This has implications for scale development theory and suggests that a critical step when selecting or generating survey items should be engaging with practitioners to ensure relevancy across different types of organisations and industries. By incorporating safety practitioners into the development of a safety climate scale, rather than just safety researchers, this thesis also made progress in bridging the gap between research and practice by asking practitioners if they felt any key information was missing from the survey presented to them. The safety practitioners surveyed did not identify any missing relevant safety climate areas, which provides further support for the NOSACQ-50 as a comprehensive measure and strong foundation for the purposes of this thesis.

The assessment of item readability was another significant practical contribution to the safety climate measurement literature. In order for work safety climate measures to provide the most accurate reflection of workgroup perceptions, workers must understand the questions they are being asked to respond to. Given many types of organisations (e.g., hospitality, retail) and high-risk industries (e.g., construction, manufacturing) have lower educational requirements for entry, and may provide employment for workers with culturally and linguistically diverse backgrounds, readability of survey items can contribute significantly to gathering accurate data. Hence, if reducing an existing

measure researchers should be mindful that items with particularly high reading levels may differentially impact participants.

The results from studies one and two suggest that augmenting statistical criteria for item selection with practically relevant information produced a statistically acceptable brief measure for work safety climate that would take approximately 10 minutes to complete. In doing so, the methods used in this thesis showed how a brief, reliable and valid measure could be designed to retain some of the diagnostic value of the more comprehensive measure on which it is based, but reduce the completion time by half. By reducing the time required to complete a safety climate survey, organisations may be encouraged to regularly implement such measures for monitoring purposes as a proactive response to identifying emerging safety concerns before they become critical, rather than what typically happens in practice wherein organisations retrospectively assess safety climate after a critical incident or accident has occurred.

From a theoretical perspective this thesis supports the methodological guidelines set by Goetz et al. (2013) as they relate to item reduction of existing measures. Additionally, this thesis highlights the importance of identifying how a measure will be used before attempting to reduce the number of items within the scale. The purpose of a measure is likely to impact the required selection criteria, and hence broad methodological recommendations are not proposed. Similarly, the purpose of a measure may also impact which approach to item reduction is most appropriate. In the case of developing a practical measure that can be used for monitoring purposes by various organisations and across numerous industries, a combination of classical test theory and the practical criteria introduced in this thesis was determined to be most appropriate. This is not to criticise item response theory as a valid method for item reduction, and in many cases such as testing for knowledge through the traditional right/wrong approach item response theory may prove more beneficial for item reduction. However, in the case of this thesis, this was not deemed the most effective method for bridging the research-practitioner gap.

6.3.2 Transforming and Validating Existing Measures

A second aim and contribution of this thesis was to develop a brief safety climate measure from an existing comprehensive scale with established reliability and validity. In doing so, this thesis refrained from adding to the many safety climate measures already in existence, and instead approached safety climate measurement from a more pragmatic position. For constructs that remain conceptually ambiguous, or where dimensionality is unclear this may be a more appropriate method. In doing so, the dimensionality of established and validated measures can be examined in a wider variety of industries or organisations, and the practical use of the existing proposed dimensions can be assessed in a brief version. Similarly, this method does not add to the unclear factor structure of safety climate measures and instead investigates the appropriateness of an existing factor structure in order to better understand the underlying construct.

Studies one and two examined the most appropriate factor structure for the safety climate measure. Where study one identified three key factors for the safety climate measure through exploratory factor analysis, study two ultimately supported the original seven dimension conceptualisation proposed by Kines et al. (2011) through confirmatory factor analysis. From a theoretical level this supports the seven dimensions of safety climate identified: management safety priority, commitment and competence; management safety empowerment; management safety justice; workers' safety commitment; workers' safety priority and risk non-acceptance; safety communication, learning, and trust in co-worker safety competence; and workers' trust in the efficacy of safety systems, as representative of the safety climate construct. Hence, instead of developing a new measure that might add to the conceptual ambiguity of safety climate as a construct, this thesis supported an existing conceptual model and dimension structure. This further supports the approach to measurement development taken. Additionally, unlike previous attempts to shorten the NOSACQ-50 (e.g., Ajslev et al., 2017; Forsell et al., 2017) the approach taken in this thesis attempted to retain some of the diagnostic value of the comprehensive NOSACQ-50 by including an approximately equal representation of items from each of the seven core dimensions of the measure. Maintaining the

dimensional integrity of the NOSACQ-50 in the development of a brief version enables researchers or practitioners to utilise the full version of the scale if a more comprehensive assessment of some or all dimensions is deemed necessary when monitoring safety climate over time.

