CULTURE AND CLIMATE OF SAFETY IN ORGANIZATIONS: CONCEPTUALIZATIONS AND ASSESSMENT

A Thesis Submitted to the College of Graduate and Postdoctoral Studies

In Partial Fulfilment of the Requirements

For the Degree of Masters of Arts in Applied Social Psychology

In the Department of Psychology

University of Saskatchewan

Saskatoon

By

MELANIE B KACZUR

PERMISSION TO USE

In presenting this thesis/dissertation in partial fulfilment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis/dissertation in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis/dissertation work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis/dissertation or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis/dissertation.

Requests for permission to copy or to make other uses of materials in this thesis/dissertation in whole or part should be addressed to:

Head of the Department of Psychology
9 Campus Drive, Arts 154
University of Saskatchewan
Saskatoon, Saskatchewan S7V 5A5 Canada

ABSTRACT

The concepts of safety culture and safety climate have received a great deal of attention from safety professionals and academic researchers as efficient non-technological means of reducing injuries and accidents within various industries. However, there is conceptual confusion regarding these constructs as there is a lack of single, unified theoretical and operational definitions for both of these constructs, which has led to a vast number of assessment tools with questionable validity and applicability. In this thesis, the author addressed some of these conceptual issues. The thesis reports two studies. In Study one, the author conducted a conceptual analysis of the two constructs, which included analysis of theoretical definitions of safety culture and safety climate, analysis of their operational definitions, and assessment of congruency between these types of definitions. Finally, a theoretical definition and an operational definition was developed and presented for each of these constructs. This conceptual analysis was complemented by the analysis of corresponding literature. In Study two, the researcher focused on developing and verifying a self-report measure for assessing safety climate in the College of Engineering. The developed theoretical and operational definitions for safety climate were used to develop the Saskatchewan Safety Climate Questionnaire. This questionnaire was administered to 267 students in the College of Engineering at a Canadian University. The developed Safety Climate Questionnaire demonstrated adequate psychometric properties and highlighted the link between safety climate and students' experience with injuries and near misses on campus. The safety climate scores were found to be related to students' discipline, previous work experience in industry, students' experience with injuries and near misses, and witnessing injuries and near misses.

ACKNOWLEDGEMENTS

I would first like to thank my thesis supervisor, Dr. Valery Chikov, for his help and guidance in completing this Master's thesis. His guidance has significantly improved my research and writing skills and, despite his own projects and classes, he has always made himself available whenever I needed advice or feedback. I would also like to thank my advisory committee members, Dr. Louise Alexitch and Denard Lynch, for their helpful feedback and assistance with the survey questionnaire development.

I want to thank my raters for putting in several tedious hours into classifying definitions for me, you all did an amazing job. Additional thanks to Michael Heimlick, Tatiana Kim, and Karissa Wall for all your help and suggestions that aided in the completion of this thesis.

Finally, I would like to thank my family for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. As well, I would like to thank all of my participants for taking the time to complete the questionnaire and providing their insightful observations about safety in their college.

This thesis would not have been possible without all of you. Thank you.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION & LITERATURE REVIEW

Just outside the small town of Pripyat, Ukraine on April 26th 1986, the Chernobyl nuclear power plant experienced one of the most devastating accidents in the nuclear power industry's history. An unexpected power surge within one of the nuclear reactors resulted in a fire that sent highly radioactive fallout into the atmosphere (Schmid, 2011). The effects of this nuclear explosion are still felt decades later, with approximately 31 deaths directly attributed to the Chernobyl accident; as well, an additional 4,000 deaths from cancer and other diseases are related to the effects of the radiation (Jaworowski, 2010). Due to the severe nature of the accident, a thorough analysis of the causes surrounding the Chernobyl accident was conducted by the International Nuclear Safety Advisory Group (INSAG). Upon reviewing the dynamics that lead up to the accident, an interesting phenomenon regarding the non-technological, human aspect of safety was uncovered.

1.1 Current Problems within the Concept of Safety Culture and Climate

1.1.1 Culture of Safety: A New Safety-Related Phenomenon Discovered

After reviewing the statements and reports of the employees and managers at the time of the Chernobyl accident, the INSAG inspectors found that the employees and managers were overlooking the non-technological aspect of safety, which involves the organizational and individual aspects of safety that are controlled by humans, such as their attitudes, beliefs, and behaviors. The attitudes and behaviors at the time of the accident among all workers reflected a disregard for safety through negligence towards safety regulations, a lack of communication between managers and employees, and prioritizing secrecy over safety (Schmid, 2011).

Firstly, it was found that on the day of the Chernobyl explosion several operators disconnected the technical protection systems that were in place to keep an accident such as this from occurring. This was done in order to test one of the generators; however, safety regulations were not properly followed (Schmid, 2011). While not found to be the direct cause of the accident, such a breach in safety protocol suggests a disregard for the regulations put in place to protect both employees and citizens. Furthermore, it also suggests a lack of knowledge among employees about the purpose and necessity of these protection systems, possibly due to insufficient training.

Secondly, it was discovered that there were oversights present in the communication and circulation of information within the nuclear power plant. When managers discovered there was a design flaw with one of the parts of the reactors, they were quick to modify the operating instructions to account for this defect. However, it was deemed unnecessary to inform the employees responsible for using this piece of equipment about the issue (Schmid, 2011). As such, this lack of communication lead to the operating staff remaining unaware of the defect in the equipment. Therefore, they did not fully comprehend why it was necessary to meticulously adhere to the modified instructions when handling the equipment.

Finally, a review of the accident demonstrated that there was greater priority placed on maintaining secrecy surrounding nuclear affairs compared to the safety of the employees and citizens. After the initial explosion and radiation leak, the plant managers attempted to cover up the severity of the situation, resulting in the explosion going unreported for days. The Chernobyl accident was only officially reported once the radioactive cloud set off Swedish radiation detectors, and by this time many employees and civilians were in danger of experiencing high radiation exposure (Schmid, 2011). If a greater priority had been placed on safety rather than keeping information classified, citizens could have been evacuated sooner, thereby reducing the explosion's harmful effects.

The non-technological aspects of safety that were discovered at Chernobyl are characterized by the safety-related attitudes and behaviors of both employees and managers. The behaviors at the time of the incident demonstrate that safety was not a priority at either the individual or organizational level. At the individual level, the employees' poor attitudes towards safety were evident through the act of disregarding essential safety measures and disconnecting vital protection systems. Moreover, the decision made by management to cover up the nuclear explosion and neglect to provide proper training to their employees demonstrates that safety was not viewed as a priority at the organizational level. The International Nuclear Safety Advisory Group (INSAG) classified this phenomenon as a defect within the "culture of safety" in the nuclear power plant and it was this defect which ultimately lead to the Chernobyl accident.

1.1.1.1 Initial definition of the concept. The INSAG defined safety culture as "that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance" (IAEA, 1991; as cited by Cooper, 2000, p. 113). This definition is in line with the

flaws in the non-technological aspects of safety which were discovered at Chernobyl, as both individuals and management were neglecting the importance of safety. The definition developed by the INSAG focuses on the collective characteristics, such as values, beliefs, and attitudes that determine how safety is prioritized.

1.1.2 Safety Culture and Organizational Performance

Safety culture has been studied extensively since the concept was conceived in 1986, attracting the attention of safety practitioners and researchers alike. After this concept entered the occupational health and safety research, researchers focused their investigations into how safety culture impacts injury rates, production quality, employee turnover, job satisfaction, and organizational cohesion.

1.1.2.1 Injury rates. Reducing injury[1] and fatality rates is the primary safety goal of any organization. Vredenburgh (2002) studied the relationship between safety culture and hospital employee injury rates, in which injury rate data included needle punctures, sprains, fractures, infectious diseases, or crushed fingers and hands that occurred in the past three months. In this study, safety culture was assessed with a perception survey which included the following factors: rewards, training, hiring, communication, participation, and management support. The safety culture survey score was negatively related to injury rates, as higher safety culture scores were related to fewer injuries. O'Toole (2002) found a relationship among employees of a concrete production company between safety perception survey scores and injury rates. The safety perception survey was used as a measure to assess the respondent's perception of the safety culture at the company. In this study, employees with a higher score on the perception survey were less likely to report experiencing injuries at work compared to employees with a low score on the perception survey. Additionally, O'Toole (2002) was able to reduce the organization's injury rates by improving the safety culture within the organization. The relationship between a strong safety culture and reduced injury rates has also been found in the lumber industry (Varonen & Mattila, 2000), the offshore oil and gas industry (Mearns, Whitaker, & Flin, 2003), as well as the manufacturing, construction, and transportation industries (Huang, Ho, Smith, & Chen, 2006).

[1] Injuries are defined as "physical harm or damage to a person resulting in the marring of appearance, personal discomfort, infection, and/or bodily hurt or impairment" (Lack, 2001).

1.1.2.2 Quality of production. It is a common belief that an organization focused on safety must sacrifice their productivity, but this need not be the case. Few studies were available that directly link production quality and safety culture; however, there are several studies that have found relations among injury rates and production quality. Following the logic of the previous discussion, production quality is indirectly linked to safety culture; that is, safety culture is related to low injury rates which in turn promotes higher quality performance. To illustrate this, Wanberg, Harper, Hallowell, and Rajendran (2013) determined the relationship between production quality and safety performance among 32 construction sites. Safety performance was assessed as any recordable injury that required receiving first aid or a hospital visit, while quality performance was assessed using the total number of defects found or units needing to be reworked on the construction site. The researchers found that the recordable injury rate was positively correlated with need to rework, in that a project with a higher rate of injuries was more likely to demonstrate poor quality of work (Wanberg et al., 2013).

Similarly, Hinze and Parker (1978) demonstrated that supervisors who were safety conscious and ensured their employees were not injured on the job, were also more likely to meet their proposed job costs and time schedules. The relationship between lower injury rates and increased productivity has also been found in the manufacturing industry (O'Toole, 2002) and the nuclear power industry (Lee & Harrison, 2000). It is also important to consider that a high number of injuries within a company results in increased insurance costs and decreased productivity due to the time lost because of these injuries and the necessary shut-down of equipment (Choudhry, Fang, & Mohamed, 2007b). So, not only are fewer injuries related to improved productivity, but it is also avoids related negative outcomes.

1.1.2.3 Job satisfaction. Safety culture has also been shown to relate to increased job satisfaction. Modak, Sexton, Lux, Helmreich, and Thomas (2007) had hospital staff complete a safety attitudes questionnaire in order to assess the safety culture of their hospital. It was found that nurses with the highest scores on the safety attitudes questionnaire also had the highest job satisfaction and positive attitudes towards working conditions. Additionally, employees who work in organizations with low incident rates experience higher job satisfaction and higher satisfaction with the tasks they are assigned (Lee, 1998). This link between low injury rates and high job satisfaction has also been found in road and bridge construction in Finland (Niskanen, 1994) and building construction in Hong Kong (Siu, Phillips, & Leung, 2004). These

associations may also mean that, because safer employees experience fewer injuries, employees require less work-related injury leave. Consequently, this saves the company the costs associated with recruiting and training new employees.

1.1.2.4 Employee turnover. Employee turnover has also been found to relate to safety culture. For example, using education and training techniques, Pronovost and colleagues (2005) implemented a comprehensive safety program designed to improve safety culture among nurses. Safety culture was assessed with a standardized medical safety survey. The researchers found that turnover decreased from 9% to 2% after the intervention, which was a practically significant change for this organization (Pronovost et al., 2005). This link between low injury rates and decreased employee turnover has also been found in other hospital studies (Colla, Bracken, Kinney, & Weeks, 2005), as well as in the aviation (Díaz & Cabrera, 1997) and chemical industries (Barling & Hutchinson, 2000).

1.1.2.5 Communication and interpersonal cohesion. A strong safety culture is also related to improved communication and teamwork. Blegen and colleagues (2010) analyzed the safety culture of a hospital before and after a communication intervention program was implemented. The intervention on communication and teamwork significantly improved the safety culture among the three included hospitals. Similarly, Hsu, Lee, Wu, and Takano (2010) analyzed Taiwanese companies that were improving their safety practises. They found that increased emphasis on safe practice was linked to more harmonious relationships, increased trust among employees, and improved team collaboration.

1.1.2.6 Concluding remarks. As illustrated, safety culture has been found to have crucial implications for workplaces among a variety of industries. There are many outcomes of a strong safety culture that would benefit an organization, ranging from low injury rates, to improved quality of production and improved employee relationships. Therefore, safety culture is a valuable concept that can be used to improve employees' well-being and an organization's productivity. However, the relationships between safety culture and climate and these beneficial outcomes are not always direct. Safety culture is a complex phenomenon that is not necessarily directly related to these beneficial outcomes. According to Cooper (2000), safety culture is a sub-feature of organizational culture. Many other sub-features are also included within organizational culture, including employee creativity, motivation, autonomy, risk-taking, teamwork, resources, decision making, learning from incidents, employee participant, and a multitude of other

constructs (Naranjo-Valencia, Jimenez-Jimenez, & Sanz-Valle, 2016). These constructs are all interconnected, in that high productivity, good management, low stress, and a strong safety culture may all work together to result in employees with high job satisfaction and a desirable workplace. This interconnectedness makes it difficult to determine a single, simple direct relationship between these constructs, which is further compounded by the differences present in each organization.

It is important to note that the current research on safety culture also demonstrates that there is a very broad range of theoretical and operational definitions of this construct among researchers, making comparisons between and applications of safety culture studies highly problematic. Even among the above studies, researchers utilized a variety of operational definitions to represent safety culture, ranging from the number of injuries within an organization (Wanberg et al., 2013), the effectiveness of an intervention program (Blegen et al., 2010), the scores on employee attitude questionnaires (Modak et al., 2007) and perception surveys (O'Toole, 2002). To make this concept more useful, researchers have to have a clear and relatively standard understanding of the nature of this safety phenomenon, as well as well-defined concepts and assessment instruments to investigate it. Without such clarity the concept of safety culture may lose its potential as an important non-technological factor within organizational functioning. The following section provides an overview of the competing definitions of safety culture, highlighting the need for greater clarity and specificity in this area.

1.1.3 Safety Culture Theoretical Definitions

A theoretical definition "attempts to describe the essence of a phenomenon in a way that represents a basic truth" (Corsini, 2002, p. 257). In other words, a theoretical definition involves the nature or mechanism of the phenomena under study. It articulates in theoretical terms an idea of what researchers plan to study. Theoretical definitions are important as they allow researchers to differentiate between related phenomenon by providing a boundary line of what a specific construct is and what it is not. Theoretical definitions also allow researchers to understand what it is they are studying as, without this understanding, researchers cannot adequately assess the construct. Continued attempts to assess a construct, without a solid theoretical definition of what it is, constitutes an inappropriate and poor research practice.

According to Edwards and Armstrong (2013) "safety culture can be viewed as the assembly of underlying assumptions, beliefs, values and attitudes shared by members of an

organisation, which interact with an organisation's structures and systems and the broader contextual setting to result in those external, readily-visible, practices that influence safety" (p. 77). This definition highlights safety culture as a collective phenomenon that influences the organizational structure, as well as management and safety practices. Conversely, according to Olive, O'Connor, and Mannan (2006), "safety culture can be viewed as the overarching policies and goals set by an organization relating to the overall safety of their facility or environment" (p. 133). In this definition, researchers exclusively highlight the organizational role of structuring safety management. Individual workers and their communities are excluded from the creation of such policies and goals. Cabrera, Isla, and Vilela (1997) suggest another definition involving "shared perceptions [about safety] of organizational members and their work environment and, more precisely, about their organizational safety policies" (p. 257). This definition is focused not on behaviors or attitudes, but on the perceptions of employees; this is more closely related to the concept of safety climate which will be discussed later.

Furthermore, the above three definitions contain different components compared to the definition suggested by the INSAG above (p. 3). While the definition from the INSAG states that safety culture includes the attitudes of members of the organization and is determined by whether safety is a priority, none of the above proposed definitions mention that safety culture involves safety being viewed as a priority (Edwards & Armstrong, 2013; Olive et al., 2006; Cabrera et al., 1997). Conversely, Olive and colleagues (2006) and Cabrera and colleagues (1997) agree that organizational policies are integral to safety culture; however, policies are not mentioned in the INSAG's definition. These contradictions illustrate that among the three different teams of researchers purporting to study the same topic, there are significant differences in their theoretical definitions of safety culture.

Overall, this varied understanding of the phenomenon, results each from research team developing their own definition of safety culture, as evidenced by the 37 definitions provided in Appendix A. Lack of a unified theoretical definition demonstrates a lack of understanding about the nature of and mechanism underlying safety culture. Consequently, any attempts to operationalize this concept in order to develop assessment instruments is hindered by the uncertainty of what the safety culture concept entails. Subsequently, the absence of congruent theoretical and operational definitions have led to the design of an abundance of safety culture

instruments which makes comparative analysis between studies on safety culture nearly impossible.

1.1.3.1 Concluding remarks. In my thesis, I decided to elaborate on the nature of the phenomenon of safety culture by conceptually analyzing the existing definitions, with the aim of providing a more encompassing and unified definition of safety culture. A more unified definition will provide a basis for a developed theoretically meaningful instrument for assessing the construct, as well as developing the functional strategies required for establishing a strong safety culture. If we do not understand the nature of safety culture, then we cannot treat it when it becomes defective.

Before moving to an analysis of the various safety culture operational definitions, there is another concept that must be discussed. The widely used concept of safety climate emerged before the introduction of the concept of safety culture and is often used interchangeably (Zohar, 1980). In order to fully address safety culture we cannot avoid discussing the phenomenon and concept of safety climate.

1.1.4 History and Theoretical Definition of Safety Climate

Before the safety culture concept was coined, the concept of safety climate was used to assess the collective non-technological aspect of safety performance (Zohar, 1980). It was not until the latter half of the 20th century that researchers began to investigate the differences between organizations where employees exhibited high-risk versus low-risk safety behavior. Zohar (1980) reviewed the literature and demonstrated that, in companies where safety was given high priority, there was a lower number of incidents and injuries; to explain these differences he introduced the concept of safety climate. Zohar (1980) sought to use this concept to explain which organizations were at a higher risk of experiencing safety-related incidents. When the concept of safety culture emerged in 1986, a conceptual confusion emerged among safety researchers, as both concepts targeted the non-technological aspect of safety performance. The presence of both concepts - safety climate and safety culture - within the literature adds to the contemporary confusion when defining and conceptualizing the collective and non-technological aspects of organizational safety. Therefore, in addition to clarifying the understanding of the safety culture phenomenon, it becomes necessary to differentiate it from the concept of climate in order to make the concepts usable.

In comparison to the concept of safety culture, the notion of climate reflects the opinions and perceptions of employees about their organization's policies and management actions about safety. Zohar (1980) illustrates this with the following definition of safety climate: "a summary of molar perceptions that employees share about their work environments" (p. 96). These perceptions are then used as a frame of reference to determine which behaviors are acceptable and which will lead to an increased risk of injury. Zohar's definition of safety climate is fairly broad and does not provide a detailed understanding of what safety climate entails. Many other researchers have created their own definition of safety climate; Appendix B provides 24 definitions of safety climate, illustrating the extent of the existing conceptual diversity. For example, Denison (1996) defines safety climate as "perceptions of 'observable' practices and procedures that are closer to the 'surface' of organization life" (p. 622). In this definition, safety climate is described as perceptions of what is observed and practiced in organizations; thus, it addresses the manifest aspects of safety regarding organizational functioning. According to Allen, Baran, and Scott (2010), safety climate "refers to a type of organizational climate in which employees perceive that management, rewards, supports, and expects safe practices" (p. 750). All three of these definitions agree that safety climate focuses on the employees' *perceptions* of safety norms and practices within their organization. However, Zohar (1980) believes these perceptions are shared and directed towards the work environment. Conversely, Denison (1996) suggests that the perceptions are directed towards observable behavior, as they deal with surface features. Lastly, Allen and colleagues (2010) proposes that safety climate is primarily concerned with employees perceptions about management.

As demonstrated, the concept of safety climate has an abundance of varied definitions that require analysis. However, there is another area of conceptual confusion surrounding the concept of safety climate. In addition to the disagreement surrounding the definition of safety climate, there is also uncertainty surrounding the relationship between notions of safety culture and safety climate.

1.1.4.1 Relationship between safety culture and climate. Safety researchers are currently divided on whether concepts of safety climate and safety culture are assessing the same or separate phenomena. Some researchers believe that safety climate and safety culture are two distinct constructs (Mearns, Flin, Fleming, & Gordon, 1997; Reichers & Schneider, 1990), whereas others use them interchangeably (Denison, 1996; Glick, 1985). Furthermore, Choudhry,

Fang, and Mohamed (2007a) suggest that safety climate is actually a subcomponent of safety culture. Colla and colleagues (2005) support this point as they consider safety climate the "measureable components of safety culture" (p. 364), as safety climate assessing more concrete, easily observable aspects of safety compared to safety culture. Nevertheless, safety climate is more often associated with perceptions of safety, while safety culture is associated with shared attitudes, beliefs, and behaviors of employees (Guldenmund, 2000).

This suggests that the notions of safety climate and safety culture are related to similar, but distinct phenomena; however, confirming evidence of this is lacking. That is why another objective of my project is to provide comparative analysis of the two concepts to inform their relations with each other.

1.1.4.2 Concluding remarks. As with safety culture, the proposed theoretical definitions for safety climate are varied and broad, making conceptualization exceedingly difficult. Therefore, in this thesis I clarify the concept of safety climate by analyzing existing definitions in order to formulate a single, inclusive definition. Additionally, I analyze the relationship between safety culture and safety climate to investigate whether they are separate or distinct concepts, or whether safety climate is best understood as a subcomponent of safety culture.

1.1.5 Problems with Operational Definitions of Safety Culture and Safety Climate

In conjunction with a concept's theoretical definition, it is also necessary to have its operational definition. An operational definition refers to "the precise operations (methods) by which any phenomenon or construct is . . . determined or measured" (Corsini, 2002, p. 668). In other words an operational definition involves describing the methods or procedures that can be used to assess and measure the concept or phenomenon. It is important to have consistent operational definitions for a construct, as it allows researchers to consistently measure a construct across samples and contexts. Furthermore, if the operational definition is based on the theoretical definition of the construct, then this results in more theoretically sound research, as the theoretical definition explains the phenomena, the operational definition states how the phenomena should be measured, and the assessment tool assesses the construct (Smith, 2015). Operational definitions are particularly important when studying safety, as a correctly formulated operational definition allows all employees within an organization to understand "safety" or "injury" in the exact same way, across contexts and time (Smith, 2015).

To further complicate the relationship between safety culture and safety climate, there is also an abundance of operational definitions that are used to build assessment tools for these concepts. For example, safety culture is operationally defined in the Safety Culture Scale (Wu, Lin, & Shiau, 2010) through items such as, "Colleagues often fall or slip at work" (p. 428). This operationalization focuses on the participant's objective observations about the behavior and practices of their colleagues.