Researchers (e.g., MacKenzie et al., 2011) have suggested that rigorous scale development and evaluation are essential when developing confidence in the validity of any measure. However, much of the current focus in safety climate measurement research appears to be on development, rather than the evaluation of measures (Shea et al., 2021). Reasons for this may include a tendency for academic journals to prefer development studies over validation studies. Additionally, the process of development, reliability and validity assessment, and practical implementation of a safety climate measure are likely to exceed the scope of one study. Hence, in order to disseminate the research findings related to a new measure, researchers may have to decide between highlighting the development, or the validation. This poses a potential problem for measures of safety climate. Many researchers who develop new scales cite inadequacy of previous research as a contributing factor, and reviews of safety climate measures support this notion (e.g., Vu & De Cieri, 2015a). This ultimately may explain why new measures continue to be developed. Thus, by demonstrating key stages of measurement development and validation across a large scale research project this thesis highlights the effectiveness of both the methodology employed, and the resulting safety climate measure.

By taking an existing validated measure of safety climate and attempting to reduce the required items to produce a brief and practically useful measure for regular monitoring, this thesis also contributes to furthering the understanding of safety climate as a construct. The NOSACQ-50 was developed through the lens of social exchange theory (Kines et al., 2011; Shea et al., 2021), and validation of a brief version of the measure further supports this approach. It is possible that much of the conceptual ambiguity regarding safety climate as a construct comes from the narrow lens through which it has been examined. As organisations and workplaces become increasingly complex, multidisciplinary approaches may be required to understand diverse phenomena such as safety climate. Hence, this thesis adds to the theoretical underpinning of safety climate by supporting social

exchange theory as a contributing factor and simultaneously demonstrates the benefit of reducing existing validated measures rather than developing a new one.

This thesis further supports assessing safety climate across multiple referents that have been previously examined in the safety climate literature. While the brief safety climate measure proposed in this thesis examines both management and workgroup referents, this does not exclude others including different levels of management and supervision that may differentially influence the development, maintenance, and remediation of a work safety climate. The studies in this thesis demonstrate the role of workers as well as managers in these aspects of work safety climate and support a move away from the management only approaches that many measures employ. Similarly, given the large impact that management practices have on perceptions of safety climate in a workplace, some practitioners may believe that the most effective way to reduce an existing safety climate measure would be to only focus on the management level. Results of this thesis argue against this approach, particularly study three, and highlight the value of worker-level referents when examining safety climate. It is highly likely that as organisations become hierarchically flatter and workers become more empowered in decision making, their impact on workplace perceptions is likely to increase, again supporting the inclusion of worker-level referents in the measurement of safety climate. Shea et al. (2021) indicated that safety climate measurements are broadly inconsistent in terms of referents and that this can subsequently impact the capacity for researchers to compare relationships between safety climate and outcomes across studies. This thesis has taken steps to addressing these concerns by supporting at least two references (management- and worker-level) when measuring safety climate.

6.3.3 Importance of Assessing Safety Climate Subcultures

A third aim of this thesis was to examine the importance of demographic subcultures as they relate to perceptions of work safety climate. These were examined at both the job level (e.g., work type, management position, employment status, workplace location) and the individual level (e.g.,

age, gender). Some researchers have suggested that if a safety climate tool is "unable to differentiate between organizations with different safety performance levels, then it is of limited use" (Singh & Verma, 2020, p. 699). However, this thesis argues that the same can be said for a work safety climate measure that is unable to differentiate between groups within large organisations.

Consistent with previous research, study three identified subcultural differences in perceptions of safety climate using the brief safety climate measure developed and validated in studies one and two. This suggests that one of the key strengths of the NOSACQ-50 has been maintained in the brief version. Additionally, the ability to distinguish between subcultures within an organisation supports both the item selection methodology employed, and validity of the measure developed in this thesis. Significant differences in perceptions of safety climate were identified based on management position, workplace location, work type, employment status, and gender. Similarly, significant interaction effects were identified for gender and managerial position wherein males in leadership positions rated "Management Safety Justice" and "Workers' Safety Priority and Risk Non-Acceptance" significantly more positively than males in a team member position. These results are consistent with the suggestions of Brondino et al. (2012) who argue that safety climate measures should account for subcultural differences due to the multilevel nature of the construct.

The need to examine multiple referents in safety climate measurement was supported by the results of study three and subcultural differences were identified for both management- and worker-level dimensions of the brief NOSACQ; for example, when comparing safety climate perceptions of permanent and casual workers, significant differences were identified for two dimensions – "Management Safety Priority, Commitment, and Competence", and "Workers' Trust in the Efficacy of Safety Systems". This example supports the multiple referent approach taken in this thesis and also highlights that only retaining the management focussed questions is not an effective or appropriate item reduction approach. This supports the methodology employed in this thesis which retained the multilevel conceptualisation and referent-shift approach of the original NOSACQ-50 when assessing perceptions of safety climate.

From a practical perspective these results have significant implications. First, not only were statistical differences identified between subcultures, but the practical interpretation of safety climate scores based on NOSACQ benchmarking criteria also differed. This is a key implication of these results, suggesting that safety climate assessments should examine perceptions across key work group demographics, rather than simply aggregating scores for the whole organisation and evaluating the mean. A mean score for an organisation in a range benchmarked as satisfactory might misrepresent the fact that this is not the case for all subcultures of the organisation and that one or more subcultures may require remediation of specific safety concerns. By examining group differences within the same organisation, safety practitioners can more accurately tailor different safety interventions to the areas where they are most needed. Similarly, this method may help to prevent unnecessary or inappropriate intervention strategies on areas that are not performing poorly with regard to safety climate, ultimately saving time and money for organisations. In combination with the availability for regular monitoring provided by the brief safety climate measure developed in this thesis, organisations can effectively remediate emerging safety concerns before they reach a critical stage, in areas where they are most required. Any safety intervention for a particular subculture with a safety concern can then be evaluated at a later point in time, based on either statistical or practical improvements in safety climate scores and safety related outcomes, respectively. Hence, the capacity of the brief measure developed in this thesis to differentiate between managers, workers and other subgroups within an organisation may be of significant value to both safety practitioners and researchers.

6.3.4 Critical Factors for Successful Organisational Change

The final aim of this thesis was to move from the development and validation of a brief measure of work safety climate, to the development of an accompanying brief measure of change capability to ensure the successful remediation of identified safety concerns. The basis for developing this brief change capability measure was the low success rates reported for organisational

interventions (Vakola, 2013). There is little point in identifying safety issues for remediation if it is unlikely that the organisation will be able to successfully implement required interventions. As such, study four examined critical success factors for organisational change and developed a brief measure of these to supplement the brief safety climate measure developed, validated, and implemented across studies one, two, and three. The four critical factors were identified from the research literature including an action research project implementing work safety interventions based on an assessment of work safety climate within a disability organisation using the full version of the NOSACQ-50 (Kirby et al., 2014; Harries et al., 2020). The four change factors (i.e., overall change capability, overt top management support, use of champions of change, and worker buy-in) received preliminary support in the form of qualitative comments from participants who rated any or all of the change capability factors as needing improvement. The qualitative comments concerning the need to improve these factors also provided useful practical information about the nature of the improvements required. The 4-item supplementary change capability measure correlated significantly with expected outcome variables (safety climate and mental wellbeing), exhibited appropriate internal consistency (Cronbach's alpha), and unidimensionality through exploratory factor analysis.

In combination with the brief safety climate measure developed and validated in this thesis, an assessment of organisational change capability could provide safety practitioners with a combined package for improving and maintaining a positive work safety climate. Regular monitoring through consistent use of the brief work safety climate and change capability measures could help to identify a progressive deterioration in work safety climate and/or change capability scores in addition to identifying emerging areas of concern with regard to safety climate and/or change capability. Organisations who regularly monitor these factors can then ensure that required safety interventions are successfully implemented before the safety issues become critical. Key subcultures can also be identified in terms of safety climate and change capability levels to examine whether potential safety and change capability concerns are applicable across an entire organisation, or whether they are localised to a particular subculture (e.g., work type, gender, employment status). Remedial action can