Conversely, the Safety Climate Questionnaire (SCQ) (Currie & Watterson, 2010) operationally defines the current workplace's safety climate as, "This is a safer place to work than other [places] I have worked for" (p. 37). This operationalization consists of the employee's opinion or attitude regarding their previous workplace. Thirdly, the Safety Culture Questionnaire (Carroll, 1998) operationally defines safety culture through "Management makes workers feel uncomfortable about raising concerns" (p. 276). This operationalization emphasizes management's behavior and attitude towards safety. As such, the operational definitions for safety culture and safety climate are very diverse and it is uncertain which operationalizations are the most valid and reliable. A consistency in operationalizing these constructs is crucially important for creating standard and comparable assessment tools by which safety culture and safety climate in different organization can be meaningfully compared and analyzed.

1.1.5.1 Congruency between theoretical and operational definitions. In order for a concept to be useful and applicable there needs to be congruence between the concept's theoretical and operational definitions. Without this congruence, any assessment instruments that are developed based on this incongruity will be flawed, due to issues with construct validity, creating further confusion among researchers. Appendix H illustrates the disagreement between how researchers have defined safety culture and safety climate and how they have operationalized these concepts. As can be seen from Appendix H, the majority of theoretical definitions do not have corresponding operational definitions, which makes assessing the congruency between them difficult. Even when the researchers include both theoretical and operational definitions in their study, these definitions do not always correspond, such that the theoretical definition will refer to safety culture while the corresponding operationalization is addressing safety climate. For example, the instrument used by the researchers is called the Safety Climate assessment toolkit (Cox & Cheyne, 2000); however the corresponding theoretical definition is directed towards safety culture, which results in an incongruity. Additionally, Cox

and Cheyne (2000) define safety culture as "an enduring aspect of the organisation with trait-like properties and not easily changed" (p. 114). However, the corresponding operationalizations include "Personally, I feel that safety issues are not the most important aspect of my job" and "I believe that safety issues are not assigned a high priority." The operational definitions do not include anything on the enduring aspect of safety culture or that it demonstrates trait-like properties. In this case, incongruences with the definitions and operationalizations of safety culture and safety climate result in later inconsistencies when assessing these concepts, as safety climate scales are commonly used when assessing safety culture. This is a major drawback in the literature as it promotes further conceptual confusion.

1.1.5.2 Concluding remarks. In my thesis, I analyzed the previously presented operational definitions for safety culture and safety climate and assessed their congruency to their theoretical definitions. This illustrates the need for more rigour when developing safety culture and safety climate assessment tools, as congruence between these theoretical and operational definitions provides a solid foundation for the development of a valid assessment tool.

1.1.6 Assessments and Measures for Safety Culture and Safety Climate

As a result of the previously discussed conceptual incongruence regarding the definitions of safety culture and safety climate the literature has a multitude of assessment tools that may not be measuring their intended concepts.

1.1.6.1 Lagging and leading indicators. The primary focus of industry managers and occupational health and safety professionals is to assess safety culture and safety climate in order to use this information to determine the probability of an incident and the overall safety of the organization. In the decades since the concepts were coined, means of assessing these concepts using self-report and objective measures have evolved. Until recently, *lagging indicators* were the primary method of assessing safety within organizations (Currie & Watterson, 2010). A lagging indicator is "a collection of retrospective data or information" (p. 36) regarding safety. Lagging indicators are reactive in that the organization's fatalities, incident rates, and near misses are assessed and corrective actions are taken after an incident has occurred. However, the major drawback of lagging indicators is that they only use reactive measures, such as injuries, fatalities, and near misses as a measure of safety culture. Consequently, employees within an organization may disregard the safety regulations and not use proper personal protective

equipment, resulting in an organization with a poor safety culture. However, lagging indicators that assess fatalities and injuries may not be able to capture the full extent of the poor safety culture if the employees are lucky enough to avoid serious injury or under-report the injuries they do receive.

Due to these limitations, more recently there has been an increased focus on *leading indicators*, such as structured questionnaires and safety audits. Leading indicators take a more proactive approach and assess the present state of safety behaviors and attitudes in an organization. The reduction of injury rates themselves, which would be a lagging indicator, are not sufficient to indicate the presence and quality of a strong safety culture. Whereas, focusing on leading indicators, such as safety training, hazard awareness, employees' motivation to adhere to safety protocols, and knowledge of safety is something that can always be improved and assessed (Cooper, 2000). As such, it is suggested that leading indicators may be a more useful approach to measuring safety culture and safety climate (Currie & Watterson, 2010), but there is currently little research on whether leading or lagging indicators provide a more valid representation of this construct within an organization.

1.1.6.2 Self-report measures and survey questionnaires. Due to the increased focus on leading indicators, over the past several decades many self-report measures for safety culture and safety climate have been developed. For example, Sexton, Helmreich, Pronovost, and Thomas (2003) created the Safety Climate Survey, which is a 19-item, 7-point Likert scale directed at medical personnel. The Safety Climate Survey includes many items assessing the opinion of the respondent (e.g. "Leadership is driving us to be a safety-centered institution"). Additionally, the Safety Climate Survey is used as a measure of safety culture (e.g. "The culture of this clinical area makes it easy to learn from the mistakes of others"), that again demonstrates the conceptual confusion or overlap between culture and climate. Another self-report questionnaire is the 2010 revision of the Safety Culture Survey (Frazier, Ludwig, Whitaker, & Roberts, 2013). The revised Safety Culture Survey consists of 28 items broken down into the following subgroups: management support for safety, peer support for safety, personal responsibility for safety, safety management systems, and miscellaneous. This survey contains some abstract, opinion questions (e.g. "Safety is considered when changes are made to rules and procedures"), as well as some concrete questions (e.g. "My supervisor often gives me positive feedback when he sees me working safely"). Additionally, Wu et al. (2010) also provide a Safety Culture Scale consisting

of 12 items regarding the attitudes and behaviors of the respondent's colleagues, as opposed to asking about the respondent's own behavior. Clearly, there is an abundance of self-report measures used to assess safety culture and safety climate, with each survey and scale formulated in a unique way (Kho, Carbone, Lucas, & Cook, 2005; Nielsen, Eid, Hystad, Saetrevik, & Saus, 2013; Singer, Gaba, Geppert Sinaiko, Howard, & Park, 2003). Given the diversity of these measures, it is difficult to compare results across studies as each survey evaluates different aspects of safety culture. Therefore, a unified assessment tool is necessary to standardize the results obtained about this collective non-technological aspect of safety.

1.1.6.3 Concluding remarks. Many culture and climate assessment tools are used interchangeably, due in part to the concept confusion surrounding the definitions and relationships between these concepts. The relationship between safety culture and safety climate is not clear, as many assessment tools use the terms interchangeably, while others see them as distinct. Additionally, there are discrepancies between the theoretical and operational definitions, which results in a vast number of assessment instruments that are of questionable validity and applicability. These problems require further study due to these discrepancies, which will be addressed in this thesis (See Table 1-1).

Table 1-1. Summary of Introduction

Current Gap in The Literature	Purpose of Current Study
Broad array of theoretical definitions for safety culture and safety climate	**Study One Part One:** Conduct a conceptual analysis of existing safety culture and safety climate definitions and propose a single unified definition for each construct
Overlap in the literature between the construct of safety culture and safety climate	**Study One Part One:** Use conceptual analysis results to determine the relationship between safety culture and safety climate
Appears to be a lack of congruency between the theoretical and operational definitions used for safety culture and for safety climate	**Study One Part Two**: Examine existing theoretical and corresponding operational definitions to determine congruency, as well develop operational definitions that correspond to theoretical definitions developed in Part One
Existing assessment tools are not based on their theoretical or operational definitions	**Study Two Part One and Two:** Develop a questionnaire for safety climate based on the developed theoretical and operational definitions and evaluate the results of this questionnaire.

As Table 1-1 illustrates, there is a need for a consensus regarding the theoretical definitions for safety culture and for safety climate, the relationship between safety culture and safety climate should be clarified, there is a need for congruency between the theoretical and operational definitions for these constructs, and existing safety assessment tools should be based on their theoretical or operational definitions. Each of these current gaps in the literature will be addressed in the current study.

CURRENT STUDY

1.2 Purpose of the Project

The purpose of the current project is to clarify relations between the concepts of safety culture and safety climate and demonstrate an applicability of the proposed conceptual clarification of at least one concept. As demonstrated above, several gaps exist in the literature regarding the concepts of safety culture and safety climate, resulting in two main issues that need to be addressed. In study one a conceptual analysis was conducted, in which the theoretical definitions for safety culture and safety climate were assessed and the congruency between the theoretical and operational definitions was examined.

The definitions for safety culture and safety climate are far too varied and consensus needs to be reached on whether safety culture and safety climate are distinct or similar constructs. In part one of study one, a conceptual analysis of the literature was conducted to examine existing theoretical definitions for safety culture and safety climate to identify common aspects within these definitions. A single, unified theoretical definition for safety culture and for safety climate was developed in order to have a better understanding of what these constructs entail. Additionally, in part two of study one, the current gap between the safety culture and safety climate theoretical and operational definitions was examined, as this incongruency impacts the validity of the assessment tools.

In study two an empirical analysis was conducted, in which a safety climate questionnaire was developed and tested on the students in the College of Engineering. In part one of study two, an assessment tool was developed that was congruent with the developed safety climate theoretical definition and included previously validated items. In part two of study two, the developed safety climate questionnaire was administered to students in the College of Engineering to determine the safety climate in the College and the psychometric properties of the scale. In order to achieve these purposes, the following research questions were articulated.

1.2.1 Research Questions

1. What is an appropriate theoretical definition for safety culture that includes the most significant aspects of the phenomenon? What is an appropriate theoretical definition for safety climate that includes the most significant aspects of the phenomenon?
2. Are the concepts of safety culture and safety climate assessing the same or distinct phenomena as identified in the conceptual analysis? Is safety climate a subcomponent of safety culture?
3. In the current literature, what is the congruency between the theoretical and operational definitions for safety culture and safety climate? What operational definitions emerge for safety culture and for safety climate that are congruent with the theoretical definitions?
4. Based on the developed theoretical and operational definitions, what items should compose an assessment tool that would adequately capture the underlying assumptions associated with safety culture and safety climate?

As Figure 1-1 displays, Study One Part One involves comparing existing safety culture and safety climate theoretical definitions to aspects within these definitions and using these common aspects to develop a single, unified definition for safety culture and for safety climate. Study One Part Two involves comparing safety culture and safety climate theoretical definitions to their corresponding operational definitions to determine their congruency, as well as developing operational definitions for safety culture and for safety climate that are congruent with the theoretical definitions developed in Part One. Study Two Part One involves using the safety climate theoretical and operational definitions developed in Study One to form an assessment tool for safety climate. Study Two Part Two involves administering this questionnaire to students in the College of Engineering to determine the psychometric properties of the questionnaire, as well as to examine the safety climate within the College of Engineering.

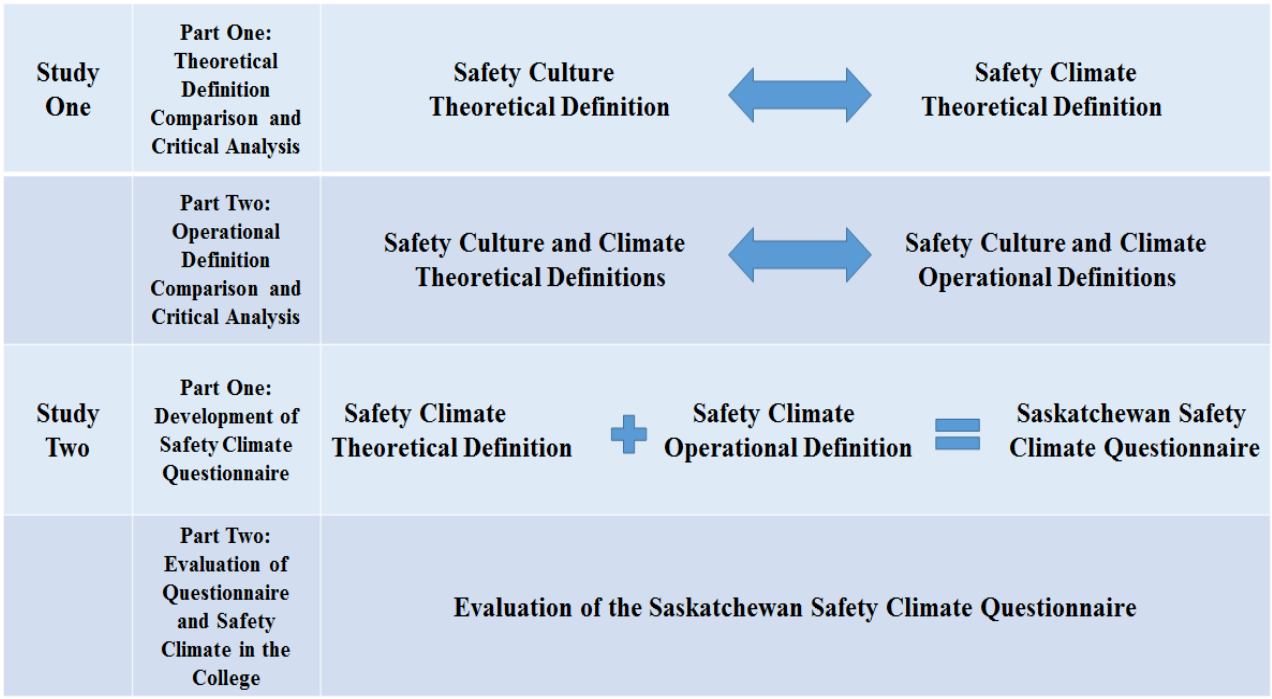


Figure 1-1. Conceptual Model of Study One and Study Two

CHAPTER 2

STUDY ONE: CONCEPTUAL ANALYSIS OF "SAFETY CULTURE" AND "SAFETY CLIMATE"

2.1 Purpose of Study One

There are several objectives for study one. The first is to provide a conceptual analysis and comparison of the notions of safety culture and safety climate conducted at the level of theoretical and operational definitions. The second purpose is to develop a comprehensive theoretical and operational definition for the concept of safety culture and the concept of safety climate. The third purpose is to outline the structure of existing safety assessment instruments and prepare a questionnaire for assessing safety climate in the College of Engineering, based on existing safety instruments and the developed safety climate theoretical definition.

2.2.1 Part 1: Analysis of Theoretical Definitions

2.2.1.1 Purpose. The purpose of part one of the conceptual analysis was to examine existing theoretical definitions of safety culture and safety climate and to identify common features within these definitions. From this analysis a single, unified definition for safety culture and a single, unified definition for safety climate was developed. Additionally, this conceptual

analysis provided evidence to conclude whether the concepts of safety culture and safety climate refer to the same or distinct phenomena.

As the theoretical definition of a construct addresses the essence or mechanism of the underlying phenomena, it is necessary to develop a single, comprehensive theoretical definition of these constructs. When multiple definitions are used to describe a construct it can be difficult to fully understand and assess the construct under study, particularly as different definitions may actually be referring to different constructs (e.g., safety culture and safety climate).

2.2.1.2 Method. In order to conduct the theoretical definition analysis, the following tasks have been done: (1) searched and selected articles of interest that contained definitions of the constructs; (2) identified dimensions that are present in the safety culture and safety climate constructs; (3) developed matrices; (4) the raters conducted an assessment of the definitions; (5) the raters' assessment was examined; and, (6) summarized the results by developing a theoretical definition for safety culture and for safety climate.

To expand on the above steps, the researcher searched and selected articles that examined the assessment, analysis, and application of the concepts safety culture and safety climate. From these articles, 72 sources were included that contained a theoretical definition for the safety concepts; 46 definitions were included for safety culture and 26 for safety climate. The researcher separated articles that developed or used theoretical definitions of the concepts from articles where a conceptual analysis of the concepts was provided. For the first part of the theoretical definition analysis, raters classified empirical research. Specifically, the definition analysis included articles that did not analyze the definitions, only provided their own definition to conduct their research. However, in order to further analyze the results of the definition analysis, additional literature was reviewed. These additional articles include review articles that compiled a list of current safety culture and climate definitions and extracted the common factors in order to determine the dimensions that make up safety culture or climate and, sometimes, to create their own definitions of the construct.

Secondly, the researcher identified 42 potential aspects or "dimensions" that were commonly identified within the safety literature (See Appendix D). Safety studies that mentioned dimensions commonly thought to be included in either the safety culture or safety climate concept were analyzed and these aspects or dimensions were compiled and compared to the list of compiled theoretical definitions. For each aspect, a definition was created that described this

aspect in order to provide clarity to raters. Examples of the aspects or dimensions include: individual-centered, group-centered, perception about policies, beliefs, attitudes, norms, organizational, behavior, etc. (See Appendix D).

Thirdly, the researcher developed matrices (See Appendix C). Definitions for both safety culture and safety climate were compiled into a matrix in Excel. The label "safety culture" or "safety climate" was removed so that raters would be unaware of which definitions they were classifying, in order to prevent any bias. The right column of each matrix contained the 72 extracted theoretical definitions of the concepts. The top row displayed the dimensions or aspects of the phenomenon in question. Appendix C does not display the full dimension labels due to limited space; however, for the raters, the full dimension labels were provided.

Fourth, the matrices were administered to four raters who then classified the 72 compiled theoretical definitions based on the aspects within them. Four rater were recruited to analyze the 72 safety culture and safety climate definitions. Raters included three females and one male and all raters were current or past graduate students at the University of Saskatchewan from various Colleges. They were not familiar with safety research and had no previous experience with the concepts of safety culture or safety climate. We were open to using more raters, however as the raters demonstrated adequate agreement in evaluating the definitions, the researchers decided not to increase their number.

Raters were emailed the instructions (Appendix E), definitions of aspects (Appendix D) and the blank excel sheet matrix into which they were to place "x" if the definition contained a specific aspect. The instructions were emailed to the rater and they had the opportunity to ask any questions. The rating process took approximately two hours, which raters completed over a series of days on their own time. Upon completion the rater emailed the completed definition analysis excel sheet to the researcher. Once all four raters had completed their ratings, the primary researcher compiled all the ratings and calculated rater agreement.

Lastly, a summary of the raters' assessment is provided below, which displays the developed theoretical definition for safety culture and for safety climate, as well as the developed structure of the concepts.

2.2.1.3 Analysis of the raters' assessments. In calculating agreement between raters, agreement between all four raters equaled a four, an agreement between three raters equaled a three, agreement between two raters equaled a two, and when one rater believed a specific aspect

was present in the definition it was assigned a one. If no raters felt an aspect was present it was assigned a zero. In this case, 4 indicates an agreement between raters of 100%, 3 indicates 75% agreement, and 2 indicates 50% agreement. Additionally, a score of 1 indicates 75% agreement and a score of zero indicates 100% agreement between raters that a particular aspect is not present in the definition. Appendix F displays the percentage of agreement for each aspect for safety culture, while Appendix G displays the percentage of agreement for each aspect for safety climate.

Following this, the safety climate and safety culture definitions were separated and agreement among the raters regarding each concept was calculated. There were 46 definitions for safety culture and 26 definitions for safety climate. In order to calculate the overall agreement for the safety culture and climate definitions, all of the 4s, 3s, 2s, 1s, and 0s for all aspects (i.e., subset of organizational culture, individual-centered, attention, etc.) were added up and divided by the total number of answers provided by raters.

For safety culture, there were 238 fours, which indicated 100% agreement that the aspect was present, and 1,631 zeros, which indicated 100% agreement that the aspect was absent. The fours and zeros equaled 1,869 for 100% agreement for safety culture, as these ratings did not need to be weighted. There were 30 threes (which indicated 75% agreement that the aspect was present) and 23 ones (which indicated 75% agreement that the aspect was absent). The threes and ones equaled 53 ratings weighted by 75% agreement, as such, 53 was multiplied by .75, which resulted in 40 weighted ratings. There were 10 twos (which indicated 50% agreement that the aspect was present or absent) which were weighted by 50%. As such, 10 was multiplied by .50, which resulted in 5 weighted ratings. Following this, the researcher summed up the weighted number of ratings by the total number of possible answers. Consequently, 1,869 was added to 40 and 5, resulting in 1,914, which was divided by the total number of possible answers which was 1,978. As such, the agreement for safety culture was 96.76%.

For safety climate, there were 92 fours, which indicated 100% agreement that the aspect was present, and 967 zeros, which indicated 100% agreement that the aspect was absent. The fours and zeros equaled 1,059 for 100% agreement for safety climate. As these ratings did not need to be weighted. There were 12 threes (which indicated 75% agreement that the aspect was present) and 13 ones (which indicated 75% agreement that the aspect was absent). The threes and ones equaled 25 ratings weighted by 75% agreement. As such, 25 was multiplied by .75, which

resulted in 19 weighted ratings. There were 7 twos (which indicated 50% agreement that the aspect was present or absent) which were weighted by 50%. As such, 7 was multiplied by .50, which equaled 4 weighted ratings. Following this, the researcher summed up the weighted number of ratings by the total number of possible answers. Consequently, 1,059 was added to 19 and 4, resulting in 1,082, which was divided by the total number of possible answers which was 1,092. As such, the total agreement for safety climate was 99.08%. As such, raters demonstrated adequate consistency of ratings for both safety culture and safety climate.

2.2.1.4 Calculation of frequency of aspects and consistency of definitions. In order to determine which aspects were present in the definitions in the highest frequency, the number of fours, threes, twos, and ones were compiled and placed into tables. All of the aspects that are present in the safety culture definitions are presented in Appendix F. All of the aspect that are present in the safety climate definitions are presented in Appendix G.

As there was an unequal number of definitions for safety culture versus safety climate, 46 and 26 respectively, these numbers could not be used to compare the frequency of aspect between safety culture and safety climate. Consequently, these numbers were transformed into percentages by dividing the aspect frequency by the total number of definitions. These percentages were weighted based on the consistency of agreement.

To illustrate how this was calculated the aspect “improve safety performance” under safety culture will be used as an example. For “improve safety performance”, there were 12 definitions in which all four raters stated that “improve safety performance” was an aspect within safety culture. This number was then divided by 46 (the total number of definitions for safety culture) which resulted in 26%. Next, there was one definition in which three raters stated that “improve safety performance” was an aspect within safety culture. This number was divided by 46 which resulted in 2%. The 2% was then multiplied by .75 in order the weight the frequency by consistency of raters, as only three raters stated “improve safety performance” was an aspect within safety culture. The result was still 2% when rounded up. Next, there were two definitions where two of the raters stated that “improve safety performance” was an aspect within safety culture. Two was divided by 46 which resulted in 4% and was multiplied by .50 in order to weight the frequency by consistency, which resulted in 2%. Finally, there were four definitions in which only one rater stated that improve safety performance was an aspect within safety culture. Four was divided by 46 which resulted in 9%, this 9% was then multiplied by .25 (as

only one rater felt these definitions contained the aspect improve safety performance), which resulted in 2%. These weighted percentages were added up to determine the overall frequency of safety culture definitions that included the aspect "improve safety performance". Twenty-six plus two plus two plus two equalled 32% of the safety culture definitions included the aspect "improve safety performance".