then be appropriately targeted. Through assessment of the four critical change capability factors organisations can tailor their implementation strategies to enhance the likelihood of successful organisational change. Once remedial action has been implemented the effectiveness of a safety solution can be examined with subsequent safety climate assessments using the brief measure. Given the response burden associated with longer survey measures (Nielsen et al., 2016), and meta-analytic evidence negatively associating response burden with response rates (Rolstad et al., 2011), the 28 quantitative items outlined in this thesis (24 safety climate items, 4 change capability items) have the potential to contribute significantly to both work safety research and practice. Both measures could further be used in triangulation approaches to validate or challenge safety data attained through other measures, such as employee interviews, safety observations, or safety audits. The triangulation method with regard to work safety combines various sources of data, and in doing so protects against the weaknesses associated with each individual collection method. As a result, triangulation has been proposed to yield more valid safety performance data than any single measure (Jespersen & Wallace, 2017). Hence, use of both brief measures may contribute to a better understanding of best practice with regard to the maintenance of a positive work safety climate and change capability, and to the identification of emerging safety or change capability issues critical for the success of intervention strategies and remedial actions.

This thesis further highlighted the effectiveness of mixed-methods research when examining change capability. Study four indicated that important contextual information was able to be drawn from participants' qualitative responses, and these responses provided support for the construct validity of the four change capability factors in the study (overall change capability, overt top management support, use of champions of change, and worker buy-in). As highlighted by Stouten et al. (2018), the results of organisational change initiatives can take many years before showing results. Hence, a brief measure of change capability that allows participants to provide qualitative feedback regarding areas that need improvement may assist organisations in developing organisation-specific remedial interventions. In doing so, a culture of change capability can be fostered, and the high failure

rates of organisational change initiatives may be reduced. While the four identified factors are likely to be applicable across organisations, the specific contextual factors provided by qualitative responses may differ. Hence, this thesis contributes to the research literature by demonstrating the importance of providing participants with the opportunity for qualitative feedback alongside quantitative measures. While this approach may require a greater time investment from researchers and practitioners for qualitative analysis, the benefit of acquiring contextually-specific information arguably outweighs this cost.

6.4 Strengths and Limitations

This thesis included a number of research strengths that have contributed to the findings. For example, the development and validation procedures employed throughout align with best practice recommendations for item-reduction (Goetz et al., 2013) and safety climate measurement development (Shea et al., 2021). Other methodological strengths include the relatively large sample sizes across all studies, and the use of multiple studies that allowed for the extension of findings from one study to another. Another strength of this thesis is its emphasis on enhancing the practical usefulness of work safety climate measures by developing a sufficiently reliable and valid work safety climate measure that takes approximately 10 minutes to complete, which makes it potentially useful for monitoring, identification, and remediation of emerging safety concerns before they become critical. Similarly, considering the brief measure in this thesis is based on the original NOSACQ-50 (Kines et al., 2011) the two versions may be used collaboratively; for example, practitioners may wish to implement the full measure annually, with the brief measure monitoring safety climate on a quarterly basis. A further strength of this thesis from a practical perspective is the range of work place samples examined which include casual workers from a variety of hospitality and retail organisations, and workers from different organisational types such as disability support, hospitality, and vocational education. Additionally, a strength of this thesis derived from basing the brief work safety climate measure on an existing measure is the potential use of the benchmarking capabilities of the

established NOSACQ-50. For safety practitioners this would be important for monitoring and comparative purposes, as opposed to safety researchers who may be more interested in statistical relationships with other work-related measures. Study two supports the use of existing benchmarks available through the NOSACQ-50 website for the brief measure, which represents a significant practical strength of the brief measure and assists in bridging the gap between research and practice.

While there were strengths of the thesis, there are some limitations that should be acknowledged. One of these limitations is that although the studies used a variety of different types of organisations, none of them represented industries which are likely to have more safety concerns about serious physical injury, such as manufacturing, construction, or mining. Additionally, the use of single-source individual data in this thesis may have implications for generalisability of results. Although indirect safety outcomes such as burnout, mental health, mental wellbeing, and physical heath were examined in this thesis, there was no link to organisational outcomes beyond perceptions (i.e., in the form of accident rates). Similarly, the multilevel nature of safety climate was not thoroughly examined through this thesis as the NOSACQ-24 evaluated only worker and management perceptions of safety climate, with no examination of factors that may reflect safety climate at the organisation level such as workers compensation claims, as these data were not available.

Another limitation is that data from studies two, three and four were collected during the COVID-19 global pandemic. When research is conducted in applied settings outside of a laboratory it may be vulnerable to extraneous factors outside the control of researchers. The COVID-19 pandemic represents one such extraneous variable present in this thesis. While groups affected by the pandemic (VET employees in studies two, three and four; casual workers in study two) were not directly compared with groups unaffected by the pandemic (disability support workers and hospitality employees in studies one and two), it is possible that VET participants in studies two, three and four reported more negative perceptions and safety related concerns than would otherwise have been reported. Thus, the results of this thesis need to be considered in light of this.

A further potential limitation of this study is that one of the key practical criterions for item selection (readability) was not able to be effectively utilised while maintaining the wording of the original NOSACQ-50. Researchers have proposed that mean readability measured by Flesch-Kincaid grade should not exceed eight. However, many of the items in the original NOSACQ scale exceeded this threshold and this could not be entirely avoided in items selected for the brief measure. Nonetheless, in order to effectively reduce the existing measure, readability assessments were utilised to ensure that the reading level of the brief version remained close to the original.

Self-report data may also be a potential limitation with the study designs employed in this thesis. With this style of responding participants may attempt impression management through artificially inflated responses or may exaggerate or underreport responses to safety questions. For example, research suggests that managers tend to respond more positively to work safety climate measures when compared to workers (e.g., Chan et al., 2021; Gambashidze et al., 2021), which may be due partly to their responsibility for work safety measures. Similarly, all four studies utilised Likert type survey measures which opens the possibility of response bias. This was partially addressed by the use of open-ended qualitative responses that gave participants the ability to expand on responses and provide context-specific examples that helped to validate their quantitative responses.

6.5 Future Research

In the previous chapters of this thesis the results of four studies were discussed and each suggested further research in particular areas of safety climate measurement and assessment. This section will suggest future research topics based across the four studies.

Further research is required into the optimal dimensionality for cross-industry safety climate measures. While this thesis supports the NOSACQ dimensionality proposed by Kines et al. (2011) and was able to translate the same structure into a brief safety climate measure, further examination of generalisation across multiple organisations and industry types will assist in further validating the brief safety climate measure. In particular, there is a need to extend these studies using the brief work

safety climate and brief change capability measures from service organisations such as hospitality, disability support, and education, to industries like manufacturing, mining, and construction where there may be greater concern about physical safety including the risk of serious physical injuries. Additionally, by utilising a practitioner-focussed approach as in study one, future research may be able to identify context-specific factors missing for unique organisations or work settings that were not reported by the safety experts in study one.

As highlighted in previous chapters, there are numerous conceptual models and dimension structures proposed for the construct of safety climate. While it might seem unrealistic at this stage for consensus to be agreed upon, the more safety climate measures are validated across organisations and industries, the stronger support for existing dimensions becomes. Future research will benefit not only from assessing existing models of safety climate, rather than generating new ones, but also from transforming existing models to enhance applicability and practicality in applied and research settings.

This thesis raises questions regarding the value of negatively worded questions in contemporary survey measures. The impact of negatively worded questions on factor structure has been assessed previously (e.g., Roszkowski & Soven, 2010). When assessing the factor structure of the brief safety climate measure through exploratory factor analysis, all questions that had been negatively worded loaded onto their own unique factor. This hampered accurate result interpretation considering a large number of negatively worded questions all came from the same dimension (Workers' Safety Priority and Risk Non-Acceptance). Hence, it was unclear whether the items were loading onto the specific safety dimension, of if the factor was affected by 'noise' introduced by the negative wording. Since exploratory factor analysis identifies clusters of items due to underlying patterns, the interpretation of an ideal factor structure in study one may have been contaminated. Given that negatively worded questions were traditionally introduced to protect against participant inattention, acquiescing and satisficing, some still argue for their usefulness in survey design. However, with modern online survey platforms such as Qualtrics, participants can be presented with survey responses in random orders, and researchers are given the total time taken to complete a

survey, both of which can be used to evaluate the accuracy of responding. Thus, future research may wish to examine the benefit of negatively worded questions in safety surveys to determine whether the potential benefits outweigh the potential costs.