This frequency percentage was calculated for each aspect and the aspects were then ranked based on the highest frequency within the safety culture definitions. The same calculations were conducted for safety climate. Some of the original aspects were clustered together if they were similar to one another. Aspects that were clumped together include (1) all perception aspects, (2) organizational and management aspects, and (3) work environment and situational aspects.

2.2.2 Theoretical Definition Results for Safety Culture

The major results for the theoretical definition analysis for safety culture are presented in Table 2-1.

Table 2-1. Most Frequent Safety Culture Aspects

Safety Culture Aspects	**100%**	**75%**	**50%**	**25%**	**Total (%)**
Organizational/Management	63%	20%	-	-	83%
Group-centered/shared	41%	18%	2%	1%	62%
Behavioral	59%	2%	-	-	61%
Individual-centered	28%	5%	3%	3%	39%
Attitudes	37%	2%	-	-	39%
Values	37%	2%	-	-	39%
Improve safety performance	26%	2%	2%	2%	32%
Beliefs	30%	-	-	-	30%
Norms	26%	-	-	-	26%
Subset of organizational culture	20%	-	-	-	20%
Commitment/Responsibility	15%	-	-	2%	17%
Perception	13%	-	-	1%	14%
Prioritize safety	11%	-	1%	1%	13%
Stable	13%	-	-	-	13%
Situational/Work Environment	13%	-	-	-	13%
Implicit	11%	-	-	1%	12%
Policies	9%	-	-	2%	11%

As Table 2-1 demonstrates, the organizational aspect, group-centred/shared aspect, and behavioral aspect were the most frequently found aspects within the analyzed definitions of safety culture. As can be seen from Table 2-1, 83% is the proportion of safety culture definitions

that have the organizational aspect (which is the highest common aspect in comparison to all others). The organizational aspect encompasses any definitions mentioning organizational members, organizational life, organizational safety practices, work organization, or the organization itself, as well as management, safety systems, or leadership. Following this, 62% is the proportion of definitions which contain the group-centered or shared aspect and 61% is the proportion of definitions that contain the behavior aspect. The group-centered or shared aspect includes any definitions that states that safety culture is held by the group, is shared among employees, or involves the staff, workers, or employees in the plural form. The behavioral aspect involves definitions that mention behaviors, practices, or procedures relating to safety.

Following this, three aspects: individual-centered, attitudes, and values all tie for fourth place, as 39% of the definitions contain these aspects. The individual-centered aspect states that safety culture is held by an individual or involves employee's perceptions, attitudes, behaviors, etc. in the singular form. The attitudes and values aspects include definitions that mention attitudes about safety or safety values and the value placed on safety respectively. Thirty-two percent is the proportion of definitions that contain improve safety performance within them, which includes any definitions that mention improving or enhancing safety in the workplace. Subsequently, 30% of the definitions contain the beliefs aspect, 26% of the definitions contain the norms aspect, and 20% contain the aspect: safety culture is a subset of organizational culture. The beliefs aspects includes any definition that mentions beliefs about the importance of safety, while the norms aspect includes definitions that state that safety culture includes norms or habits of thought. Safety culture is a subset of organizational culture includes definitions that state that safety culture refers to or is a part of the organizational culture of the workplace. Commitment to safety and safety responsibility is present in 17% of the safety culture definitions, as employees feel they have a personal responsibility to safety or a personal commitment to safety. Safety perception is present in 14% of the definitions and refers to perceptions or impressions about safety or employees' general perceptions, as well as, employees' perceptions about safety policies, management attitudes or values, management behavior, practises, rewards, or actions, co-worker practices or behavior, or their work environment, work setting, or work organization.

Prioritize safety, stability, and situational/work environment were present in 13% of the definitions. Prioritize safety refers to any definitions in which safety is given priority. Stability refers to any definitions that state that safety culture is long-lasting or difficult to change. The

situational/work environment aspect refers to safety culture as being dependent on the situation, contextual setting, social context, or work environment. Twelve percent is the proportion of definitions that have the implicit aspect within their definitions and 11% is the proportion of definitions with policies as an aspect. The implicit aspects suggests that safety culture involves habits of thought and underlying assumptions, while policies refer to the safety policies within the workplace. The following aspects were present in less than 10% of the safety culture definitions: thoughts/cognitions, symbolic meaning, jobs, attention, rewards, learning about safety, feelings, public safety, goal-directed, communication, multiple/holistic, psychological, and abstract. There were also several aspects that were not present in any of the safety culture definitions, including: safety culture as a subset of organizational climate or safety culture, transient aspect, and surface features.

2.2.3 Results of Theoretical Definition Analysis for Safety Climate

The major results for the theoretical definition analysis for safety climate are presented in Table 2-2.

Table 2-2. Most Frequent Safety Climate Aspects

Safety Climate Aspects	**100%**	**75%**	**50%**	**25%**	**Total**
Perception	62%	9%	4%	1%	76%
Group-centered/shared	65%	-	2%	-	67%
Organizational/Management	30%	23%	4%	3%	60%
Behavioral	27%	-	-	2%	29%
Subset of safety culture	27%	-	-	-	27%
Transient	27%	-	-	-	27%
Work environment/Situational	15%	-	4%	2%	21%
Subset of organizational climate	15%	-	-	-	15%
Attitudes	15%	-	-	-	15%
Manifest	15%	-	-	-	15%
Policies	8%	-	-	2%	10%

As Table 2-2 demonstrates, the perception aspect, group-centred/shared aspect, and organizational aspect were the most frequently found aspects within the current definitions for safety climate. As can be seen from Table 2-2, 76% is the proportion of safety climate definitions that have the safety perception aspect (which is the highest common aspect in comparison to all others). The perception aspect includes perceptions or impressions about safety or employees' general perceptions, as well as, employees' perceptions about safety policies, management attitudes or values, management behavior, practises, rewards, or actions, co-worker practices or

behavior, or their work environment, work setting, or work organization. Sixty-seven percent is the proportion of definitions that include the group-centered aspect and 60% is the proportion of definitions that include the organizational aspect. The organizational aspect encompasses any definitions mentioning organizational members, organizational life, organizational safety practices, work organization, or the organization itself, as well as management, safety systems, or leadership. The group-centered or shared aspect includes any definitions that states that safety climate is held by the group, is shared among employees, or involves the staff, workers, or employees in the plural form.

Safety behavior is present in 29% of the safety climate definitions and involves definitions that mention behaviors, practices, or procedures relating to safety. Twenty-seven percent is the proportion of definitions that include the transient aspect and that safety climate as a subcomponent of safety culture. The transient aspect suggests that safety climate is temporary, subject to change, only observable at a particular moment in time, or involves current-state reflections. Work environment is present in 21% of the safety climate definitions and refers to safety climate as being dependent on the situation, contextual setting, social context, or work environment.

Following this, three aspects: safety climate as a subcomponent of organizational climate, attitudes, and manifest are all present in 15% of the safety climate definitions. The manifest aspect suggests that safety climate addresses safety perceptions that are closer to the surface. Ten percent is the proportion of definitions with policies as an aspect. The following aspects were present in less than 10% of the safety climate definitions: beliefs, improve safety performance, prioritize safety, individual-centered, values, feelings, rewards, symbolic meaning, training, communication, and jobs. There were also several aspects that were not present in any of the safety climate definitions. According to these definitions, safety climate is not implicit, stable, abstract, multiple/holistic, goal-directed, psychological, or a subset of organizational culture. Additionally, safety climate does not include: norms, attention, commitment/responsibility, thoughts/cognitions, public safety, or learning about safety.

2.2.4 A Comparison of the Conceptual Analysis with Analysis of Current Literature

Six review articles that contained a conceptual analysis of the concepts were examined in order to determine which dimensions or aspects are common to safety culture and safety climate. These six review articles were chosen because they compiled existing definitions of safety

culture and safety climate in a similar approach with the current study, and used these compiled definitions to identify common factors. However, these articles did not systematically assess the existing definitions, only noted common factors and they used a much smaller sample of definitions.

2.2.4.1 Common safety culture factors identified in literature. These articles identified several common factors associated with safety culture, including: "organization systems and sub-systems" (Cooper, 2000), as well as "the management and supervisory systems" (Wiegmann et al., 2004). Safety culture is a concept defined at the "group level or higher that refers to the shared values among all the group or organization members" (Wiegmann et al., 2004). Safety culture also has been described in terms of "values, beliefs, attitudes, social mores, norms, rules, practices, competencies, and behavior" (Mearns & Flin, 1999). Additionally, safety culture is "reflected in an organization's willingness to develop and learns from error, incidents, and accidents (Wiegmann et al., 2004). Safety culture is "relatively stable and not subject to change on an hourly, daily, or weekly basis (Cox & Flin, 1998). Safety culture includes "organizational commitment, management involvement, [and] employee empowerment" (Wiegmann et al., 2004). Safety culture is about "assumptions, expectations, and outlooks that are taken for granted by organizational members and are therefore not immediately interpretable by outsiders" (Mearns & Flin, 1999). Safety culture is also "holistic and involves dimensionality (Guldenmund, 2000), in that safety culture is a complex construct that encompasses a multitude of aspects (i.e., organization, norms, beliefs, values, policies, improving safety, behavior, etc.) and assesses their underlying assumptions.

Table 2-3 displays the common factors associated with safety culture, as identified in the review articles.

Table 2-3. Common Safety Culture Factors Identified in Review Articles

Common Factors associated with Safety Culture	Authors
1. Organizational level safety issues, organizational commitment, management involvement	Wiegmann et al., 2004
2. Group level and involves a shared, collective commitment to safety	Cooper, 2000; Cox & Flin, 1998; Guldenmund, 2000; Mearns & Flin, 1999; Wiegmann et al., 2004
3. Practices and behaviors of management and employees	Cooper, 2000; Mearns & Flin, 1999; Wiegmann et al., 2004

4. Individual's attitudes, values, beliefs, and norms regarding safety	Cooper, 2000; Cox & Flin, 1998; Guldenmund, 2000; Mearns & Flin, 1999
5. Improvement of the organization's safety performance and willingness to learn from incidents	Wiegmann et al., 2004
6. Employee empowerment and commitment to safety	Mearns & Flin, 1999; Wiegmann et al., 2004
7. Relatively enduring, stable, and resistant to change	Cox & Flin, 1998; Guldenmund, 2000; Wiegmann et al., 2004
8. A holistic, implicit concept that is dependent on the constructed systems of meanings, as well as, the assumptions and expectations of organizational members	Cox & Flin, 1998; Guldenmund, 2000; Mearns & Flin, 1999

2.2.4.2 Safety Culture Theoretical Definition. The following definition was created for the safety culture concept, developed from both an investigation of the theoretical definition analysis conducted by four raters and from a review of the literature:

"Safety culture is an organizational, collective phenomenon that is developed and maintained by sharing norms and attitudes regarding safety. Development of safety culture starts with management, which is responsible for safety leadership and safety policies, but a strong safety culture will not exist if it is not also supported and shared by individual employees. This sharing of safety norms results in safety behaviors that become implicitly followed and, at some point, automatic and taken for granted. The end goal of safety culture is to improve and enhance the safety of the organization and to learn from incidents, as well as, create an environment in which all employees feel empowered and personally responsible for their own and other's safety. Safety culture is a subcomponent of organizational culture and includes the deeply-held, implicit assumptions and underlying expectations of organizational members, which consequently results in a phenomenon that is relatively stable and resistant to change."

2.2.4.3 Common safety climate factors identified in literature. Four review articles were synthesized in order to determine dimensions common to safety climate. Some common factors associated with safety climate include that it "describes a set of perceptions and beliefs held by an individual and/or group about a particular entity" (Mearns & Flin, 1999). Safety climate is "shared" and "involves the work environment" (Guldenmund, 2000). Safety climate "represents a more transient mood state, sensitive to external pressures" (Cox & Flin, 1998). Safety climate is a "temporal phenomenon, a 'snapshot' of safety culture" (Wiegmann et al., 2004) that is "directly observable" (Mearns & Flin, 1999). Finally, safety climate also includes

employees' perceptions of "a strong management commitment to safety. . . [and an] emphasis put on safety training" (Zohar, 1980, p. 97). Perception is defined as an awareness of external objects, qualities, or events, in which the individual can interpret a stimulus and form an opinion based on it (Corsini, 2002, p. 705). According to this definition, perception consists of two separate aspects: first, is what our senses can determine through sight and hearing, and second, is our opinion or interpretation of what the senses tell us. Perception is the act of recognizing what you see or hear and interpreting it using your own opinions. For example, safety perceptions are formed by an individual noticing a safety hazard in their workplace, then forming an opinion of their organization's safety conscientiousness based on the safety hazard they noticed and whether they view their organization adequately addressing the safety hazard.

Table 2-4 displays the common factors associated with safety climate, as identified in the review articles.

Table 2-4. Common Safety Climate Factors Identified in Review Articles

Common Factors associated with Safety Climate	Authors
1. Perceptions or opinions of organizational members	Cox & Flin, 1998; Guldenmund, 2000; Mearns & Flin, 1999; Wiegmann et al., 2004; Zohar 1980
2. Both an individual and a shared phenomenon	Guldenmund, 2000; Mearns & Flin, 1999
3. Dependent on the current situation or work environment and is sensitive to external pressures	Cox & Flin, 1998; Guldenmund, 2000; Wiegmann et al., 2004
4. Involves the manifest, surface perceptions of employees at a specific point in time, and these perceptions are easily changeable	Cox & Flin, 1998; Mearns & Flin, 1999; Wiegmann et al., 2004
5. Safety climate is a subcomponent of safety culture	Cox & Flin, 1998; Mearns & Flin, 1999; Wiegmann et al., 2004

Within the literature, there seem to be five main aspects that form safety climate: (1) Safety climate involves the perceptions or opinions of organizational members (Cox & Flin, 1998; Guldenmund, 2000; Mearns & Flin, 1999; Wiegmann et al., 2004; Zohar 1980); (2) Safety climate is both an individual and a group phenomenon (Guldenmund, 2000; Mearns & Flin, 1999); (3) Safety climate is dependent on the current situation or work environment and is sensitive to external pressures (Cox & Flin, 1998; Guldenmund, 2000; Wiegmann et al., 2004); (4) Safety climate involves the manifest, surface perceptions of employees at a specific point in time, and these perceptions are easily changeable (Cox & Flin, 1998; Mearns & Flin, 1999;

Wiegmann et al., 2004); and (5) Safety climate is a subcomponent of safety culture (Cox & Flin, 1998; Mearns & Flin, 1999; Wiegmann et al., 2004).

2.2.4.4 Safety Climate Theoretical Definition. The following definition was created for the safety climate concept, developed from both an examination of the theoretical definition analysis conducted by four raters and from a review of the literature:

"Safety climate reflects what employees perceive regarding safety within their organization, where "perceive" refers to the employees' awareness, interpretation, and opinion formation regarding specific safety events. These opinions are developed by individual employees, but when these opinions become shared, they are what form the safety climate of an organization. The major aspect of safety climate involves how employees perceive the safety attitudes and behaviors of both management and fellow co-workers, their organization's safety policies, and the safety of their work environment. Safety climate is sensitive to external influence and involves the temporary, surface features of safety culture, which only captures the safety of the organization at a specific point in time."

2.2.4.5 Comparative Analysis of the Concepts Safety Culture and Safety Climate. As these definitions demonstrate, safety culture and safety climate appear to be two distinct constructs, in which safety climate is a subcomponent of safety culture. First, the overlap between the concepts will be discussed, then the distinction between safety culture and safety climate will be discussed.

2.2.4.5.1 Overlap. Safety culture and safety climate both deal with the non-technological aspect of safety. Both safety culture and safety climate involve individual employees' views and the shared attitudes of the group regarding safety. Safety culture and safety climate both involve the perceptions (i.e., safety climate) or attitudes (i.e., safety culture) of their organization's safety policies and the working environment. On the surface, safety culture and climate both involve organizational features, management, and behaviors

2.2.4.5.2 Discrepancy. There are also several aspects on which safety culture and safety climate differ.

1. Firstly, safety culture is a subcomponent of organizational culture, while safety climate is a subcomponent of safety culture.

2. Safety climate involves perceptions and opinions, meaning that these are reflections of the work environment regarding safety, while safety culture encompasses attitudes, beliefs,

values, norms, and behaviors or a shared socio-cultural reality within which employees work and function in organizations.

3. Safety climate represents the easily observable, surface features of safety culture, while safety culture involves the deeply-held, implicit assumptions that are believed and followed by employees. These deeply-held assumptions and expectations are often adopted by employees and they become the "norm" and are often taken for granted. Consequently, safety culture can be difficult to assess as it involves measuring the underlying assumptions held by employees.

4. Additionally, safety climate is a temporary phenomenon that represents safety at a specific point in time and is easy to change. Safety climate is temporary in the sense that it can change under pressure of deadlines, financial issues, productivity goals, and other external pressures. Conversely, safety culture is a stable phenomenon that is long-lasting and difficult to change. The goal of safety culture is to improve and enhance the safety of the organization. Safety culture is also an abstract, holistic, psychological phenomenon that includes learning about safety and researching goals. These dimension are not shared by safety climate.

While it was previously stated that safety culture assesses deeply held assumptions and beliefs about safety that have become norms to the extent that some of these beliefs are followed without conscious thought (Guldenmund, 2000), it seems apparent that such a complex concept could not be assessed through a simple survey questionnaire. Survey questionnaires are recognized as useful for assessing participant perceptions, not norms and unconsciously held beliefs. Assessing safety culture through a questionnaire may not adequately provide the necessary depth of information needed to grasp the concept (Cooper, 2000). To adequately assess the construct of safety culture, a multimethod approach is needed, involving ethnography, observation, focus group, and interviews. As such, the phenomenon is too complex to be adequately assessed with a survey questionnaire and is beyond the scope of this study. Conversely, safety climate mainly addresses the participants' opinions and perceptions of safety (Flin et al., 2000). Consequently, safety climate may be a more suitable concept to be assessed through a questionnaire.

While both safety culture and climate do address some of the same safety features, namely organizational management, group-centered or shared, and safety behavior, these safety features are addressed in different ways and on different levels. For example, both safety culture and safety climate are group-centered constructs. However, safety climate assesses the group's

perceptions of safety, while safety culture assesses the group's underlying assumptions, values, and norms. Furthermore, while safety culture and safety climate include management and behavior, safety climate addresses employees' perceptions of management and employees' perceptions of their own and other's behavior, through survey questionnaires. While safety culture will more directly assess management through documents review and behavior through participant observation. While safety climate assesses concrete, easily observable aspects of safety, safety culture addresses the underlying assumptions that guide the observable aspects of safety.

It is also natural to expect safety culture and climate to share some of the same safety features, as safety climate is a subcomponent of safety culture and they both assess the non-technological aspects of safety. However, there are a number of aspects that diverge between the concepts, and it is these nuances that truly highlight why safety climate should be considered a subcomponent of safety culture. Safety culture is qualitatively different from safety climate.

2.3 Part 2: Theoretical and Operational Definition Congruency

2.3.1 Purpose. The purpose of the operational definition analysis was to analyze the existing operational definitions for the safety culture and safety climate concepts and their corresponding theoretical definitions in order to evaluate the congruency between them. Once the conceptual classification in part one was completed and a single, unified theoretical definition for safety culture and safety climate was created, then the current operational definitions were analyzed in order to create an operational definition for safety culture and for safety climate that corresponded to the previously created theoretical definitions. This aids in developing a valid assessment tool for safety culture and safety climate.

As operational definitions provide the methods or procedures through which a construct should be measured, it is particularly important to ensure that any operational definition for a construct are consistent with the theoretical definition of the same construct. If a theoretical definition for safety culture results in an operational definition for safety climate, then the researchers cannot be certain they are assessing the correct construct. It is also important to ensure that the operational definition logically follows from the theoretical definition to ensure consistent use to the constructs.

2.3.2 Procedure. Numerous definitions of safety culture and safety climate were obtained and matched with their available corresponding operational definitions. It was then

determined whether each aspect of the theoretical definition was accounted for by the provided operational definition. The researcher rated the congruence between the theoretical and operational definitions, which are provided in Appendix H.

Once the theoretical and operational definitions were given a percentage rating on congruency, then these percentages were placed into levels. The first congruency level includes a congruency rating of 75% to 100%, the second congruency level includes a rating of 50% to 74%, and the third congruency level includes a rating below 50%. The frequency of definitions that fall within each congruency level identified clusters of theoretical and operational definitions that are congruent and incongruent.

2.3.3 Results. As Appendix H illustrates, congruency between theoretical and operational definitions for the safety climate and safety culture constructs are lacking. Out of a total of 47 theoretical and operational definition pairs, 26 were missing either the theoretical definition or the operational definition. This indicated that 55% of the studies did not have both a theoretical definition and a corresponding operational definition when they analyzed the safety culture or climate constructs. Of the remaining 45% of the definitions, 6 had a congruency rating below 50%, 12 had a congruency rating between 50% and 74%, and 3 had a congruency rating between 75% and 100%. Only 6% of the studies had adequate congruency between their theoretical and operational definitions. As such, it is evident that current studies are lacking when developing operational definitions that correspond to their theoretical definitions.

Consequently, when developing the Safety Climate Questionnaire, it was ensured that the developed the operational definitions and items that form the questionnaire were consistent with safety climate theoretical definition, in order to aid in the development of a theoretically sound and reliable assessment tool. An operational definition refers to the methods or procedures that describe how a concept or phenomenon should be assessed and measured (Corsini, 2002, p. 668). In other words, an operational definitions involves stating how a specific phenomenon should be empirically examined.

2.3.3.1 Safety Culture Operational Definition. *"An organizational culture of safety is supported when both upper level management and frontline workers place high value on safety. Endorsement of these values can be measured through self-report measures, as well as expressed in implicit, taken-for-granted cues observed and discovered in organization meetings, discussion, communications, and interactions among all levels of organizational hierarchy.*

Another indicator of a prevailing safety culture includes the existing number of functional and efficient programs and policies that are endorsed by workers. Direct (self-report) and indirect manifestations of workers endorsement of safety culture, their personal responsibility, and their proactive attitude toward safety are also important psychological indicators of a positive culture of safety.

To assess an organization's safety culture, multiple methods should be used: self-report questionnaires, purposefully selected interviews, focus groups with different groups of employees, naturalistic, participant observation of various activities related to safety (i.e., safety meetings at different levels, safety minutes, instructions before a shift, execution of various programs, peer-to-peer evaluations, coaching, etc.), content and tone of safety related horizontal and vertical communication, analysis of documents, and statistical records and reports."