To address some of the potential issues associated with self-report and Likert type response, future research may benefit from accompanying surveys with open-ended qualitative responses to provide participants with an opportunity to elaborate on responses or include context-specific information. The advantage of such an approach was outlined in study four and may benefit both safety climate practitioners and researchers as they examine safety climate. This approach may also address concerns raised by some researchers regarding the context-specific safety information relevant to particular industries, such as construction (Choudhry et al., 2007). If safety climate measures can be supplemented with open-ended responses to provide the specific information missing in the survey measures, future researchers may be able to focus on refining and improving universal safety climate measures over developing ones specific to particular organisations or industries. Potential options for supplementary qualitative questions may include what was asked of participants in study four – "Are there any comments you would like to make about your answers to the safety in the workplace questions?", or options such as "What currently works well with regard to work safety in your organisation?" and "What could be done to improve work safety in your organisation?". These questions are likely to elicit specific references to the workplace/industry that facilitate the use of general rather than industry-specific work safety climate measures and they could be incorporated by safety practitioners or researchers when attempting to understand and remediate work safety climate concerns.

In view of the changes in work arrangements that have arisen with the COVID-19 global pandemic, further research is also needed to investigate differences in safety climate perceptions between individuals and groups who work either completely at home, under blended work arrangements involving a combination of at work and home, or completely on site. This question was examined in study three; however, limited participants who worked only at home excluded further

examination of safety climate issues for this group. Numerous safety concerns associated with working from home have been identified including physical hazards (e.g., physical strain injuries from ergonomically improper workstations, fatigue and eye strain injury from poor lighting, tripping hazards from communal walkways), but also psychosocial hazards (e.g., due to family or domestic violence) (Safe Work Australia, 2021b). As the workplace becomes increasingly flexible, and remote positions become more available, this is a significant area for future research, particularly if blended and work from home arrangements persist post-COVID.

Longitudinal research on the critical factors for change capability may also be a focus of future research. While previous research has examined the broader change factors (e.g., Harries et al., 2020) and their usefulness, the measure developed in this thesis was unable to be assessed using a pre-post study design due to the COVID-19 pandemic. While study four did provide preliminary support for the identified factors and the 4-item measure designed to assess them, applied research examining how to effectively use the change capability information provided is an area for future research. Whether the qualitative comments associated with the brief change capability measure can be usefully reduced or augmented for practical purposes is also an area for future research. For example, the measure might be reduced in time taken to complete by only having one qualitative question at the end requesting participants to comment on any of the change capability factors needing improvement, rather than one qualitative question for each of the four items. An additional quantitative question or questions might also be considered, bearing in mind the need to keep the measure brief, to assess another key factor or factors for successful change such as the degree to which professional behaviour informs change efforts.

To fulfil the aims of this thesis, future longitudinal research is required to determine the extent to which the brief work safety climate measure together with the brief change capability measure are capable as monitoring instruments for identifying emerging work safety and/or change capability issues and assessing improvements in either or both as a result of relevant implemented interventions.

6.6 Conclusion

The studies in this thesis were based on the fact that many comprehensive safety climate measures are too long to be practically implemented on a regular basis for monitoring purposes by researchers and practitioners and that existing brief versions of work safety climate, while useful for research purposes, do not provide useful practical information on what needs to be improved with respect to work safety. As a result, the effectiveness of safety climate as a preventative leading indicator for safety outcomes is compromised. Simultaneously, numerous safety climate measures exist, and many have questionable reliability and validity. Hence, it was determined that the most appropriate way to enhance the practical usefulness of a work safety climate measure was to develop a brief measure from an existing reliable and validated comprehensive measure through a novel item reduction approach that incorporates practically focussed criteria, which included retaining the diagnostic structure of the comprehensive measure. The studies within this thesis provide preliminary support for this method, and for the potential usefulness for monitoring purposes of the measure developed. The implications of these findings highlight potential issues with item reduction approaches and safety climate measures that have been employed in the past. They also support the possible use of a brief measure for monitoring work safety climate as an effective method for identifying emerging work safety issues so that they can be remediated before reaching a critical point, thus reducing negative safety outcomes in terms of costly safety incidents and accidents, both in human and financial terms. While safety climate and its measurement remain complex subjects, this thesis has attempted to reduce the conceptual ambiguity surrounding the topic and bridge the gap between research and practice.