2.3.3.2 Safety Climate Operational Definition. *"The safety climate of an organization is supported by the perceptions of employees that are developed and shared between management and employees. Approval of these perceptions and opinions can be measured through self-report measures, such as survey questionnaires. Due to the changing nature of safety climate, frequent assessments should be conducted to determine any changes in within the organization's safety perceptions and attitudes.*

To assess the safety climate of an organization, survey questionnaires should assess worker's perceptions and opinions on a variety of safety climate related factors, including: employees' perceptions and opinions of their organization's safety policies and procedures, employees own adherence to policies and procedures, the extent to which other employees adhere to the policies and procedures within the organization, their perception of the effectiveness of the safety training employees receive, employees' perception of management's approach to reporting incidents and punishing safety violations, the communication between frontline employees and management regarding safety, the effectiveness of the organization's safety equipment, employees' perceptions of safety leadership, the extent to which employees look out for one another's safety, and employees' own perceptions and opinions regarding the conflict between safety and production."

2.4 Discussion for Study One

To validate the conceptualizations of these concepts, I analyzed the review articles that addressed the same conceptual confusion for the safety culture and climate theoretical definitions

(Cooper, 2000; Cox & Flin, 1998; Guldenmund, 2000; Mearns & Flin, 1999; Wiegmann et al., 2004). These review articles demonstrate that there seem to be eight main aspects that form safety culture:

(1) Safety culture encompasses safety issues at the organizational level.

(2) Safety culture occurs at the group level and involves a shared, collective commitment to safety.

(3) Safety culture involves the behaviors of management and employees.

(4) Safety culture includes the individual's attitudes, beliefs, and norms regarding safety.

(5) A strong safety culture is reflected in improving the organization's safety performance and willingness to learn from incidents.

(6) Safety culture includes employee empowerment and commitment to safety.

(7) Safety culture is relatively enduring, stable, and resistant to change.

(8) Safety culture is a holistic, implicit concept that is dependent on the constructed systems of meanings, as well as, the assumptions and expectations of organizational members.

These eight main aspects associated with safety culture in the literature, corresponded the most significant aspects identified in the theoretical definition analysis, further supporting the developed theoretical definitions for safety culture.

Review articles were also analyzed that further confirmed the theoretical definition for safety climate (Cox & Flin, 1998; Guldenmund, 2000; Mearns & Flin, 1999; Wiegmann et al., 2004; Zohar 1980). These review articles demonstrate that there seem to be five main aspects that form safety climate:

(1) Safety climate involves the perceptions or opinions of organizational members.

(2) Safety climate is both an individual and a group phenomenon.

(3) Safety climate is dependent on the current situation or work environment and is sensitive to external pressures.

(4) Safety climate involves the manifest, surface perceptions of employees at a specific point in time, and these perceptions are easily changeable.

(5) Safety climate is a subcomponent of safety culture.

These five main aspects associated with safety climate in the literature, corresponded the most significant aspects identified in the theoretical definition analysis, further supporting the developed theoretical definitions for safety climate.

2.4.2 Relationship between safety culture and safety climate. The next research question asked whether safety culture and safety climate assessed the same or distinct constructs, or whether safety climate should be considered a subcomponent of safety culture.

It is evident that safety culture and safety climate must be somewhat related as both constructs assess individual employees safety views, shared attitudes of the group, and the impact of policies and the working environment on safety (See Table 2-1 and Table 2-2). However, it is also evident that safety culture and safety climate are not assessing the exact same non-technological aspects of safety as there are many discrepancies between the two constructs. Firstly, while safety climate involves perceptions, opinions, and impressions, safety culture encompasses attitudes, beliefs, values, and norms. Secondly, safety climate represents the more easily observable, surface features of safety, while safety culture involves the deeply-held, implicit assumptions that are believed and followed by employees. Finally, safety climate is a temporary phenomenon that represents safety perceptions at a specific point in time and is subject to change. Conversely, safety culture is a more stable phenomenon that is long-lasting and difficult to change and the goal of developing a positive safety culture is to improve and enhance the safety performance of the organization.

Based on both the classification of aspects and the common consensus within the literature, safety climate seems to be a subcomponent of safety culture, where safety climate includes the surface perceptions of safety culture. Within the theoretical definition analysis, 27% of the compiled theoretical definitions stated that safety climate was a subcomponent of safety culture. None of the definitions mentioned that safety climate was a distinct construct from safety culture. Furthermore, of the included review articles, three out of five state that safety climate is a subcomponent of safety culture (Cox & Flin, 1998; Mearns & Flin, 1999; Wiegmann et al., 2004). As such, safety climate appears to be a subcomponent of safety culture, which is in line with Choudhry and colleagues (2007b) beliefs.

2.4.3 Congruency between theoretical and operational definitions. The next research question focused on the congruency between the safety theoretical definitions and operational definitions in the literature.

The theoretical and operational definition analysis indicated that 55% of the definitions were missing their corresponding operational definition, suggesting that 55% of the current

studies did not develop both a theoretical definition and an operational definition when developing an assessment tool. Thirteen percent of the studies had a congruency rating below 50%, suggesting that their theoretical definition and operational definition did not closely match. Twenty-six percent of the studies had a congruency rating between 50% and 74%, suggesting that their theoretical definition and operational definitions matched on some aspects, but not on others. Finally, 6% of the studies had a congruency rating between 75% and 100%, suggesting that the theoretical and operational definitions were closely matched. No studies obtained a congruency rating above 85%. As such, these results indicate that current studies need to improve the congruency between their theoretical and operational definitions when developing assessment tools.

CHAPTER THREE

STUDY TWO

3.1 Study Two: Development and Evaluation of the Safety Climate Questionnaire

The purpose of study two part one was to develop and pilot the Saskatchewan Safety Climate Questionnaire, while the purpose of study two part two was to administer the questionnaire in the College of Engineering to determine its psychometric properties and evaluate the safety climate in the College of Engineering.

3.1.1 Part 1: Development of a Safety Climate Questionnaire

3.1.1.1 Purpose. The purpose of study two part one was to utilize the developed theoretical and operational definitions for safety climate to design a questionnaire based on these definitions. The questionnaire was piloted on students in the College of Engineering to determine its suitability and make any needed improvements.

3.1.1.2 Materials. The materials used in study two was the 62 item Saskatchewan Safety Climate questionnaire that I created. Consequently, the procedure section below provides a detailed description of how the questionnaire was developed.

3.1.1.3 Procedure. The theoretical definition of safety climate developed in part one of study one was used as the foundation for the assessment tool.

"Safety climate reflects what employees perceive regarding safety within their organization, where "perceive" refers to the employees' awareness, interpretation, and opinion formation regarding specific safety events. These opinions are developed by individual employees, but when these opinions become shared, they are what form the safety climate of an

organization. The major aspect of safety climate involves how employees perceive the safety attitudes and behaviors of both management and fellow co-workers, their organization's safety policies, and the safety of their work environment. Safety climate is sensitive to external influence and involves the temporary, surface features of safety culture, which only captures the safety of the organization at a specific point in time."

From this theoretical definition, a corresponding operational definition for safety climate was developed that was tailored specifically to the College of Engineering and used to develop scale items for the assessment tool. The operational definition is below.

"The safety climate in the College is supported by the perceptions of students that are developed and shared between instructors, teaching assistants, and students. Approval of these perceptions and opinions can be measured through self-report measures, such as survey questionnaires. Due to the changing nature of safety climate, frequent assessments should be conducted to determine any changes in within the College's safety perceptions and attitudes.

To assess the safety climate of the College, survey questionnaires should assess student's perceptions and opinions on a variety of safety climate related factors, including: students' perceptions and opinions of their College's safety policies and procedures, students own adherence to policies and procedures, the extent to which other students adhere to the policies and procedures within the College, the effectiveness of the safety training students receive, students' perception of their instructor's approach to reporting incidents and punishing safety violations, the communication between students and instructors regarding safety, the effectiveness of the College's safety equipment, students' perceptions of the safety leadership of their instructors and teaching assistants, the extent to which students look out for one another's safety, and students' own perceptions and opinions regarding the conflict between safety and efficiency."

Existing safety culture and safety climate assessment tools were analyzed based on their validity and reliability. Items from the assessment tools that reported adequate reliability and validity were included in the potential pool of items for the survey questionnaire (See Appendix I for list of assessment tools). The researcher classified them based on whether or not they corresponded to the above safety climate definition. Items were included if the content of the item was congruent with the aspects identified in the theoretical definition for safety climate. See

Appendix J for the list of the classified items. Another rater then categorized the uncertain items based on whether or not they corresponded to the safety climate definition..

The remaining items that correspond with the theoretical definition were grouped into subsections (i.e., safety policies, safety training, etc.). These subsections were identified based on the developed operational definition as well as on common themes that occurred around many items (e.g., many items referred to safety policies). The wording of the items was adjusted for use in a university/lab setting.

Several demographic questions about gender, age, and year of study of the participant were asked to examine these factors in relation to safety climate scores. Whether the participant had previous work experience in industry was also assessed as students who had been previously exposed to industry level safety regulations may have a different approach to safety than students who lacked this experience. Questions about whether the participant had experienced or witnessed an injury or near miss were also asked in order to determine the relationship between an individual's safety climate score and exposure to injury. The term "near miss" was used as it is a common term used in both the literature and industry that simply refers to any event that could have resulted in an injury (Jones, Kirchsteiger, & Bjerke, 1999).

The questionnaire was then assessed by two experts in the field. These experts assessed the items based on their applicability for the College of Engineering at the University of Saskatchewan and provided their feedback. The recommended changes to the items were implemented and the draft survey was piloted on engineering students in the College.

3.1.2 Piloting the Questionnaire

The purpose of this pilot study was to determine whether the Saskatchewan Safety Climate Questionnaire is easily understood by participants, to collect feedback from participants regarding the structure of the questionnaire, and to conduct preliminary psychometric analysis on the survey's results.

3.1.2.1 Participants. The pilot sample included 35 participants. During class time twenty-three participants completed the online survey and 12 completed the paper-and-pencil survey. The demographics for the pilot sample are presented in Table 3-1. As Table 3-1 indicates, the majority of participants are male (66%), born in 1994 (34%), in geological engineering (34%), and have previous work experience (80%).

Table 3-1. Demographics Frequency and Percentage

Demographic	Frequency	Percent (%)
Gender		
Male	23	65.7
Female	12	34.3
Year of Birth		
1995	5	14.3
1994	12	34.3
1993	10	28.6
1992	1	2.9
1991	1	2.9
1990	3	8.6
1989 or earlier	3	8.6
Year of Study		
Third year	1	2.9
Fourth year	17	48.6
Fifth year or above	17	48.6
Engineering Discipline		
Chemical and Biological Engineering	3	8.6
Civil Engineering	2	5.7
Geological Engineering	12	34.3
Environmental Engineering	8	22.9
Electrical Engineering	1	2.9
Mechanical Engineering	9	25.7
Previous Work in Industry		
Yes	28	80
No	7	20
Total	**35**	**100**

3.1.2.2 Procedure. The pilot survey was conducted in November 2016. During a senior engineering class, participants were given the choice to either complete an online version of the survey through Fluid Surveys or to complete a paper and pencil version of the survey provided by the researcher. The survey took approximately 15 to 20 minutes to complete. After completion of the survey, participants were presented with a Debriefing Form and were asked if they had any comments or suggestions regarding the design and format of the survey

3.1.2.2.1 Participants' suggestions. Several participants said they found the policies and procedures section of the survey difficult as they had little exposure and knowledge of the College of Engineering's safety procedures. However, the researcher chose to keep the policies and procedures section included in the survey, as it provided valuable data. Some of the participants did seem to have some basic knowledge of the policies, and the fact that many

participants were unfamiliar with the safety policies provided necessary data about the safety knowledge in the College of Engineering.

Additional feedback suggested that the safety experiences and knowledge gained in the College of Engineering should be compared to that in industry. While this is a very interesting direction of the research, it is beyond the scope of this project, but may be addressed with future research.

And finally, several participants suggested that the items repeated themselves or were redundant. However, as some redundancy is necessary to determine reliability and the fact that the questionnaire was only 15 to 20 minutes in length, resulted in all items remaining in the questionnaire. Furthermore, reliability analysis did not suggest that the items were redundant; however this will be discussed at length below.

3.1.2.3 Results. In order to prepare the data for analysis the following steps were taken: (1) The negatively worded items were reverse coded to allow for reliability analysis to be conducted. (2) The total scale scores were created for each safety subscale (i.e., safety policies, safety training, etc.) as well as for the overall safety climate score. Total scale score were created using both "sum" and "mean". (3) Normality plots with tests were calculated to determine if the data were normally distributed. The Q-Q plots, as well as the comparison of the 5% trimmed mean to the mean indicated that the items in each subscale were normally distributed. (4) Frequency analysis, descriptive analysis, reliability alpha-coefficient, inter-item correlations, and item-total score correlations were conducted in order to analyze the usefulness of the data.

3.1.2.4 Statistical Analysis of the Items. When analyzing the usefulness of the items, the researcher examined three different aspects:

1. Whether the distribution of the answers was normal or whether there were any abnormalities or unusual patterns, as very strong agreement or very strong disagreement suggested there may be problems with the wording of the item.
2. Whether the inter-item correlations were non-significant or negative, as this suggests that items within the same subcategory are unrelated to one another
3. Whether Cronbach's alpha was adequate and what the alpha would become if certain items were deleted.

These criteria were used to determine if the items should remain, be re-worded, or be removed.

3.1.2.4.1 Safety climate scale. Cronbach's alpha for the scale items was .94. An alpha this high suggests that the items are measuring the same safety construct. Next, each subcategory was analyzed separately to determine the adequacy of the items. Overall, all subcategories demonstrated a normal distribution, evident from the normalcy plots and tests conducted. For each subcategory, the mean was compared to the 5% trimmed mean and no significant differences were found. Furthermore, all plots indicated a normal distribution.

3.1.2.4.2 Safety policies. All items in the safety policies subcategory were adequate (See Table 3-2). Cronbach's alpha for safety policies was .788 which exceeds the minimum guideline of .70 (Santos, 1999). Some of the items were slightly skewed towards "agree", however, the majority were normally distributed. Only items 4 and 7 would have resulted in a higher alpha if removed, and this increase only resulted in an alpha of .793 and .805 respectively. Seeing as these two items were normally distributed and the inter-item correlations were mostly significant, no items were removed from the policies section.

Table 3-2. Item Analysis of Safety Policies

	Normally Distributed	**Inter-Item Correlations**	**Alpha Alpha if item deleted**
1. When safety rules or procedures are changed, the changes are promptly communicated to all affected students.	Slightly skewed (agree)	6 were significant out of 13	.788 .768
2. My college values students' correct observation of safety rules and procedures.	Slightly skewed (agree)	3	.788 .784
3. Students can explain health and safety policies in the College.	Normal	1	.788 .785
4. Not all the health and safety rules or procedures are strictly followed here. **Reverse**	Normal	3	.788 .793 higher
5. Some health and safety rules or procedures are difficult to follow. **Reverse**	Slightly skewed (disagree)	6	.788 .757
6. In my college, disregarding safety policies and procedures is rare.	Slightly skewed (agree)	2	.788 .785
7. It would help students to work more safely if safety procedures were more realistic. **Reverse**	Normal	2	.788 .805 higher
8. All the safety rules and procedures in my college really work.	Slightly skewed (agree)	7	.788 . 760
9. Safety procedures are carefully followed.	Slightly skewed (agree)	5	.788 .772
10. Some safety rules and procedures do not need to be followed to get the task done safely **Reverse**	Normal	4	.788 .780
11. Some health and safety rules and procedures are not really practical. **Reverse**	Slightly skewed (agree)	8	.788 .758

12. Safety is considered when changes are made to rules and procedures.	Slightly skewed (agree)	10	.788 .746
13. Safety is not sacrificed for speed during a task.	Slightly skewed (agree)	6	.788 .761
14. Safety is not sacrificed for quality during a task.	Slightly skewed (agree)	3	.788 .779

3.1.2.4.3 Safety training. All items in the safety training subcategory were adequate (See Table 3-3). Cronbach's alpha for safety training was .708 which exceeds the minimum guideline of .70. The majority of the items were normally distributed. Only items 3 and 4 would have resulted in a higher alpha if removed; however, the increase was minimal and these items were normally distributed and the inter-item correlations were mostly significant. As such, the safety training items were not changed.

Table 3-3. Item Analysis of Safety Training

	Normally Distributed	**Inter-Item Correlations**	**Alpha Alpha if item deleted**
1. Students have the necessary competence to perform tasks in a safe manner because of the safety training they have received.	Slightly skewed (agree)	4 were significant out of 5	.708 .589
2. Most of the safety training students receive is effective.	Slightly skewed (agree)	3	.708 .653
3. It would help students to work more safely if we received more frequent safety training. **Reverse**	Normal	2	.708 .739 higher
4. It would help students to work more safely if we were given better quality safety training. **Reverse**	Normal	2	.708 .720 higher
5. Our safety training program ensures all students who do the same task learn to do it the same safe way.	Normal	3	.708 .672
6. When asked to do a new job or task, students receive enough training to be able to do it safely.	Normal	4	.708 .613

3.1.2.4.4 Safety communication. The items in the safety communication subcategory were also adequate (See Table 3-4). The alpha for safety communication was .711. Only two items, items 4 and 5, would have resulted in a higher Cronbach's alpha if removed, resulting in an increase of .722 and .725 respectively. These items were normally distributed and the majority of the inter-item correlations were significant. Consequently, none of the safety communication items were changed or removed.

Table 3-4. Item Analysis of Safety Communication

	Normally Distributed	**Inter-Item Correlations**	**Alpha Alpha if item deleted**

1. Students are recognized for working safely.	Slightly skewed (disagree)	6 were significant out of 12	.711 .675
2. Reporting a safety problem will not result in negative repercussions for the persons reporting it. **Reverse**	Slightly skewed (disagree)	3	.711 .708
3. Students are rewarded for taking quick action to identify a safety problem.	Normal	3	.711 .688
4. It would help students to work more safely if the instructors recognized and praised our safe behaviour. **Reverse**	Normal	2	.711 .722 higher
5. Students are not blamed for acting unsafely.	Normal	4	.711 .725 higher
6. If students violate safety regulations they will be disciplined.	Slightly skewed (agree)	4	.711 .704
7. Students are not comfortable reporting a safety violation, because they will be disciplined. **Reverse**	Slightly skewed (agree)	1	.711 .711
8. Students' suggestions about safety would be acted upon if they expressed them to the instructors.	Slightly skewed (agree)	2	.711 .686
9. There is good communication in the College between instructors and students about health and safety issues.	Normal	5	.711 .675
10. Safety information is always brought to our attention by our instructor.	Slightly skewed (agree)	6	.711 .664
11. Our instructor does not always inform us of current safety concerns and issues. **Reverse**	Normal	6	.711 .679
12. Students frequently offer ideas and suggestions to improve safety.	Normal	3	.711 .703
13. Accidents that happen here are always reported and discussed.	Normal	3	.711 .666

3.1.2.4.5 Safety attitudes about instructors. Cronbach's alpha for safety attitudes about instructors was adequate at .781. Some of the items were slightly skewed towards agreement. However, the majority of the inter-item correlations were significant and none of the items would have resulted in a higher Cronbach's alpha if removed. Consequently, there were no areas of concerns for this subcategory (See Table 3-5).

Table 3-5. Item Analysis of Attitudes about Instructors

	Normally Distributed	**Inter-Item Correlations**	**Alpha** **Alpha if item deleted**
1. In my college, the instructor acts quickly to correct safety problems.	Normal	4 were significant out of 9	.781 .763
2. Corrective action is always taken when the college is told about unsafe practices.	Slightly skewed (agree)	6	.781 .735

3. In my college, instructors pay serious attention to the safety of students.	Slightly skewed (agree)	1	.781 .777
4. Instructors and supervisors express concern if safety procedures are not adhered to.	Slightly skewed (agree)	4	.781 .751
5. The college clearly considers the safety of students of great importance.	Slightly skewed (agree)	5	.781 .756
6. Instructors sometimes turn a blind eye to people who are not observing the health and safety procedures. **Reverse**	Normal	2	.781 .782
7. Our college supplies enough safety equipment.	Slightly skewed (agree)	5	.781 .756
8. Our college checks equipment to make sure it is free of faults.	Slightly skewed (agree)	3	.781 .778
9. Sometimes conditions here hinder my ability to work safely. **Reverse**	Slightly skewed (agree)	2	.781 .759
10. I cannot always get the equipment I need to do the task safely. **Reverse**	Slightly skewed (agree)	4	.781 .763

3.1.2.4.6 Safety attitudes about fellow students. The subcategory for safety attitudes about fellow students was the only category that had an alpha below the suggested guidelines at .667. The majority of the items were normally distributed. However, the number of significant inter-item correlations was low for some of the items. Only, two items, items 3 and 7, would have resulted in a higher Cronbach's alpha if removed, resulting in an alpha of .668 and .672 respectively. This increase would have been minimal. Furthermore, upon assessing these two items, at face value they are useful items to have in the questionnaire (i.e., "I ask my fellow students to stop work which I believe is performed in an unsafe manner, Students and instructors accept safety violations as long as there are no accidents"). The lower than recommended alpha could be due to two factors. Firstly, this subcategory only has seven items, which may have resulted in the low alpha. Additionally, it is also possible that there are two separate factors within this subcategory that are assessing two different constructs. Looking at the items within this subcategory there seems to be two separate constructs, one assessing safety cooperation between fellow students and the other assessing safety violations of other students. Additional participants are needed to confirm the presence of these two factors using a confirmatory factor analysis. Ultimately, no items were removed or changed within this subcategory (See Table 3-6).

Table 3-6. Item Analysis of Attitudes about Fellow Students

	Normally Distributed	**Inter-Item Correlations**	**Alpha Alpha if item deleted**
1. I am encouraged by my fellow students to report any safety concerns I may have.	Normal	2 were significant out of 6	.667 .620
2. Students take no responsibility for each other's safety. **Reverse**	Slightly skewed (agree)	0	.667 .663
3. I ask my fellow students to stop work which I believe is performed in an unsafe manner.	Slightly skewed (agree)	1	.667 .668 higher
4. My fellow students look out for my safety.	Normal	3	.667 .586
5. When I see a fellow student working at-risk, I caution him or her.	Slightly skewed (agree)	3	.667 .584
6. In my college, there is significant peer pressure to discourage unsafe practices.	Slightly skewed (disagree)	3	.667 .617
7. Students and instructors accept safety violations as long as there are no accidents. **Reverse**	Normal	1	.667 .672 higher

3.1.2.4.7 Own safety reflections. The final subcategory, reflections on one's own safety attitudes, had an alpha of .879, which is adequate. The majority of the items were normally distributed and most of the inter-item correlations were significant. Only two items, items 1 and 12, would have resulted in a higher alpha if removed, and this increase was minimal. Consequently, none of the items in this subcategory were removed (See Table 3-7).

Table 3-7. Item Analysis of Own Safety Reflections

	Normally Distributed	**Inter-Item Correlations**	**Alpha Alpha if item deleted**
1. I tend to take more risks in my tasks when instructors aren't present. **Reverse**	Slightly skewed (agree)	5 were significant out of 11	.879 .883 higher
2. If I make a mistake that has significant safety consequences and nobody notices, I do not tell anyone about it. **Reverse**	Slightly skewed (agree)	11	.879 .856
3. I believe the most important part of completing a task is being safe.	Slightly skewed (agree)	10	.879 .859
4. I believe that safety issues are not assigned a high priority in my College. **Reverse**	Slightly skewed (agree)	8	.879 .870
5. I do not skip any safety step even to increase work efficiency.	Normal	10	.879 .860
6. I cannot avoid taking risks in my College. Reverse	Slightly skewed (agree)	7	.879 .879
7. I believe some tasks here are difficult to do safely. **Reverse**	Normal	9	.879 .865
8. I pride myself on my ability to work safely.	Normal	8	.879 .866

9. I hope to be known as a safe worker.	Slightly skewed (agree)	10	.879 .863
10. I only get involved in safety activities because I'm required to do so. **Reverse**	Slightly skewed (agree)	6	.879 .878
11. When people ignore safety procedures here, I feel it is none of my business. **Reverse**	Slightly skewed (agree)	9	.879 .857
12. I practice the safety attitudes and behaviors I have learned in the College of Engineering in other contexts (i.e., home, work).	Slightly skewed (agree)	3	.879 .888 higher

3.1.3 Conclusion

Overall, none of the items in the safety survey were removed and only one section of questions was altered. Questions in the injury and accident section were worded differently in order to obtain more standardized answers. In the pilot survey, the participants were asked to fill in the blank on how many injuries they witnessed or experienced. This format resulted in answers ranging from 0 to "a few", which made it difficult to classify the number of injuries and near misses experienced by participants. Consequently, answer categories in the final version of the survey were changed so that participants chose from a series of options rather than fill in the blank. In the pilot questionnaire, the question asked "how many times have you experienced a minor injury" and allowed the participant to enter in any number of their choosing, However, the finalized version of the questionnaire had specific answer categories, such as "never", "1 to 5 times", "6 to 9 times", and "10 or more times." Answer categories for these options were designed based on the responses participants provided in the pilot survey.

As the pilot survey was found to be reliable with this sample and no significant changes were made to the survey, the data obtained in the pilot sample were incorporated into the overall sample pool. For the question that was changed, the researcher manually entered the pilot data responses into the correct answer categories. The final version of the survey is provided in Appendix R.

3.2 Part 2: Evaluation of Safety Climate in the College of Engineering

The majority of research on safety climate has been focused on the industrial setting, such that construction sites, mines, and hospitals have been the main focus of safety research. However, it is also important to assess the safety climate in other settings, such as university campuses, particularly when these colleges have experimental laboratories, testing grounds, or practice factories where safety may be a concern (Wu, Liu, & Lu, 2007). Wu and colleagues (2007) administered a safety climate questionnaire to 100 universities in Taiwan and found that

safety climate was related to the presence of a safety management and safety committee. Additionally, safety climate was found to relate to safety training, as individuals who received more safety training were more likely to report an improved safety climate, compared to those with little or no safety training. Consequently, it is important to examine safety climate within universities and colleges in order to determine the safety climate at specific institutions, as well as a means of improving safety climate within universities (Wu, Liu, & Lu, 2007). Finally, it is also important to assess safety climate within Canada, as different countries and cultures will have a variety of safety climates and different facilitators and barriers associated with improving their specific safety climate.

3.2.1.1 Purpose. The purpose of part two of study two was to use the developed questionnaire to examine the psychometric properties of the scale and to evaluate the safety climate in the College of Engineering at the University of Saskatchewan. The following research questions were examined:

1. What are the main psychometric properties of the developed Safety Climate Questionnaire?
2. What is the safety climate in the College of Engineering? Are there significant differences between reported scores on the safety climate subscales?
3. How are the Safety Climate scores associated with the demographic variables (i.e., gender, year of study, discipline, experience with injuries, etc.) obtained in the College of Engineering?

3.2.1.2 Participants. The sample consisted of 232 participants from three sections of a senior engineering classes attended in January 2017, as well as the 35 participants included from the pilot sample. One hundred eighty-seven participants completed the online version of the questionnaire and 80 completed the paper-and-pencil version of the questionnaire. Nine participants failed to complete the questionnaire, as such these questionnaires were removed from analysis. However, due to an administration error, 43 paper-and-pencil versions of the questionnaire were missing the last page, which had 12 items. Consequently, the results have two different sample sizes depending on the subscale, as the final subscale, Reflections on one's own safety attitudes, only has a sample size of 215. Consequently, the final number of surveys used in the analysis was 258, with 215 having complete data.

As Table 3-8 indicates, the majority of participants were male (80%), born between 1993 and 1995 (80%), and in mechanical engineering (26%), civil engineering (22%), or chemical and biological engineering (21%). The majority of participants had previous work experience in industry (75%).

Table 3-8. Demographics Frequency and Percentage

Demographic	Frequency	Percent (%)
Gender		
Male	207	80.2
Female	51	19.8
Year of Birth		
1996	2	0.8
1995	66	25.6
1994	103	39.9
1993	37	14.3
1992	13	5.0
1991	8	3.1
1990	7	2.7
1989	11	4.3
1988	3	1.2
1987 or earlier	8	3.1
Year of Study		
Third year	4	1.5
Fourth year	178	69.0
Fifth year or above	76	29.5
Engineering Discipline		
Chemical and Biological Engineering	55	21.3
Civil Engineering	57	22.1
Geological Engineering	19	7.4
Environmental Engineering	13	5.0
Electrical Engineering	26	10.1
Computer Engineering	11	4.3
Engineering Physics	9	3.5
Mechanical Engineering	68	26.4
Previous Work in Industry		
Yes	194	75.2
No	64	24.8
Total	**258**	**100**

As Table 3-9 indicates, 32% of participants had experienced at least one near miss, 10% had experienced at least one minor injury, and 2% had experienced a major injury. Forty-six percent of participants had witnessed at least one near miss on campus, 25% had witnessed a minor injury, and 10% had witnessed a major injury. These percentages indicate that injuries and

accidents are fairly uncommon on campus and in the College of Engineering. While near misses and minor injuries may occur occasionally, major injuries are rare.

Table 3-9. Experiencing and Witnessing Injuries

Type of Injury	Frequency of Injury	Frequency	Percent (%)
Experiencing Injuries			
Near Miss	Never	176	68.2
	1 to 5 times	73	28.3
	6 to 9 times	4	1.6
	10 or more	5	1.9
Minor Injury	Never	233	90.3
	1 to 5 times	20	7.8
	6 to 9 times	5	1.9
	10 or more	0	0
Major Injury	Never	252	97.7
	1 to 5 times	6	2.3
	6 to 9 times	0	0
	10 or more	0	0
Witnessing Injuries			
Near Miss	Never	139	53.9
	1 to 5 times	100	38.8
	6 to 9 times	7	2.7
	10 or more	12	4.7
Minor Injury	Never	195	75.6
	1 to 5 times	59	22.9
	6 to 9 times	1	0.4
	10 or more	3	1.2
Major Injury	Never	232	89.9
	1 to 5 times	26	10.1
	6 to 9 times	0	0
	10 or more	0	0
Fatality	Never	254	98.4
	1 to 5 times	4	1.6
	6 to 9 times	0	0
	10 or more	0	0
Total		**258**	**100**

3.2.1.3 Procedure. For each of the three classes, a time was agreed upon that was convenient for the professor and their class to participate in the safety questionnaire. At the beginning of class, the researcher briefly introduced the project and went over the consent form. The participants chose whether they wanted to complete the online version of the questionnaire or the paper-and-pencil version. The online version of the survey was sent as a link to the professor in advance and the professor either emailed the link to their students or posted the link

on blackboard. The researcher provided the paper-and-pencil copies to students who did not have a laptop or phone available. The paper-and-pencil versions of the questionnaire were collected once completed and entered into Fluid Surveys manually. The survey took participants approximately 20 minutes to complete.

3.2.2 Results

In order to prepare the data for analysis the following steps were taken:

1. Participants who did not complete the survey were removed from the analysis. Several items had missing data, as such Little's MCAR was calculated to determine if the data was missing at random. The Little's MCAR test resulted in chi-square = 1143.45 (*df* = 1080, *p* = .088), which indicated that the data was missing at random. To input the missing data an expectation maximization (EM) technique was used, with inferences assumed based on the likelihood of the normal distribution (Tabachnick, Fidell, & Osterlind, 2001).
2. The negatively worded items were reverse coded to allow for reliability analysis to be conducted.
3. The total scale scores were created for each safety subscale (i.e., safety policies, safety training, etc.) as well as for the safety climate questionnaire.
4. Normality plots with tests were calculated to determine if the data were normally distributed. The Q-Q plots, as well as the comparison of the 5% trimmed mean to the mean indicated that the items in each subscale were normally distributed.

3.2.3 Psychometric analysis

The purpose of the psychometric analysis is to examine the quality of the questionnaire items and the questionnaire as a whole. It includes the following steps: item analysis, reliability analysis, exploratory factor analysis, and validity analysis.

3.2.3.1 Item analysis. Item analysis involves evaluating the quality of items using a number of parameters (Varma, 2006). Within this item analysis the following parameters were analyzed: mean, standard deviation, frequency and percentage of each answer choice, Cronbach's alpha, and Pearson correlation of the items' score with the questionnaire total score.

Mean is the average of participants' responses. Standard deviation is a measure of how far the scores deviate from the average score. If the standard deviation is low, there is little

variability. If the standard deviation is high, this indicates the scores are spread out from the mean.

The frequency and percentage of participants' answer choices is assessed to determine the distribution of the answer on the questionnaire answer scale. If all participants indicate an answer choice of "neutral" this may indicate a problematic item as there is not enough variability in the answer choices. The distribution of the Safety Climate Questionnaire is displayed in Appendix Q.

Internal consistency is a type of reliability that measures how well items on a test assess the same construct or idea. Internal consistency is assessed using Cronbach's alpha and .70 is often considered the acceptable cut-off value (Tabachnick, Fidell, & Osterlind, 2001). The Cronbach's alpha for each subscale was assessed based on whether the alpha would increase if a specific item was deleted. The Cronbach's alpha increased significantly with the deletion of a certain item, this indicates that this item may be problematic.

Pearson correlation values range for -1.0 to +1.0. A large positive Pearson coefficient value indicates that participants with high safety climate questionnaire scores are also reporting high scores on individual items. A low Pearson coefficient value would indicate that participants with high overall safety climate scores are reporting low safety climate scores on individual items, which would indicate an anomaly in the items. A Pearson value of 0.25 is recommended, although the value should be at least 0.15 (Varma, 2006).

3.2.3.1.1 Safety policies. Appendix K displays the means, standard deviations, Cronbach's alpha, frequency and percentage of each answer choice, and Pearson correlation coefficients for the safety policies subscale.

The mean for the items for safety policies range from 2.76 for item 7 to 4.14 for item 2. The majority of the items are between 3.0 and 4.0. The standard deviation of the items range from .74 for item 2 to 1.35 for item 12. For safety policies the Cronbach's alpha was .795, which exceeds the minimum guideline of .70. Comparing the Cronbach's alpha of .795 to the Cronbach's alpha if an item is deleted indicates that none of the items would result in a higher Cronbach's alpha if deleted which indicates the good quality of the include items.

For the frequency and percentage of answer choices, the results were fairly normally distributed with the majority of participants selecting "neutral" or "agree". Few participants selected strongly disagree, with this answer choice selected most commonly for item 7 at 9%.

Participants were most likely to choose “neutral” for items 3, 7, and 10. Participants were mostly likely to choose “agree” for items 1, 2, 8, 9, 12, 13, and 14. The Pearson correlation value for each item was above the recommended guideline of 0.25 and all items were significantly associated with the mean total scale score.

3.2.3.1.2 Safety training. Appendix L displays the means, standard deviations, Cronbach’s alpha, frequency and percentage of each answer choice, and Pearson correlation coefficient for the safety training subscale. The mean for the items for safety training range from 2.52 for item 4 to 3.71 for item 1. The standard deviation of the items range from .926 for item 6 to 1.10 for item 3. For safety training Cronbach’s alpha is .74, which exceeds the minimum guideline of .70. Comparing the Cronbach’s alpha of .74 to the Cronbach’s alpha if an item is deleted indicates that the deletion of item 3 would result in a Cronbach’s alpha of .743, however, this increase is minor.

For the frequency and percentage of answer choices, the results were fairly normally distributed with the majority of participants selecting “neutral” or “agree”. Participants were most likely to choose “neutral” for items 3, 4, and 5. Participants were mostly likely to choose “agree” for items 1, 2, 5, and 6. The Pearson correlation value for each item was above the recommended guideline of 0.25 and all items were significantly associated with the mean total scale score.

3.2.3.1.3 Safety communication. Appendix M displays the means, standard deviations, Cronbach’s alpha, frequency and percentage of each answer choice, and Pearson correlation coefficient for the safety communication subscale.

The mean for the items for safety communication range from 1.89 for item 2 to 3.79 for item 10. The majority of the items are between 2.0 and 3.0. The standard deviation of the items range from .88 for item 10 to 1.57 for item 13. For safety communication the Cronbach’s alpha was .663, which does not meet the minimum guideline of .70. Comparing the Cronbach’s alpha of .663 to the Cronbach’s alpha if an item is deleted indicates that there were three items that would result in a higher alpha if deleted. These included item 5 at .668, item 2 at .674, and item 4 at .677. Deletion of any of these items alone does not result in a Cronbach’s alpha that meets the minimum guideline of .70. If all three of these items are deleted, the resulting Cronbach’s alpha is .702.

For the frequency and percentage of answer choices, the results were fairly normally distributed with the majority of participants selecting “neutral” or “disagree”. Participants were most likely to choose “neutral” for items 1, 3, 5, and 12. Participants were mostly likely to choose “disagree” for items 2, 4, 5, and 12. The Pearson correlation value for each item was above the minimum recommended guideline of 0.15. Items 2 and 4 were below the recommended guideline of 0.25, but all other items were higher than 0.25.

3.2.3.1.4 Attitudes about instructors. Appendix N displays the means, standard deviations, Cronbach’s alpha, frequency and percentage of each answer choice, and Pearson correlation coefficient for the attitudes about instructors subscale.

The mean for the items for safety attitudes about instructors range from 2.73 for item 8 to 4.03 for item 5. The majority of the items are between 3.0 and 4.0. The standard deviation of the items range from .84 for item 5 to 1.70 for item 8. For attitudes about instructors Cronbach’s alpha is .789, which exceeds the minimum guideline of .70. Comparing the Cronbach’s alpha of .789 to the Cronbach’s alpha if an item is deleted indicates that Cronbach’s alpha would be .794 if item 8 was deleted.

For the frequency and percentage of answer choices, the results were fairly normally distributed with the majority of participants selecting “neutral” or “agree”. Few participants selected strongly disagree, with this answer choice selected most commonly for item 7 and 8 at 3% each. Participants were most likely to choose “neutral” for items 1, 6, 7, and 8. Participants were mostly likely to choose “agree” for items 1, 3, 4, and 5. The Pearson correlation value for each item was above the recommended guideline of 0.25 and all items were significantly associated with the mean total scale score.

3.2.3.1.5 Attitudes about fellow students. Appendix O displays the means, standard deviations, Cronbach’s alpha, frequency and percentage of each answer choice, and Pearson correlation coefficient for the attitudes about fellow students subscale.

The mean for the items for attitudes about fellow students range from 2.91 for item 6 to 3.90 for item 5. The standard deviation of the items range from .74 for item 5 to 1.27 for item 7. For attitudes about fellow students Cronbach’s alpha is .610, which does not exceed the minimum guideline of .70. Comparing the Cronbach’s alpha of .610 to the Cronbach’s alpha if an item is deleted indicates that the Cronbach’s alpha would be .614 if item 6 was deleted and the alpha would be .641 if item 7 was deleted.

For the frequency and percentage of answer choices, the results were fairly normally distributed with the majority of participants selecting “neutral” or “agree”. Few participants selected strongly disagree, with this answer choice selected most commonly for item 6 at 5%. Participants were most likely to choose “neutral” for items 1, 4, and 6. Participants were mostly likely to choose “agree” for items 2, 3, 4, and 5. The Pearson correlation value for each item was above the recommended guideline of 0.25 and all items were significantly associated with the mean total scale score.

3.2.3.1.6 Reflections on one’s own safety attitudes. Appendix P displays the means, standard deviations, Cronbach’s alpha, frequency and percentage of each answer choice, and Pearson correlation coefficient for reflections on one’s own safety attitudes subscale.

The mean for the items for own safety reflections range from 3.04 for item 10 to 4.07 for item 9. The majority of the items are between 3.0 and 4.0. The standard deviation of the items range from .74 for item 9 to 1.13 for item 6. For reflections on one’s own safety attitudes Cronbach’s alpha is .789, which exceeds the minimum guideline of .70. Comparing the Cronbach’s alpha of .789 to the Cronbach’s alpha if an item is deleted indicates that Cronbach’s alpha would be .792 if item 10 was deleted.

For the frequency and percentage of answer choices, the results were fairly normally distributed with the majority of participants selecting “neutral” or “agree”. Few participants selected strongly disagree, with this answer choice selected most commonly for item 10 at 6%. Participants were most likely to choose “neutral” for items 2, 5, 10, and 11. Participants were mostly likely to choose “agree” for items 8, 9, 11, and 12. The Pearson correlation value for each item was above the recommended guideline of 0.25 and all items were significantly associated with the mean total scale score.

Overall, the items for the safety policies subscale seem appropriate and do not indicate any problematic items and the scale is normally distributed (See Appendix Q). The items for the safety training subscale also seem appropriate and do not indicate any problematic items. The majority of the items for the safety communication subscale seem appropriate; however, items two, four, and five may be problematic. In future versions of this scale, and in the shortened version of the Safety Climate Questionnaire, these items should be removed. For the attitudes about instructors subscale the items seem appropriate and do not indicate any issues. While Cronbach’s alpha is lower than the recommended guideline, the items for the attitudes about

fellow students subscale seem appropriate as all are normally distributed and the Pearson correlation is acceptable. And finally, the items for the own safety reflections subscale seem appropriate and do not indicate any problematic items.

3.2.3.2 Reliability analysis. Internal consistency was calculated as it is a standard aspect of psychometric analysis and it assesses how inter-related the items are to one another. Cronbach's alpha was calculated for the entire safety scale and for each individual subscale, with the alphas presented in Table 3-10.

Table 3-10. Cronbach's alpha for scale and subscales

Scale	Cronbach's Alpha
Safety Climate Scale	.920
Safety Policies	.795
Safety Training	.740
Safety Communication	.663
Attitudes about Instructors	.789
Attitudes about Fellow Students	.610
Reflections on One's Own Safety Attitudes	.789

As Table 3-10 illustrates, Cronbach's alpha met the minimum guidelines of .70 for all subscales except safety communication and fellow students' attitudes. Removal of any of the items in these two subscales did not result in an alpha that meets the minimum of .70, suggesting that the lower Cronbach's alpha on these items was not due to low quality of items.

3.2.3.3 Exploratory factor analysis. Exploratory factor analysis is a statistical technique that reveals the structure of the scale by determining which items form subsets. Items within a subset should be correlated with one another, but should not be strongly correlated with items in other subsets (Tabachnick, Fidell, & Osterlind, 2001). An exploratory factor analysis was conducted as it is a standard aspect of psychometric analysis, checks the dimensionality of the scale, and it provides the student researcher with a broad range of statistical experience. Exploratory factor analysis was conducted on each subscale to determine the underlying structure of the safety climate items. A factor loading cut-off of .40 was used as Tabachnick, Fidell, and Osterlind (2001) suggest a .40 cut-off is useful for interpretive purposes. Hair and colleagues (1998) also argue that a .40 cut-off is sufficient so long as the sample size exceeds 200 participants and the sample size for this study is 258. An exploratory factor analysis using principal axis factoring and an oblique rotation using direct oblimin was performed on each

subscale. The scree plot, eigenvalues, and parallel analysis test was used to indicate the number of factors identified in each subscale.

3.2.3.3.1 Safety policies. For safety policies, a three-factor model appeared to best fit to the data. The factors loaded cleanly on one factor and none of these items cross-load on any other factor. With the cut-off of .40, all 14 items loaded on one factor, with the majority of items exceeding the cut-off at .50 or higher. In sum, there were three factors within the safety policies subscale, consisting of: skills and knowledge of safety policies, safety versus production, and practicality of safety policies (See Table 3-11).

Table 3-11. Summary of Exploratory Factor Analysis for Safety Policies

	Factor Loadings		
Item	Knowledge of Policies	Safety vs. Production	Practicality of Policies
When safety rules or procedures are changed, the changes are promptly communicated to all affected students	**.54**	-.03	-.01
My college values in the students correct observation of safety rules and procedures	**.52**	-.06	-.10
Students can explain health and safety policies in the College	**.55**	.05	-.03
Not all the health and safety rules or procedures are strictly followed here	**.45**	.15	.14
Some health and safety rules or procedures are difficult to follow	.22	.08	**.61**
In my college, disregarding safety policies and procedures is rare	**.60**	-.01	.02
It would help students to work more safely if safety procedures were more realistic	.13	.12	**.50**
All the safety rules and procedures in my college really work	**.57**	-.04	.21
Safety procedures are carefully followed	**.60**	-.17	.14
Some safety rules and procedures do not need to be followed to get the task done safely	-.11	-.10	**.55**
Some health and safety rules and procedures are not really practical	-.06	-.14	**.80**
Safety is considered when changes are made to rules and procedures	**.42**	-.14	-.10
Safety is not sacrificed for speed during a task	.14	**-.83**	.04
Safety is not sacrificed for quality during a task	.06	**-.88**	.09
Eigenvalues	3.99	1.86	1.55
% of variance	28.52	13.26	11.04

Note: Factor loadings over .40 appear in bold.

3.2.3.3.2 Safety training. For the safety training subscale, a two-factor model appeared to best fit to the data. The factors loaded cleanly on one factor and none of these items cross-load on any other factor. All factors exceeded the cut-off of .40. In sum, there were two factors within the safety training subscale, consisting of: current safety training effectiveness and improvements to future training (See Table 3-12).

Table 3-12. Summary of Exploratory Factor Analysis for Safety Training

	Factor Loadings	
Item	Current Training	Training Improvement
Students have the necessary competence to perform tasks in a safe manner because of the training they have received	**.72**	.02
Most of the safety training students receive is effective	**.85**	-.12
It would help students to work more safely if we received more frequent safety training	-.01	**.68**
It would help students to work more safely if we were given better quality safety training	.03	**.84**
Our safety training program ensures all students who do the same task learn to do it in the same safe way	**.56**	.02
When asked to do a new job or task, students receive enough training to be able to do it safely	**.61**	.10
Eigenvalues	2.69	1.32
% of variance	44.79	21.96

Note: Factor loadings over .40 appear in bold.