Work safety climate is a dynamic summary of worker perceptions regarding how safety is valued by their organisation. Although there are safety communalities between all organisations, there is unlikely to be a 'one size fits all' solution for safety monitoring and the remediation of safety concerns. Every organisation will have different issues and require different strategies for improvement. The series of studies reported in this thesis have provided a brief work safety climate

measure that could be used by safety practitioners and researchers to regularly monitor, identify, remediate safety concerns, and evaluate required safety interventions. The final study has provided a brief change capability measure that can identify critical factors associated with organisational change that may need to be remediated if safety interventions are to be successfully implemented. Further research is needed to determine the extent to which these measures can be successfully generalised for use in other types of organisations and industries with other types of working conditions. Further longitudinal research is also needed to determine whether as monitoring instruments, these measures can be used proactively to identify emerging issues in work safety climate and/or change capability and facilitate the successful implementation of remedial interventions to prevent critical work-related incidents and accidents that are costly both in human and financial terms.

Appendix: Nordic Occupational Safety Climate Questionnaire (NOSACQ-50). Note: ** = Item is used in the 24-item version and r indicates negatively worded (reversed scored) items.

Dimension 1: Management safety priority, commitment and competence.

1. Management encourages employees here to work in accordance with safety rules - even when the work schedule is tight. **
2. Management ensures that everyone receives the necessary information on safety. **
3r. Management looks the other way when someone is careless with safety.
4. Management places safety before production. **
5r. Management accepts employees here taking risks when the work schedule is tight.
6. We who work here have confidence in the management's ability to deal with safety.
7. Management ensures that safety problems discovered during safety rounds/evaluations are corrected immediately. **
8r. When a risk is detected, management ignores it without action.
9r. Management lacks the ability to deal with safety properly.

Dimension 2: Management safety empowerment.

10. Management strives to design safety routines that are meaningful and actually work.
11. Management makes sure that everyone can influence safety in their work environment. **
12. Management encourages employees here to participate in decisions which affect their safety. **
13r. Management never considers employees' suggestions regarding safety.
14. Management strives for everybody at the worksite to have high competence concerning safety and risks. **
15r. Management never asks employees for their opinions before making decisions regarding safety.
16. Management involves employees in decisions regarding safety. **

Dimension 3: Management safety justice.

17. Management collects accurate information in accident investigations. **
18r. Fear of sanctions (negative consequences) from management discourages employees here from reporting near-miss accidents.
19. Management listens carefully to all who have been involved in an accident.
20. Management looks for causes, not guilty persons, when an accident occurs. **
21r. Management always blames employees for accidents.
22. Management treats employees involved in an accident fairly. **

Dimension 4: Workers' safety commitment.

23. We who work here try hard together to achieve a high level of safety. **

24. We who work here take joint responsibility to ensure that the workplace is always kept tidy. **

25r. We who work here do not care about each others' safety.

26r. We who work here avoid tackling risks that are discovered.

27. We who work here help each other to work safely. **

28r. We who work here take no responsibility for each others' safety.

Dimension 5: Workers' safety priority and risk non-acceptance.

29r. We who work here regard risks as unavoidable.

30r. We who work here consider minor accidents to be a normal part of our daily work. **

31r. We who work here accept dangerous behaviour as long as there are no accidents.

32r. We who work here break safety rules in order to complete work on time. **

33. We who work here never accept risk-taking even if the work schedule is tight.

34r. We who work here consider that our work is unsuitable for cowards.

35r. We who work here accept risk-taking at work. **

Dimension 6: Safety communication, learning, and trust in co-worker safety competence.

36. We who work here try to find a solution if someone points out a safety problem. **

37. We who work here feel safe when working together.

38. We who work here have great trust in each others' ability to ensure safety.

39. We who work here learn from our experiences to prevent accidents. **

40. We who work here take each others' opinions and suggestions concerning safety seriously. **

41r. We who work here seldom talk about safety.

42. We who work here always discuss safety issues when such issues come up.

43. We who work here can talk freely and openly about safety. **

Dimension 7: Workers' trust in the efficacy of safety systems.

44. We who work here consider that a good safety representative plays an important role in preventing accidents.

45r. We who work here consider that safety rounds/evaluations have no effect on safety.

46. We who work here consider that safety training is good for preventing accidents. **

47r. We who work here consider early planning for safety as meaningless.

48. We who work here consider that safety rounds/evaluations help find serious hazards. **

49r. We who work here consider safety training to be meaningless.

50. We who work here consider it important to have clear-cut goals for safety. **

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