3.2.3.3.3 Safety communication. For the safety communication subscale, a two-factor model appeared to best fit to the data. The factors in this solution did not load as cleanly. One item double-loaded on two factors and four items did not meet the cut-off of .40. There were two factors within the safety communication subscale, consisting of: student safety engagement and reporting and instructors disclosure of safety information (See Table 3-13).

Table 3-13. Summary of Exploratory Factor Analysis for Safety Communication

	Factor Loadings	
Item	Student Engagement and Reporting	Instructors Disclosure of Information
Students are recognized for working safely	.26	-.38
Reporting a safety problem will not result in negative repercussions for the persons reporting it	.14	.25
Student are rewarded for taking quick action to identity a safety problem	**.68**	-.03

It would help students to work more safely if the instructors recognized and praised our safe behavior	-.03	-.18
Students are not blamed for acting unsafely	.24	.25
If students violate safety regulations they will be disciplined	**.46**	.06
Students are not comfortable reporting a safety violation because they will be disciplined	**.45**	.04
Students' suggestions about safety would be acted upon if they expressed them to the instructors	**.51**	-.05
There is good communication in the College between instructors and students about health and safety issues	**.42**	**-.46**
Safety information is always brought to our attention by our instructor	.18	**-.71**
Our instructor does not always inform us of current safety concerns and issues	.05	**-.46**
Students frequently offer ideas and suggestions to improve safety	**.47**	-.09
Accidents that happen here are always reported and discussed	**.47**	-.01
Eigenvalues	2.85	1.75
% of variance	21.95	13.45

Note: Factor loadings over .40 appear in bold.

3.2.3.3.4 Attitudes about instructors. For the attitudes about instructors subscale a two-factor model appeared to best fit to the data. The factors loaded cleanly on one factor and none of these items cross-load on any other factor. All factors exceeded the cut-off of .40. Overall, there were two factors within the attitudes about instructors subscale, consisting of: visible safety leadership and the effectiveness of the safety equipment (See Table 3-14).

Table 3-14. Summary of Exploratory Factor Analysis for Attitudes about Instructors

	Factor Loadings	
Item	Visible Safety Leadership	Effectiveness of Equipment
In my college the instructor acts quickly to correct safety problems	**.69**	.07
Corrective action is always taken when the college is told about unsafe practices	**.71**	.13
In my college instructors pay serious attention to the safety of students	**.56**	-.15
Instructors and supervisors express concern if safety procedures are not adhered to	**.63**	-.07
The college clearly considers the safety of students of great importance	**.48**	-.26
Instructors sometimes turn a blind eye to people who are not observing the health and safety procedures	.16	**-.49**
Our college supplies enough safety equipment	.30	**-.43**

Our college checks equipment to make sure it is free of faults	**.43**	.01
Sometimes conditions here hinder my ability to work safely	-.12	**-.80**
I cannot always get the equipment I need to do the task safely	-.03	**-.81**
Eigenvalues	3.73	1.58
% of variance	37.25	15.76

Note: Factor loadings over .40 appear in bold.

3.2.3.3.5 Attitudes about fellow students. For attitudes about fellow students, a two-factor model appeared to best fit to the data. The factors loaded cleanly on one factor and none of these items cross-load on any other factor. All factors exceeded the cut-off of .40. Overall, there were two factors within the attitudes about fellow students subscale, consisting of: looking out for fellow students and peer support (See Table 3-15).

Table 3-15. Summary of Exploratory Factor Analysis for Attitudes about Fellow Students

	Factor Loadings	
Item	Looking out for Fellow Students	Peer Support
I am encouraged by my fellow students to report any safety concerns I may have	.23	.30
Students take no responsibility for each other's safety	-.11	**.59**
I ask my fellow students to stop work which I believe is performed in an unsafe manner	**.59**	.11
My fellow students look out for my safety	.17	**.57**
When I see a fellow student working at-risk I caution him or her	**.81**	-.08
In my college there is significant peer pressure to discourage unsafe practices	.30	.01
Students and instructors accept safety violations as long as there are no accidents	.03	.24
Eigenvalues	2.33	1.09
% of variance	33.25	15.52

Note: Factor loadings over .40 appear in bold.

3.2.3.3.6 Own reflections about safety. For one's own reflections about safety subscale a two-factor model appeared to best fit to the data. Most of the factors loaded cleanly on one factor and none of these items cross-load on any other factor. However, two items did not meet the .40 cut-off. Overall, there were two factors within the own safety reflections subscale, consisting of: valuing safety as a priority and job hindrances (See Table 3-16).

Table 3-16. Summary of Exploratory Factor Analysis for Reflections on Own Safety Attitudes

	Factor Loadings

Item	Valuing Safety as a Priority	Job Hindrances
I tend to take more risks in my tasks when instructor's aren't present	**.41**	.13
If I make a mistake that has significant consequences and nobody notices I do not tell anyone about it	**.57**	.04
I believe the most important part of competing a task is being safe	**.53**	.08
I believe that safety issues are not assigned a high priority in my college	.23	.37
I do not skip any safety step even to increase work efficiency	**.59**	.08
I cannot avoid taking risks in my college	-.01	**.69**
I believe some tasks here are difficult to do safely	.01	**.79**
I pride myself on my ability to work safely	**.70**	-.10
I hope to be known as a safe worker	**.69**	-.05
I only get involved in safety activities because I'm required to do so	**.46**	-.20
When people ignore safety procedures here I feel it is none of my business	**.60**	.11
I practice the safety attitudes and behaviors I have learned in the College of Engineering in other contexts (i.e., home, work)	.35	.19
Eigenvalues	3.85	1.62
% of variance	32.09	13.48

Note: Factor loadings over .40 appear in bold.

Figure 3-1 displays the means and standard deviations of the safety subscales identified by the exploratory factor analysis (EFA).

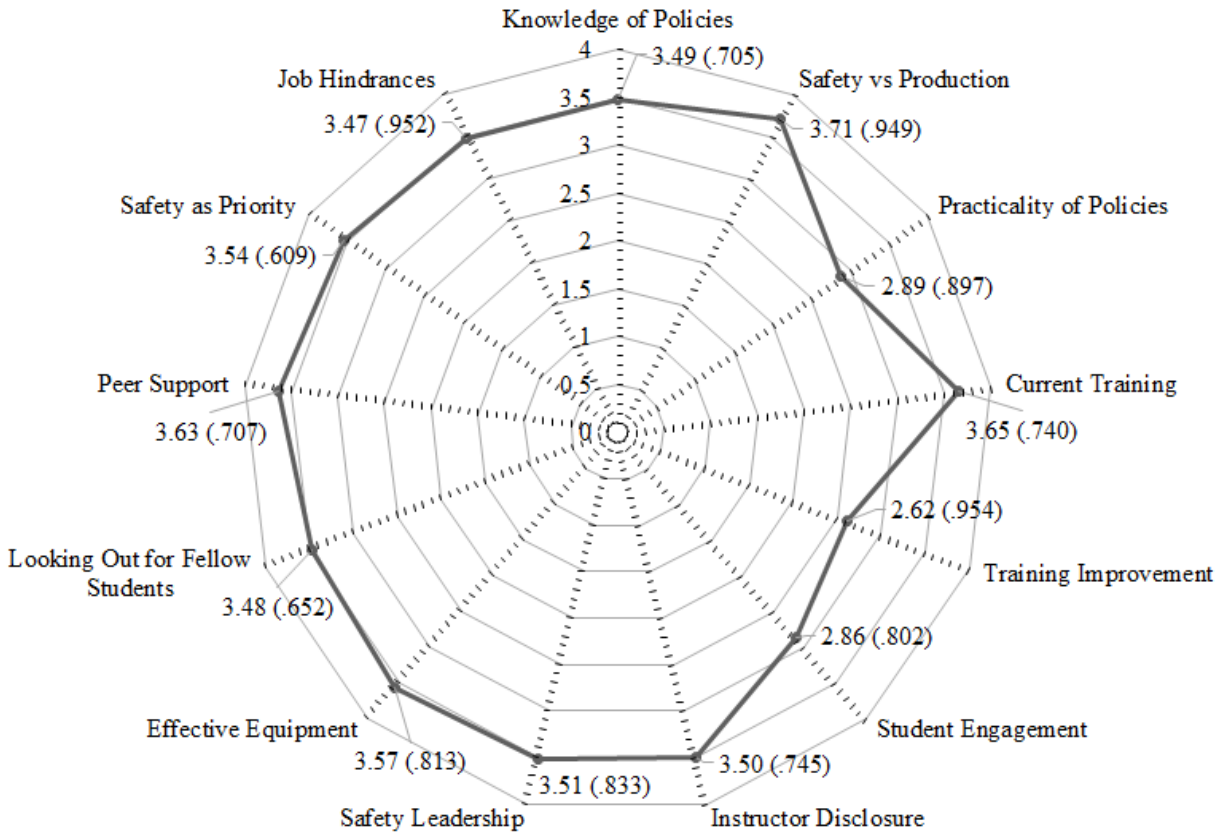


Figure 1-1. Means and Standard Deviations for Safety Subscales Identified by EFA

As can be seen from Figure 3-1, safety scores are highest for Safety versus Production, Current Training, Peer Support, and Effectiveness of Equipment. Safety scores were lowest for Practicality of Policies, Training Improvement, and Student Engagement.

Overall, the exploratory factor analysis found clear and easily interpretable factors for four out of six of the subscales. Safety communication had several items that double loaded or did not meet the .40 cut-off. The own reflections about safety subscale also had two items that did not meet the .40 cut-off. Consequently, a shortened version of the scale was created that only included items with high factor loadings.

3.2.3.4 Shortened version of scale. The dimensions identified by the EFA were used to form a shortened version of the Saskatchewan Safety Climate Questionnaire. Using the EFA factor loadings a conservative shortened scale was created and a cut-off of .60 was used, as

factor loadings of .60 or higher are considered strong (Cabrera-Nguyen, 2010). The shortened version of the scale included 27 items and can be viewed in Appendix S.

Following this, the 27 item scale was compared to the 62 item scale to determine its effectiveness. Firstly, the shortened scale had a Cronbach's alpha of .861. While the internal consistency of the scale was not as high as the 62 items scale, it was still adequate.

Next, both the 62 item scale and the 27 item scale were correlated with participants' gender, year of study, discipline, previous work experience, and experience with injuries. The results are displayed in Table 3-17, which demonstrates that the 62 item scale and the 27 item scale are highly correlated with one another at .951, and the correlations for both the 62 item scale and the 27 item scale with the other variables are in the same direction and display the same significance levels.

Finally, an independent samples *t*-test was conducted with both the 62 item scale and the 27 item scale, comparing these scales to previous work experience and experience with injuries. For participants' previous work experience, both the 27 item scale (p = .040) and the 62 item scale (p = .027) demonstrated similar significance values.

For participants' experience with injuries, both the 27 item scale and the 62 item scale demonstrated similar significance values. For the 62 item scale, the independent samples *t*-test found that there was a significant relationship between safety climate and experiencing injuries, $t(256) = 2.24$, p = .026, d = .295, in which individuals with no injury experience (M = 3.37, SD = .447) reported higher safety climate scores, compared to individuals with injury experience (M = 3.24, SD = .448). For the 27 item scale, the independent samples *t*-test found that there was a significant relationship between safety climate and experiencing injuries, $t(256) = 2.38$, p = .018, d = .315, as individuals with no injury experience (M = 3.52, SD = .489) reported higher safety climate scores, compared to individuals with injury experience (M = 3.37, SD = .477).

Table 3-17. Correlation Results for 62 item and 27 item scales

		62 item scale	27 item scale	Gender	Discipline	Work Experience	Experience Injuries
62 item scale	Pearson Correlation	1	.951**	-.004	-.045	.138*	-.139*
27 item scale	Pearson Correlation	.951**	1	.021	-.053	.128*	-.147*

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level

In sum, the shortened version of the Safety Climate Questionnaire consists of 27 items and has demonstrated adequate reliability, high correlation with the 62-item scale, and results that are in the expected directions and of similar significance levels as those found with the 62-item measure. As such, the 27-item measure may be a more efficient version of the original Saskatchewan Safety Climate Questionnaire.

3.2.3.5 Validity analysis. Validity refers to the degree that a scale measures what it is intending to measure (Tabachnick, Fidell, & Osterlind, 2001). Specifically, construct validity refers to "the extent to which any test measures the underlying hypothetical qualities or factors of whatever it is intended to measure" (Corsini, 2002, p. 213). Convergent validity is a subset of construct validity that demonstrates that the results of a scale are consistent with theory.

This results of this study suggest that the Saskatchewan Safety Climate Questionnaire has adequate convergent construct validity for this sample population, as the results of the study are in the predicted direction and in line with current theory on safety climate. A high safety climate score should be related to lower incidences of injuries and accidents (Smith, Huang, Ho, & Chen, 2006). As such, it was predicted that students in the College of Engineering with high safety climate scores would also be less likely to experience or witness injuries and near misses. This prediction was confirmed and in the predicted direction.

Furthermore, several measures were taken to ensure that the Safety Climate Questionnaire was valid. Firstly, a pool of 247 items were compiled and analyzed based on their congruence with the developed safety climate theoretical definition (Appendix J). Only items that had been previously assessed by other researchers and found to have adequate reliability and validity were included in the questionnaire. Furthermore, the items were assessed by two experts in the field, safety and engineering, to ensure they were applicable to the population under study. Finally, the questionnaire was piloted on a sample of engineering students in order to obtain feedback and further assess the applicability of the questionnaire.

Further evidence towards the preliminary validation of the Safety Climate Questionnaire was demonstrated through the exploratory factor analysis and item analysis of the questionnaire. These psychometric analyses ensure that problematic items are identified and the dimensionality of the scale is acceptable. Any issues that are identified in the Safety Climate Questionnaire were remedied in the shortened version of the scale.

3.2.4 Answering Research Questions about Climate in the College

After developing and analyzing the quality of the developed questionnaire, the same data was then used to describe and analyze the safety climate that exists in the College of Engineering. The results are then further expanded upon in the discussion section. For analyses where a Multivariate Analysis of Variance (MANOVA) was conducted, diagnostic tests were also conducted. Multivariate analysis of variance is used to assess if a combination of multiple dependent variables varies as a function of the independent variable or treatment variable. Conducting one MANOVA, rather than multiple ANOVAs, reduces the risk of Type I errors (Tabachnick, Fidell, & Osterlind, 2001). Diagnostics were conducted to ensure the data were suitable for multivariate analysis of variance. Firstly, there was no multicollinearity, as correlations between subscales were within acceptable ranges, below .80 (Tabachnick, Fidell, & Osterlind, 2001). Furthermore, mahalanobis distance was calculated for each case. Seven cases exceeded the critical chi-square values of 16.81 and were removed. The 42 scores lost in the administration error were also removed from the analysis by default when the values that exceeded chi-square's critical value were removed. Analyses were conducted both with and without the 42 cases removed and the significant findings were not affected by the removal of these cases.

3.2.4.1 Significant difference between subscales. In order to answer research question two and determine whether significant differences were present between the safety climate subscales a paired samples *t*-test was conducted. The safety subscale with the highest mean score was compared to the safety subscale with the lowest mean score to determine if they were significantly different from one another. Table 3-18 displays the sample size, mean, and standard deviation for each subscale.

Table 3-18. Mean and Standard Deviation of Safety Subscales

Safety Climate Subscales	N	Mean	Standard Deviation
Safety Policies	258	3.35	.601
Safety Training	258	3.31	.657
Safety Communication	258	2.83	.532
Attitudes about Instructors	258	3.54	.699
Attitudes about Fellow Students	258	3.45	.528
Reflections on One's Own Safety Attitudes	215	3.54	.548

Reflections on one's own safety attitudes (M = 3.54, SD = .548) was compared to safety communication (M = 2.83, SD = .532). There was a significant difference between own safety attitudes and safety communication, $t(214) = 16.046$, $p = .001$, $d = 1.31$. Following this, reflections on one's own safety attitudes was compared to the subscale with the next lowest mean, safety training (M = 3.31, SD = .657). There was a significant difference between own safety attitudes and safety training, $t(214) = 4.860$, $p = .001$, $d = .385$. Next, reflections on one's own safety attitudes was compared to the next smallest subscale, safety policies (M = 3.35, SD = .601). There was a significant difference between own safety attitudes and safety policies, $t(214) = 4.490$, $p = .001$, $d = .289$. Next, reflections on one's own safety attitudes was compared to the next smallest subscale, attitudes about fellow students (M = 3.45, SD = .528). There was a significant difference between own safety attitudes and attitudes about fellow students, $t(214) = 2.636$, $p = .009$, $d = .162$. Finally, reflections on one's own safety attitudes was compared with attitudes about instructors (M = 3.54, SD = .699). There was no significant difference between own safety attitudes and safety policies, $t(214) = .023$, $p = .982$, $d = .002$.

Overall, the safety subscales are significantly different from one another. Figure 3-2 displays a profile diagram of the means for the safety climate subscales. As the figure illustrates, attitudes about instructors and own safety reflections have the highest safety score. Attitudes about fellow students has the next highest safety score, followed by safety policies. The safety training subscale and the safety communication subscale have the lowest safety scores and may require the most improvement.

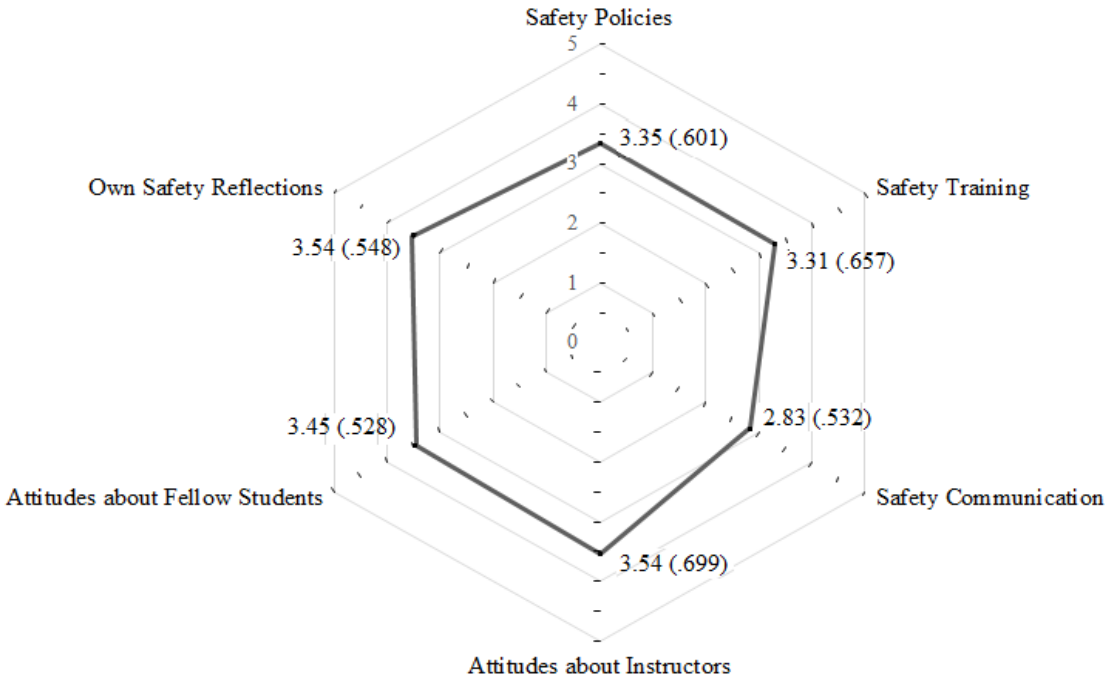


Figure 3-2. The Level and Structure of Safety Climate in the College of Engineering

3.2.4.2 Gender. A one-way MANOVA was performed with six dependent variables: safety policies, safety training, safety communication, instructor attitudes, fellow students' attitudes, and own safety reflections. The independent variable was gender (male or female). Box's M test was statistically non-significant, suggesting that the assumptions of equality of variance-covariance was not violated, $F = .630$, $p = .900$. Pillai's Trace criterion did not reveal a multivariate effect for the categorical variable of gender, $V = .037$, $F(6, 201) = 1.30$, $p = .260$, $\eta^2 = .037$. Consequently, participants' gender was not related to the safety climate subscales and further testing via discriminant analysis was not performed.

3.2.4.3 Year of study. A one-way MANOVA was performed with six dependent variables: safety policies, safety training, safety communication, instructor attitudes, fellow students' attitudes, and own safety reflections. The independent variable was year of study, which had three levels: third year, fourth year, and fifth year or above. Box's M test was statistically non-significant, suggesting that the assumptions of equality of variance-covariance was not violated, $F = .863$, $p = .641$. With the use of Pillai's Trace, the combined dependant variables were not significantly affected by year of study, $V = .064$, $F(12, 402) = 1.10$, $p = .358$, $\eta^2 = .032$. Consequently, participants' year of study was not related to the safety climate subscales and further testing via discriminant analysis was not performed.

3.2.4.4 Discipline. A one-way MANOVA was performed with six dependent variables: safety policies, safety training, safety communication, instructor attitudes, fellow students' attitudes, and own safety reflections. The independent variable was participant's discipline, which had eight levels: chemical and biological engineering, civil engineering, geological engineering, environmental engineering, electrical engineering, computer engineering, engineering physics, and mechanical engineering. Box's M test was statistically non-significant, suggesting that the assumptions of equality of variance-covariance was not violated, $F = 1.078$, $p = .261$. With the use of Pillai's Trace, the combined dependant variables were not significantly affected by discipline, $V = .250$, $F(42, 200) = 1.24$, $p = .140$, $\eta^2 = .042$. Consequently, participants' discipline was not related to the safety climate subscales and further testing via discriminant analysis was not performed.

However, while discipline was not related to the safety subscales, a one-way ANOVA found a relationship between the safety climate score and participants' discipline. There was homogeneity of variance as assessed by Levene's Test for Equality of Variances ($p = .799$) and a statistically significant difference between the participants' discipline and the overall safety climate score, $F(7,250) = 2.061$, $p = .048$, $\eta^2 = .055$. Comparison testing with Tukey could not be conducted as the sample size was too small for some of the sub-disciplines. Descriptive analysis indicates that participants in the Chemical and Biological Engineering discipline had the highest safety climate score (M = 3.46, SD = .412), while participants in the Environmental (M = 3.14, SD = .437) and Computer Engineering (M = 3.19, SD = .330) had the lowest safety climate scores.

3.2.4.5 Previous work experience. Box's M test was statistically non-significant, suggesting that the assumptions of equality of variance-covariance was not violated, $F = 1.151$, $p = .285$. A one-way MANOVA was performed on six dependent variables: safety policies, safety training, safety communication, attitudes about instructors, attitudes about fellow students, and reflections on one's own safety attitudes. The independent variable was previous work experience (i.e., experience or no experience). Pillai's Trace criterion did not reveal a multivariate effect for the categorical variable of previous work experience, $V = .059$, $F(6, 201) = 2.10$, $p = .055$, $\eta^2 = .059$. Consequently, participants' previous work experience was not related to the safety climate subscales and further testing via discriminant analysis was not performed.

However, an independent samples *t*-test was conducted comparing previous work experience to the overall safety climate score. Previous work experience (i.e., experience or no experience) was the grouping variable, while the safety climate score was the dependent variable. Levene's test was non-significant ($F = .206$, $p = .650$), suggesting that homogeneity of variance was not violated. The independent samples *t*-test found that there was a significant relationship between safety climate and previous work experience, $t(256) = -2.22$, $p = .027$, $d = .328$, as individuals with no previous work experience ($M = 3.44$, $SD = .415$) reported higher safety climate scores, compared to individuals with previous work experience ($M = 3.29$, $SD = .457$).

3.2.4.6 Experiences with near misses and injuries. Box's M test was statistically non-significant, suggesting that the assumptions of equality of variance-covariance was not violated, $F = 1.149$, $p = .287$. A one-way MANOVA was performed on six dependent variables: safety policies, safety training, safety communication, attitudes about instructors, attitudes about fellow students, and reflections on one's own safety attitudes. The independent variable was experience of injuries (i.e., experience or no experience). Experience of injuries included near misses, minor injuries, and major injuries. Pillai's Trace criterion revealed a multivariate effect for the categorical variable of injury experience, $V = .064$, $F(6, 201) = 2.29$, $p = .036$, $\eta^2 = .064$. To investigate this multivariate effect, a discriminant analysis was conducted.

For the discriminant analysis, seven cases that exceeded the critical chi-square values of 16.81 were removed. The grouping variable was "experiencing injuries" and the independent variables were safety policies, safety training, safety communication, attitudes about instructors, attitudes about fellow students, and reflections on one's own safety attitudes.

The canonical correlation was .253; thus, 6.4% of the variance in whether one does or does not experience injuries could be accounted for by the safety climate subscales. Inspection of the structure matrix revealed that four dimensions of the safety climate scale appeared to correlate substantially with experience with injuries. Specifically, safety training exceeded the .30 threshold at .857, attitudes about instructors at .615, safety policies at .555, and attitudes about fellow students at .408. The other dimensions, reflections on one's own attitudes and safety communication, did not meet the .30 threshold. The mean group centroid for experiencing injuries was -.343, whereas the mean group centroid for no experience with injuries was .198. As such, those who had experienced injuries reported lower safety climate scores in comparison to

those who did not experience injuries. Classification results indicated that, of the 132 participants who had not experienced an injury, 120 could be classified correctly on the basis of a linear combination of the six safety dimensions (a "hit" rate of 90.9%). Of the 76 participants who had experienced an injury, 17 could be classified accurately (a "hit" rate of 22.4%). Thus, the model is more accurate at classifying students who have not experienced an injury compared to those who have.

In sum, the combined effect of the safety training, attitudes about instructors, safety policies, and attitudes about fellow students' subscales were related to participants' injuries and near miss experience. Participants with high scores on these subscales were more likely to have fewer experiences with injuries and near misses, compared to participants with low scores on these subscales.

3.2.4.7 Witnessing near misses and injuries. Box's M test was statistically non-significant, suggesting that the assumptions of equality of variance-covariance was not violated, $F = .877$, $p = .622$. A one-way MANOVA was performed on six dependent variables: safety policies, safety training, safety communication, attitudes about instructors, attitudes about fellow students, and reflections on one's own safety attitudes. The independent variable was witnessing injuries (witnessed or not witnessed). Witnessing injuries included near misses, minor injuries, major injuries, and fatalities. Pillai's Trace criterion revealed a multivariate effect for the categorical variable witnessing injuries, $V = .131$, $F(6, 201) = 5.03$, $p = .001$, $\eta^2 = .131$. To investigate this multivariate effect, a discriminant analysis was conducted.

For the discriminant analysis, the grouping variable was witnessing injuries and the independent variables were safety policies, safety training, safety communication, attitudes about instructors, attitudes about fellow students, and reflections on one's own safety attitudes. The canonical correlation was .361; thus, 13.0% of the variance in whether one has or has not witness an injury could be accounted for by the safety climate subscales. Inspection of the structure matrix revealed that four dimensions of the safety climate scale appeared to correlate substantially with witnessing injuries. Specifically, safety training exceeded the .30 threshold at .847, attitudes about instructors at .592, safety policies at .455, and own safety reflections at .349. The other dimensions, safety communication and attitudes about fellow students, did not meet the .30 threshold. The mean group centroid for witnessing injuries was -.334, whereas the mean group centroid for not witnessing injuries was .446. As such, those who had witnessed

injuries reported lower safety climate scores in comparison to those who did not witness injuries. Classification results indicated that, of the 89 participants who had not witnessed an injury, 47 could be classified correctly on the basis of a linear combination of the six safety dimensions (a "hit" rate of 52.8%). Of the 119 participants who had witnessed an injury, 93 could be classified accurately (a "hit" rate of 78.2%). Thus, the model is more accurate at classifying individuals who had witnessed an injury, compared to those who had not.

In sum, the combined effect of the safety training, attitudes about instructors, safety policies, and own safety reflections subscales were significantly related to whether participants' witnessed injuries or near misses. Participants with high scores on these subscales were more likely to have witnessed fewer injuries and near misses, compared to participants with low scores on these subscales.

3.2.4.8 Concluding statement. Overall, gender and year of study were not related to the safety climate score or the subscales. Participants' discipline was not related to the safety subscales, but it was related to the safety climate score, as participants in the Chemical and Biological Engineering discipline had the highest safety climate scores, while participants in the Environmental and Computer Engineering discipline had the lowest safety climate scores. Additionally, participants' previous work experience was not related to the safety subscales, but it was related to the safety climate score, as participants with no previous work experience reported higher safety climate scores, compared to individuals with previous work experience. There was a significant relationship between the safety subscales and participants' experiences with near misses and injuries and whether they had witnessed a near miss or injury. Participants with high scores on the safety training, attitudes about instructors, safety policies, and attitudes about fellow students were more likely to have fewer experiences with injuries and near misses, compared to participants with low scores on these subscales. Participants who had witnessed fewer injuries and near misses were more likely to report high scores on safety training, attitudes about instructors, safety policies, and own safety reflections subscales, compared to participants who had witnessed more injuries and near misses.

3.2.5 Analysis of Students' Comments

Comments from participants were analyzed separately based on subscale and common themes were identified. Overall, students in the College of Engineering view safety in the College in a variety of ways. Some students suggest that they are dissatisfied with the current

safety practices and would like to see them improved. Conversely, other students indicate that their work requires very little high risk behavior and that further emphasis on safety would be unnecessary. Each subscale was analyzed for themes separately.

3.2.5.1 Safety policies. There were five themes identified from the 47 comments on safety policies (See Table 3-19). For the first theme, fifteen participants stated that safety policies in the College of Engineering are explained to students and students are familiar with the safety policies and procedures in the College. Fifteen participants stated that students are not aware of the safety policies and procedures in the College. Seven participants stated that students do not always follow the safety policies even if they are aware of them, due to time constraints or poor safety equipment. Finally, five participants stated that they were disappointed in the safety policies in the College and five participants claimed they would like safety policies to be more accessible to students and to be taught in class.

Table 3-19. Safety Policies Classified by Theme

Theme	Number of Participants/ Theme	Additional Comments
Safety policies are explained and known to students	15	-Labs explain safety procedures well -There is a safety handbook -Logic of safety policies makes sense -Safety days and lab manual are all that is needed
Students are not aware of safety policies or procedures	15	-Certain policies are not clearly communicated -Don't have much experience with safety procedures -The safety procedures do not pertain to me/my discipline
Students do not follow safety policies even if they know them	7	-Students won't leave during fire drill unless told -Busy labs can cause negligence (sometimes safety is sacrificed a little) -Certain safety procedures would be easier to follow if equipment (i.e., safety glasses) were in better condition
I am disappointed in the policies	5	-College's safety procedures often feels shallow -Seems more concerned with legal matters than personal safety -A lot of safety procedures are overrated/certain safety procedures are not necessary
I would like safety policies to be taught more	5	-Only get safety days and we may forget -Should be taught every year -Policies should be documented so they everyone has access to them -Procedures in the Hardy lab are not as clearly presented -More drills would be nice

3.2.5.2 Safety training. There were six themes identified from the 46 comments on safety training (See Table 3-20). The first theme was identified by 17 participants who claimed that the current safety training was adequate and/or they did not want additional training. The second theme was also identified by 17 participants who claimed that they wanted additional safety training. Fourteen participants stated that they had not received enough safety training. Additionally, 3 participants stated that they found Safety Days very effective and helpful, while another 3 claimed that Safety Days was not effective, primarily because they wanted more hands-on practice or they forgot the information they had learned at Safety Days. The last theme was identified by 2 participants who stated that safety training practices are not always enforced in labs or hands-on practice.

Table 3-20. Safety Training Classified by Theme

Theme	Number of Participants/ Theme	Additional Comments
Current safety training is fine/Do not want more safety training	17	-Don't need more training because we are not doing anything dangerous -TA's are clear on safety issues -WHMIS is enough training -More training is not needed as it is impractical and not taken seriously -Common sense is enough -Safety training can be annoying
Need/Want additional safety training	17	-Would enjoy more training, as it's helpful to apply what is learned -Need more refreshers and hands-on training -More training for machinery and shop -Hatch and Hardy lab need more training -We only receive brief safety talks before labs -Not allowed to operate equipment due to hazards, want to be taught how to safety handle it because they will need to in industry -TA's do not take safety training seriously
I have not received much training	14	-Most cite Safety Days or WHMIS as the only training they receive -Expected to read safety manual during own time, not covered in class -CPR and First Aid are not offered -Have only received safety training on trivial tasks
Found Safety Days effective	3	-Would like Safety Days for upper years

Did not find Safety Days effective	3	-Need more practical lab safety -Forgot a lot of information from Safety Days
Safety training lessons are not enforced	2	-Lab does not always have proper safety procedures

3.2.5.3 Safety communication. There were seven themes identified by the 31 comments on safety communication (See Table 3-21). The first theme was that safety was not discussed or communicated much, which was identified by 8 participants. The second theme was that safety procedures were discussed an adequate amount and that incidents were reported, which was identified by 7 participants. Conversely, four participants stated that incidents are not discussed and they sometimes go unreported. The fourth theme was that safety procedures and communication is not needed because students are not doing anything high risk, which was identified by four participants. Two participants claimed that students are not recognized for acting safely, two participants would like safety discussed more frequently, and two participants were unfamiliar with their College's approach to safety communication.

Table 3-21. Safety Communication Classified by Theme

Theme	Number of Participants/ Theme	Additional Comments
Safety is not discussed much	8	-Talked about only at start of labs or Safety Days -TA's discuss more than Instructors -TA's set a bad example -Only discussed in Ethics class -Safety not discussed for shop work -Students are not told about incidents until after they occur
Incidents/Safety procedures are reported and/or discussed	7	-Never witnessed an incident -Instructors are brief as the students already know what they are doing -Students are encouraged to come forward
Incidents go unreported	4	-Don't want to "rat" out fellow students -Rules are not known by students -Accidents that occur are never discussed
Safety measures are not needed	4	-Safety measures/communication are not needed during the 3 hour labs -Labs are not dangerous
Students are not recognized for acting safely	2	-Notice is only taken when they are acting unsafely -Should not be the professor's job to praise students

Would like safety discussed more	2	-Monthly safety bulletins and emails with safety statistics would be nice -More class discussion on safety would be nice (5mins/week) -Make standard policies available through PAWS so student have access
Unfamiliar with College's approach to safety communication	2	

3.2.5.4 Students' attitudes about instructors. There were four themes that were identified based on the 25 comments on instructor attitudes (See Table 3-22). The first theme, which was identified by 10 participants, was that safety equipment was not always adequate and that the College should supply better safety equipment. The second theme was that instructors display a good safety example and that equipment was always available, which was identified by 6 participants. The next theme, identified by 6 participants, was that instructors do not always show a good example or they may not say anything if a student is being unsafe. The final theme was that safety was not considered an issues because nothing was high-risk; this was identified by 3 participants.

Table 3-22. Attitudes about Instructors Classified by Theme

Theme	Number of Participants/ Theme	Additional Comments
College should supply safety equipment/Equipment is not always adequate	10	-Having enough money to buy safety gear should not be a barrier to being safe in the labs -Would like more safety glasses (sometimes they are stolen) -Basic PPE is not always available -Metallurgy lab needs another apron -Equipment is not cleaned, so it is unpleasant to wear -Gloves are worn out, glasses are scratched, ear muffs can spread lice and disease
Instructors show good safety example/Equipment is good	6	-It's great -Safety gear is never missing from labs -Instructors take safety into consideration, even for small tasks TAs point out unsafe practices

Instructors sometimes do not show good safety actions	6	-Instructors don't always tell us how to be safe -Instructors sometimes show bad examples -Instructors were more watchful in first year -Most students do not know where the AED is -Students do not have access to inspection reports (they don't know if they are doing a good job) -Safety communications are usually handled through e-mails, not in-class by instructors
Safety is not an issue because we don't do anything high risk	3	

3.2.5.5 Fellow students' attitudes. There were four themes identified by the 16 comments about fellow students' attitudes (See Table 3-23). The first theme, identified by 7 participants, was that students help each other to be safe and look out for one another. The second theme was the safety was not an issues since practices were not high-risk, which was identified by 5 participants. The next theme was that students do not say anything when others are being unsafe, which was identified by 2 participants. The final theme was that students do not participate in safety, which was identified by one participant.

Table 3-23. Attitudes about Fellow Students Classified by Theme

Theme	Number of Participants/ Theme	Additional Comments
Students help each other to be safe	7	-Tell others to put safety glasses back on Say something if it is a major violation
Safety is not an issue because we don't do anything high risk	5	
Students do not step in when others are unsafe	2	-A lot of safety infractions during unsupervised work -Do not say anything if it is minor
Students do not participate in safety much	1	-College needs to entice students to be safe

3.2.5.6 Students' own reflections on safety. There were four themes identified by the 18 comments on students' own reflections on safety (See Table 3-24). The first theme was that training and experiences in industry were more helpful than what the college offers, which was identified by 6 participants. Five participants stated that safety is not an issue because tasks are

not high-risk. Three participants stated that safety in the College could be improved. And the final theme was that students value safety, which was identified by 2 participants.

Table 3-24. Students Own Reflections Classified by Theme

Theme	Number of Participants/ Theme	Additional Comments
The safety training/experiences I have had in industry are more useful than what the College teaches	6	-Safety needs to be better communicated in the College and needs to be incorporated into all courses and labs -I learned very strong safety practices in Industry -The only safety training I received was in the workplace
There are no safety risks in my discipline	5	-Common sense is all that is needed
Safety in the College could be improved	3	-Safety is only preached due to liability, not well-being of students -Do not learned much about safety procedures
Students value safety	2	-Safety is important both inside and outside the College

In sum, there were a multitude of positive comments regarding the College's current safety climate. There was a total of 74 comments highlighting positive safety perceptions, such as, students are familiar with their College's safety polices, students receive adequate safety training, students found Safety Days effective, incidents are frequently reported and discussed, instructors model safe behavior, proper safety equipment is provided, students value safety, and that further safety measures are not needed as students discipline does not involve them with dangerous work.

However, there were also 114 contradictory comments that suggested that there are areas in need of improvement within the College. Some of these areas of improvement include that students are unaware of their College's safety policies, that these safety policies are not always followed even when they are known, that students have not received enough safety training and they want additional safety training, that safety is not often discussed and sometimes incidents go unreported, that students are not encouraged when they work safely, that safety equipment is not always available or useable, that some instructors do not model safe behavior, that students do not always participate in safety activities, and that some students report that the safety experience they had within industry was more useful that what the College provides. Also, it should be noted that these comments are not all from individual students, as many students commented in more than one category.

3.3 Discussion

3.3.1 Psychometric Properties of Scale. The psychometric properties of the Safety Climate Questionnaire appear to be adequate. Firstly, the overall safety climate scale had an alpha of .92, which exceeds the recommended guidelines. Two of the subscales were below the recommended cut-off of .70. The item analysis revealed that if items two, four, and five were removed from the safety communication subscale Cronbach's alpha would exceed .70. The attitudes about fellow students subscale also had a low alpha, but removal of any of the items did not result in an alpha that exceeded .70, suggesting that the lower alpha was not due to inappropriate use of items. Coupled with the fact that the overall safety climate alpha was .92, this suggests that the internal consistency of the Safety Climate Questionnaire is adequate.

In general, the dimensionality of the Safety Climate Questionnaire was adequate. The safety policies subscale was the only subscale with three factors, as all other subscales had two factors. The safety communication dimensionality was not easily interpretable, as one item loaded on two factors and four items did not meet the .40 cut-off. Additionally, on the own reflections about safety subscale, two items did not meet the .40 cut-off. All other subscales reported easily interpretable factors that did not cross load. The factors identified in the exploratory factor analysis were consistent the common safety climate factors found in the literature.

For safety policies, the identified factors consisted of (1) the students skills, knowledge, and adherence to safety policies and procedures; (2) the practicality of the policies and procedures within the College; and, (3) the priority placed on safety versus production (Flin, Mearns, O'Connor, & Bryden, 2000; Wang & Lin, 2012). For safety training, the identified factors consisted of (1) the current safety training effectiveness, and (2) improvements to future safety training (Flin, Mearns, O'Connor, & Bryden, 2000). For safety communication, the identified factors consisted of (1) students safety engagement and reporting, and (2) the instructors' disclosure of safety information to students (Bentley & Tappin, 2010; Wamuziri, 2013). For attitudes about instructors, the identified factors consisted of (1) visible safety leadership, and (2) the quality and availability of safety equipment (Wamuziri, 2013; Wang & Liu, 2012). For attitudes about fellow students, the identified factors consisted of (1) looking out for fellow students, and (2) peer support (Wu, Lin, & Shiau, 2010; Frazier et al., 2013). For reflections on one's own safety attitudes, the identified factors consisted of (1) valuing safety as

a priority, and (2) job hindrances (Boughaba et al., 2014; Grosch, Gershon, Murphy, & DeJoy, 1999).

A shortened version of the Safety Climate Questionnaire was developed, both for efficiency purposes and to remove any items that may be potentially problematic. Only the most relevant items were included, which also removed any problematic items. The shortened version of the questionnaire consisted of 27 items. It demonstrated adequate internal consistency and was highly correlated with the 62 item version of the scale. Furthermore, when comparing the scales to their relationship with experiencing injuries, the 27 item scale had a stronger effect size than the 62 item scale, which suggests that the shorter scale may be a useful assessment tool. However, further testing of the shortened scale is needed to confirm the scale's usefulness.

Finally, the preliminary results on validation revealed that the safety climate scores were in the predicted direction regarding experiences with injuries and accidents. In this case, participants with lower safety climate scores were also more likely to have experienced or witnessed an injury. This suggests that the safety climate scores are assessing what they intend to measure, as lower safety climate scores should be related to higher injury rates (Wu, Liu, & Lu, 2007).

3.3.2 Safety Climate in the College of Engineering. Firstly, it was found that there were significant differences between the subscales, as participants reported the highest safety climate scores for attitudes about instructors and for reflections on one's own safety attitudes. In conjunction with participants' open-ended responses, for attitudes about instructors, the majority of comments stated that improved safety equipment should be supplied. There were also several comments that not all instructors exhibited a good safety example at all times. However, an equal number of comments stated that instructors displayed a strong safety example and that the safety equipment was always provided. Regarding reflections on one's own safety attitudes, the majority of the comments mentioned that there were few safety risks in their specific engineering discipline. While others states that the students in the College value safety. Several students did state that safety in the College could be improved, particularly as several comments stated that the safety training and procedures in industry were superior to those in the College.

The next highest safety score was attitudes about fellow students, followed by safety policies. Comments regarding attitudes about fellow students focused on how well students helped one another out and that their tasks in the College were not hazardous. A few students

mentioned that other students do not always step in when someone is being unsafe and that students do not participate in safety. For safety policies, an equal number of comments stated that safety policies are familiar to students as well as unfamiliar to students. Additional comments stated that students do not follow policies even when they know them, that students are disappointed with the current policies and procedures, and that they would like additional lectures or instruction on safety policies and procedures.

Safety training was the next highest score, with participants reported the lowest safety climate score for safety communication. For safety training, an equal number of comments stated that students are happy with the current safety training as well as students who would like additional safety training. Several students stated that they have not received very much training in the College and they would like to attend Safety Days beyond second year. For safety communication, the majority of comments stated that safety is not often discussed, that they would like safety discussed more frequently, and that students are not recognized or rewarded for safe behavior. Contradictory comments stated that incidents often go unreported and that safety incidents are usually reported and discussed.

Regarding the relationship between the demographics and the safety climate in the College of Engineering, the results revealed that gender was not related to safety climate or any of its subscales. This finding is contradictory to Strahan, Watson, and Lennon (2008), as they found that gender was significantly related to safety climate, as males had lower safety climate scores than females. However, it is also possible that the sample size for females was too small to find significant results, as only 20% (N = 51) of the sample was female. However, the small effect size suggests that gender is not related to safety climate regardless of sample size. Consequently, this particular population had no differences in safety climate scores for gender. Regardless, future research to determine the relationship between gender and safety climate is needed. Participants' year of study was not significantly related to their safety climate scores; however, the majority of participants were in their 4^{th} year of study, with a few in their 3^{rd} or 5^{th} year. In order to draw more accurate conclusions regarding the relationship between year of study and safety climate, participants from the first to final year of study should be included in the sample.

The safety climate subscales were not significantly related to the participants' discipline in the College. However, the overall safety climate scale was significantly related to discipline.

The results indicated that participants in the Chemical and Biological Engineering discipline had the highest safety climate score, while participants in the Environmental and Computer Engineering had the lowest safety climate scores. Further research is needed to determine why participants' in certain disciplines report higher or lower safety scores.

While the safety climate subscales were not significantly related to previous work experience, the overall safety climate scale was significantly related. The results found that participants who had previous work experience in industry (i.e., mining, construction, etc.) had lower safety climate scores compared to those with no experience. These findings contradict those found in previous studies. Gyekye and Salminen (2010) found that industry workers with more work experience exhibit improved safety perceptions, higher job satisfaction, and lower accident frequency compared to workers with less work experience. These contradictory findings could be due to the fact that the current sample consists of students with very little to no work experience. However, open-ended comments from participants on the questionnaire suggest that students with experience in industry learn more about safety while in industry than they do within the College. As such, students who have been exposed to the stricter safety awareness and training in industry may be more likely to notice potential areas of improvement within the College, which may be why these participants reported a lower safety climate score than students with no previous work experience. Future research is needed to examine this relationship.

Finally, it was found that safety climate was related to experiencing and witnessing injuries or near misses. Specifically, the safety training, attitudes about instructors, safety policies, and attitudes about fellow students' subscales were significantly related to experiencing injuries and near misses. Additionally, safety training, attitudes about instructors, safety policies, and own safety reflections subscales were significantly related to witnessing injuries or near misses. Individuals who had experienced or witnessed more injuries were more likely to have a lower safety climate score. It could be the case that individuals who engage in hazardous behavior experience more injuries and, consequently, report lower safety climate scores. However, this does not account for the participants with lower safety climate scores who *witness* near misses and injuries. As such, it could be the case that individuals who witness or experience more injuries become more safety conscious and notice more areas for safety improvement in the in their environment, which results in them reporting lower safety climate scores (Smith & Dejoy, 2014).

CHAPTER 4
GENERAL DISCUSSION

The current study adds to the current literature by providing a theoretical definition for safety culture and for safety climate that is supported by current literature and a conceptual analysis. The current study also provides operational definitions of these constructs that are consistent with their theoretical definitions. Furthermore, a Safety Climate Questionnaire was developed that is theoretically sound as it is based on the developed theoretical and operational definitions for the safety climate construct. This Safety Climate Questionnaire may be a useful means of examining safety climate in colleges and universities.

4.1.1 Limitations

The first limitation is that this study did not collect survey data from instructors and technical staff, as this limits the objective data that can be used to validate the questionnaire. Additionally, the small sample of females may have limited the chances of finding a statistically significant effect of gender. Another limitation involved the development of the Safety Climate Questionnaire, as only items from assessment tools that could be accessed through PsycINFO were included in the item pool. If the authors wanted payment to access their scale then it was not used and this may have limited the variety of items available in the survey.

The sample size was adequate for the majority of the analysis performed. However a larger sample size across participants' sub-disciplines may have been able to indicate which disciplines exhibited statistically significantly higher or lower safety climate scores compared to other disciplines. Post hoc testing could not be conducted as several disciplines had a low sample size ($n = 9$). Furthermore, the generalizability of the study only extends to students in the College of Engineering at the University of Saskatchewan. The usefulness of the scale within industry is uncertain.

Finally, the assessment tool was only developed for safety climate, as safety culture assesses the deeply held assumptions and implicit beliefs and norms that one follows which is not easily examined through a survey questionnaire that only assesses perceptions (Guldenmund, 2000). Developing an assessment tool for safety culture would involve interviews, focus groups, participant observation, and documents review, as such it was beyond the scope of this study.

4.1.2 Future Directions

Future research should assess whether gender is related to safety climate, or whether this relationship is dependent on the specific population from which the sample is taken. Additionally, future research on the Safety Climate Questionnaire used in this study should assess the validity of the scale. Preliminary validation suggests that the safety climate scores are correlated in the expected direction with injuries and near misses. However, the limited incidence of injuries and accidents within the College does not allow for conclusive findings to be drawn about the validity of the scale. As such, it may also be useful to assess the criterion-related concurrent validity and compare the Safety Climate Questionnaire used in this study to another widely used safety climate scale to ensure they are correlated.

Another area of future research would be to conduct a longitudinal study and assess the safety climate scores before and after the participant has experienced or witnessed an injury or near miss, as this will provide insight into whether the safety climate scores are lower due to engaging in hazardous behavior or due to become more safety conscious. Future longitudinal studies could also examine safety climate scores before and after students receive safety training. Finally, a shortened version of the Safety Climate Questionnaire should be developed in order to make it easier to administer and to remove the items that double loaded or did not meet the cut-off.

Future research is also needed to further understand the relationship between safety climate and gender, discipline, and previous work experience in industry. Additionally, the shortened version of the Safety Climate Questionnaire had demonstrated preliminary applicability; however, the scale still needs to be tested on a sample of participants. Future research should examine this scale to confirm its usefulness, both within the College and within industry to expand the generalizability of the Safety Climate Questionnaire.

Finally, as a survey questionnaire was not an adequate method to assess the safety culture, the current study was unable to determine the safety culture within the College. As such, future research should develop a safety culture assessment tool that incorporates document reviews of safety policies and accident reports, observation of employees to determine the norms within the organization, and interviews with both management and employees.

4.2 Conclusion

Safety culture and safety climate are two very popular and intensively used constructs when studying the non-technological aspects of occupational safety. The current study analyzed these concepts, outlined their structure, provided definitions, and suggested an assessment tool for the safety climate construct. This study substantially clarified the conceptual confusion around these concepts and may serve as a basis for further psychometric and content-based analysis of safety in organizations.

Based on both the classification of aspects and the common consensus within the literature, safety climate seems to be a subcomponent of safety culture, where safety climate includes the surface perceptions of safety culture. Based on the theoretical definition for safety culture, it is evident that this complex construct cannot be assessed through a perception questionnaire. However, the theoretical definition for safety climate formed the basis of the developed Saskatchewan Safety Climate Questionnaire. Overall, the psychometric properties of the Saskatchewan Safety Climate Questionnaire appeared adequate with only a few minor areas of improvement, which were addressed with the shortened version of the scale. It was found that participants with previous work experience in industry reported lower safety climate scores. As well, participants who had experienced or witnessed a near miss or injury reported lower safety climate scores. The developed Saskatchewan Safety Climate Questionnaire may be a useful means of examining safety climate within colleges and universities.

References

Allen, J. A., Baran, B. E., & Scott, C. W. (2010). After-action reviews: A venue for the promotion of safety climate. *Accident Analysis and Prevention, 42*(2), 750-757.

Amirah, N. A., Asma, W. I., Muda, S., & Amin, A. (2013). Operationalisation of safety culture to foster safety and health in the Malaysian manufacturing industries. *Asian Social Science, 9*(7), 283-289.

Barling, J., & Hutchinson, I. (2000). Commitment vs. control-based safetypPractices, safety reputation, and perceived safety climate. *Canadian Journal of Administrative Sciences/Revue Canadienne Des Sciences De L'administration, 17*(1), 76-84.

Bentley, T., & Tappin, D. (2010). Incorporating organisational safety culture within ergonomics practice. *Ergonomics, 53*(10), 1167-1174.

Blegen, M., Sehgal, N., Alldredge, B., Gearhart, S., Auerbach, A., & Wachter, R. (2010). Republished paper: Improving safety culture on adult medical units through multidisciplinary teamwork and communication interventions: the TOPS Project. *Postgraduate medical journal, 86*(1022), 729-733.

Boughaba, A., Hassane, C., & Roukia, O. (2014). Safety culture assessment in petrochemical industry: a comparative study of two Algerian plants. *Safety and health at work, 5*(2), 60-65.

Brown, R., & Holmes, H. (1986). The use of a factor-analytic procedure for assessing the validity of an employee safety climate model. *Accident Analysis & Prevention, 18*(6), 455-470.

Cabrera-Nguyen, P. (2010). Author guidelines for reporting scale development and validation results in the Journal of the Society for Social Work and Research. *Journal of the Society for Social Work and Research, 1*(2), 99-103.

Cabrera, D. D., Isla, R., & Vilela, L. D. (1997). An evaluation of safety climate in ground handling activities. *Aviation safety*, 255-268.

Cappuccio, W. R., Collins Jr, G. E., & Eason, C. A. (1997). Safety Climate Survey. *Edgewood Research Development and Engineering Center*, 2-16

Carroll, J. S. (1998). Safety culture as an ongoing process: Culture surveys as opportunities for enquiry and change. *Work & Stress, 12*(3), 272-284.

Choudhry, R. M., Fang, D., & Mohamed, S. (2007a). Developing a Model of Construction Safety Culture. *Journal of Management in Engineering, 23*(4), 207-212. doi: 10.1061/(ASCE)0742-597X(2007)23:4(207)

Choudhry, R. M., Fang, D., & Mohamed, S. (2007b). The nature of safety culture: A survey of the state-of-the-art. *Safety Science, 45*(10), 993-1012.

Colla, J., Bracken, A., Kinney, L., & Weeks, W. (2005). Measuring patient safety climate: a review of surveys. *Quality and safety in health care, 14*(5), 364-366.

Cooper. (2000). Towards a model of safety culture. *Safety Science, 36*(2), 111-136.

Cooper, M. D., & Phillips, R. A. (2004). Exploratory analysis of the safety climate and safety behavior relationship. *Journal of Safety Research, 35*(5), 497-512.

Corsini, R. (2002). *The Dictionary of Psychology*. New York, NY: Brunner-Routlege.

Cox, & Cheyne, A. (2000). Assessing safety culture in offshore environments. *Safety Science, 34*(1), 111-129.

Cox, & Flin, R. (1998). Safety culture: Philosopher's stone or man of straw? *Work & Stress, 12*(3), 189-201. doi: 10.1080/02678379808256861

Coyle, I. R., Sleeman, S. D., & Adams, N. (1996). Safety climate. *Journal of Safety Research, 26*(4), 247-254.

Craig, B., Das, K. P., & Khago, A. M. S. (2010). Shipboard and shore side perception of safety culture. *IIE Annual Conference Proceedings*, 1-6.

Currie, L., & Watterson, L. (2010). Measuring the safety climate in NHS organisations. *Nursing Standard, 24*(24), 35-38.

de Castro, B. L., Gracia, F. J., Peiró, J. M., Pietrantoni, L., & Hernandez, A. (2013). Testing the validity of the International Atomic Energy Agency (IAEA) safety culture model. *Accident Analysis & Prevention, 60*, 231-244.

Dedobbeleer, N., & Béland, F. (1991). A safety climate measure for construction sites. *Journal of Safety Research, 22*(2), 97-103.

Denison, D. R. (1996). What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. *Academy of management review, 21*(3), 619-654.

Díaz, R. I., & Cabrera, D. D. (1997). Safety climate and attitude as evaluation measures of organizational safety. *Accident Analysis & Prevention, 29*(5), 643-650.

dos Santos Grecco, C. H., Vidal, M. C. R., Cosenza, C. A. N., dos Santos, I. J. A. L., & de Carvalho, P. V. R. (2014). Safety culture assessment: A fuzzy model for improving safety performance in a radioactive installation. *Progress in Nuclear Energy, 70*, 71-83.

Edwards, J. R. D. D. J., & Armstrong, K. (2013). Returning to the roots of culture: A review and re-conceptualization of safety culture. *Safety Science, 55*, 70-80.

Fang, D., & Wu, H. (2013). Development of a safety culture interaction (SCI) model for construction projects. *Safety Science, 57*, 138-149.

Fernandez-Muniz, B., Montes-Peon, J. M., & Vazquez-Ordas, C. J. (2007). Safety culture: Analysis of the causal relationships between its key dimensions. *Journal of Safety Research, 38*(6), 627-641. doi: 10.1016/j.jsr.2007.09.001

Fleming, M. (2007). Developing safety culture measurement tools and techniques based on site audits rather than questionnaires. *Final Project Report, Saint Marys University*, 1-63.

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science, 34*(1), 177-192.

Frazier, C. B., Ludwig, T. D., Whitaker, B., & Roberts, D. S. (2013). A hierarchical factor analysis of a safety culture survey. *Journal of Safety Research, 45*, 15-28.

Fugas, C. S., Silva, S. A., & Meliá, J. L. (2012). Another look at safety climate and safety behavior: Deepening the cognitive and social mediator mechanisms. *Accident Analysis & Prevention, 45*, 468-477.

Geller, E. S. (1994). Ten principles for achieving a total safety culture. *Professional Safety, 39*(9), 18-20.

Glick, W. H. (1985). Conceptualizing and measuring organizational and psychological climate: Pitfalls in multilevel research. *Academy of management review, 10*(3), 601-616.

Grosch, J. W., Gershon, R. R., Murphy, L. R., & DeJoy, D. M. (1999). Safety climate dimensions associated with occupational exposure to blood-borne pathogens in nurses. *American Journal of Industrial Medicine, 36*(s 1), 122-124.

Guldenmund, F. W. (2000). The nature of safety culture: A review of theory and research. *Safety Science, 34*(1–3), 215-257.

Gutierrez, R. & Solutions, D. S. (2012). Why don't people just follow the rules? A psychologist's explanation of safety management beyond behavior based safety. Retreived from

http://www2.dupont.com/sustainable-solutions/en-us/sites/default/files/WhyDontPeopleJustfollowtheRulesv5.pdf

Gyekye, S., & Salminen, S. (2010). Organizational safety climate and work experience. *International journal of occupational safety and ergonomics*, *16*(4), 431-443.

Hair, J. F., Tatham, R. L., Anderson, R. E., & Black, W. (1998) *Multivariate data analysis.* (Fifth Ed.) Prentice-Hall: London.

Hellings, J., Schrooten, W., Klazinga, N., & Vleugels, A. (2007). Challenging patient safety culture: Survey results. *International journal of health care quality assurance, 20*(7), 620-632.

Hinze, J., & Parker, H. W. (1978). Safety: productivity and job pressures. *Journal of the Construction Division, 104*(1), 27-34.

Hon, C. K., Chan, A. P., & Yam, M. C. (2012). Determining safety climate factors in the repair, maintenance, minor alteration, and addition sector of Hong Kong. *Journal of Construction Engineering and Management, 139*(5), 519-528

Hsu, S. H., Lee, C.-C., Wu, M.-C., & Takano, K. (2010). The influence of organizational factors on safety in Taiwanese high-risk industries. *Journal of Loss Prevention in the Process Industries, 23*(5), 646-653.

Huang, Y.-H., Ho, M., Smith, G. S., & Chen, P. Y. (2006). Safety climate and self-reported injury: Assessing the mediating role of employee safety control. *Accident Analysis & Prevention, 38*(3), 425-433.

Jaworowski, Z. (2010). Observations on the Chernobyl disaster and LNT. *Dose-Response, 8*(2), 148-171

Jones, S., Kirchsteiger, C., & Bjerke, W. (1999). The importance of near miss reporting to further improve safety performance. *Journal of Loss Prevention in the process industries, 12*(1), 59-67.

Kennedy, R., & Kirwan, B. (1998). Development of a hazard and operability-based method for identifying safety management vulnerabilities in high risk systems. *Safety Science, 30*(3), 249-274.

Kho, M., Carbone, J., Lucas, J., & Cook, D. (2005). Safety climate survey: Reliability of results from a multicenter ICU survey. *Quality and safety in health care, 14*(4), 273-278.

Landis, J., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159-174.

Lee, & Harrison, K. (2000). Assessing safety culture in nuclear power stations. *Safety Science, 34*(1), 61-97.

Lee, T. (1998). Assessment of safety culture at a nuclear reprocessing plant. *Work & Stress, 12*(3), 217-237.

Mariscal, M. A., Herrero, S. G., & Otero, A. T. (2012). Assessing safety culture in the Spanish nuclear industry through the use of working groups. *Safety Science, 50*(5), 1237-1246.

Mearns, & Flin, R. (1999). Assessing the state of organizational safety—culture or climate? *Current Psychology, 18*(1), 5-17.

Mearns, Whitaker, S. M., & Flin, R. (2003). Safety climate, safety management practice and safety performance in offshore environments. *Safety Science, 41*(8), 641-680.

Mearns, K., Flin, R., Gordon, R., & Fleming, M. (2001). Human and organizational factors in offshore safety. *Work & Stress, 15*(2), 144-160.

Modak, I., Sexton, J. B., Lux, T. R., Helmreich, R. L., & Thomas, E. J. (2007). Measuring safety culture in the ambulatory setting: The safety attitudes questionnaire—ambulatory version. *Journal of General Internal Medicine, 22*(1), 1-5.

Naranjo-Valencia, J. C., Jiménez-Jiménez, D., & Sanz-Valle, R. (2016). Studying the links between organizational culture, innovation, and performance in Spanish companies. *Revista Latinoamericana de Psicología, 48*(1), 30-41.

Nielsen, M. B., Eid, J., Hystad, S. W., Saetrevik, B., & Saus, E.-R. (2013). A brief safety climate inventory for petro-maritime organizations. *Safety Science, 58*, 81-88.

Niskanen, T. (1994). Safety climate in the road administration. *Safety Science, 17*(4), 237-255.

O'Toole, M. (2002). The relationship between employees' perceptions of safety and organizational culture. *Journal of Safety Research, 33*(2), 231-243.

Olive, C., O'Connor, T. M., & Mannan, M. S. (2006). Relationship of safety culture and process safety. *Journal of Hazardous Materials, 130*(1), 133-140.

Ostrom, L., Wilhelmsen, C., & Kaplan, B. (1993). Assessing safety culture. *Nuclear safety, 34*(2), 163-172.

Parker, D., Lawrie, M., & Hudson, P. (2006). A framework for understanding the development of organisational safety culture. *Safety Science, 44*(6), 551-562.

Pidgeon, N. F. (1991). Safety culture and risk management in organizations. *Journal of Cross-Cultural Psychology, 22*(1), 129-140.

Pronovost, P., & Sexton, B. (2005). Assessing safety culture: Guidelines and recommendations. *Quality & Safety in Health Care, 14*(4), 231-233.

Pronovost, P., Weast, B., Rosenstein, B., Sexton, J. B., Holzmueller, C. G., Paine, L., . . . Rubin, H. R. (2005). Implementing and validating a comprehensive unit-based safety program. *Journal of Patient Safety, 1*(1), 33-40.

Reichers, A. E., & Schneider, B. (1990). Climate and culture: An evolution of constructs. *Organizational Climate and Culture, 1*, 5-39.

Rollenhagen, C. (2010). Can focus on safety culture become an excuse for not rethinking design of technology? *Safety Science, 48*(2), 268-278.

Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of extension, 37*(2), 1-5.

Schmid, S. D. (2011). When safe enough is not good enough: Organizing safety at Chernobyl. *Bulletin of the Atomic Scientists, 67*(2), 19-29.

Sexton, J. B., Helmreich, R., Pronovost, P., & Thomas, E. (2003). Safety climate survey. *Boston, MA: Institute for Healthcare Improvement*. Retrieved from http://primaris.org/sites/default/files/resources/Patient%20Safety/safety%20climate%20survey.pdf

Singer, S. J., Gaba, D., Geppert, J., Sinaiko, A., Howard, S., & Park, K. (2003). The culture of safety: Results of an organization-wide survey in 15 California hospitals. *Quality and safety in health care, 12*(2), 112-118.

Siu, O.-l., Phillips, D. R., & Leung, T.-w. (2004). Safety climate and safety performance among construction workers in Hong Kong: The role of psychological strains as mediators. *Accident Analysis & Prevention, 36*(3), 359-366.

Smith, G. S., Huang, Y. H., Ho, M., & Chen, P. Y. (2006). The relationship between safety climate and injury rates across industries: The need to adjust for injury hazards. *Accident Analysis & Prevention, 38*(3), 556-562.

Smith, T. (2015). Operational definitions: When it comes to safety does your company have 'failure to communicate'? Retrieved from http://www.mocalinc.com/uploads/2/7/4/9/2749872/operational_definitions.pdf

Sorra, J. S., & Dyer, N. (2010). Multilevel psychometric properties of the AHRQ hospital survey on patient safety culture. *BMC Health Services Research, 10*(1), 199.

Tabachnick, B. G., Fidell, L. S., & Osterlind, S. J. (2001). *Using multivariate statistics*. Fifth edition. Pearson Education.

Tholen, S. L., Pousette, A., & Torner, M. (2013). Causal relations between psychosocial conditions, safety climate and safety behaviour – A multi-level investigation. *Safety Science, 55*, 62-69.

Turner, B., Pidgeon, N., Blockley, D., & Toft, B. (1989). *Safety culture: its importance in future risk management.* Paper presented at the Position paper for the second World Bank workshop on safety control and risk management, Karlstad, Sweden.

Uttal, B. (1983). The corporate culture vultures. *Fortune, 108*(8), 66-72.

Varma, S. (2006). Preliminary item statistics using point-biserial correlation and p-values. *Educational Data Systems Inc, 16*(7), 1-8.

Varonen, U., & Mattila, M. (2000). The safety climate and its relationship to safety practices, safety of the work environment and occupational accidents in eight wood-processing companies. *Accident Analysis & Prevention, 32*(6), 761-769.

Vredenburgh, A. G. (2002). Organizational safety: Which management practices are most effective in reducing employee injury rates? *Journal of Safety Research, 33*(2), 259-276.

Wamuziri, S. (2013). Factors that influence safety culture in construction. *Proceedings of the Institution of Civil Engineers-Management, Procurement and Law, 166*(5), 219-231.

Wanberg, J., Harper, C., Hallowell, M. R., & Rajendran, S. (2013). Relationship between construction safety and quality performance. *Journal of Construction Engineering and Management, 139*(10), 2-10.

Wang, C. H., & Liu, Y. J. (2012). The dimensions and analysis of safety culture. *Process Safety Progress, 31*(2), 193-194.

Wiegmann, D. A., Zhang, H., Von Thaden, T. L., Sharma, G., & Gibbons, A. M. (2004). Safety culture: An integrative review. *The International Journal of Aviation Psychology, 14*(2), 117-134.

Williamson, A. M., Feyer, A.-M., Cairns, D., & Biancotti, D. (1997). The development of a measure of safety climate: The role of safety perceptions and attitudes. *Safety Science, 25*(1), 15-27.

Worthington, R. L., & Whittaker, T. A. (2006). Scale development research: A content analysis and recommendations for best practices. *The Counseling Psychologist, 34*(6), 806-838.

Wu, T. C., Liu, C. W., & Lu, M. C. (2007). Safety climate in university and college laboratories: Impact of organizational and individual factors. *Journal of Safety Research, 38*(1), 91-102.

Wu, T. C., Lin, C. H., & Shiau, S. Y. (2010). Predicting safety culture: The roles of employer, operations manager and safety professional. *Journal of Safety Research, 41*(5), 423-431.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology, 65*(1), 96-102.

Appendix A: List of Safety Culture Definitions

Safety Culture Definitions

Reference	Definition
Amirah, Asma, Muda, and Amin (2013)	"Safety culture can be viewed as a component of the organizational culture that refers to the individuals, jobs and organizational characteristics that affect employees' health and safety" (p.283)
Carroll (1998)	"[S]afety culture refers to a high value (priority) placed on worker safety and public (nuclear) safety by everyone in every group and at every level of the plant. It also refers to expectations that people will act to preserve and enhance safety, take personal responsibility for safety, and be rewarded consistent with these values" (p. 10)
Choudhry et al. (2007b)	"[S]afety culture could be defined as: the product of individual and group behaviors, attitudes, norms and values, perceptions and thoughts that determine the commitment to, and style and proficiency of, an organization's system and how its personnel act and react in terms of the company's on-going safety performance within construction site environments" (p. 1008)
Cooper (2000)	"[Organizational culture is the] product of multiple goal-directed interactions between people (psychological), jobs (behavioural) and the organisation (situational)" (p. 118) "[Safety culture is] that observable degree of effort with which all organisational members direct their attention and actions towards improving safety on a daily basis" (p. 115) "Safety culture is a sub-facet of organisational culture, which is thought to affect members' attitudes and behaviour in relation to an organisation's ongoing health and safety performance" (p. 111).
Cox and Cheyne (2000)	"Culture in general, and safety culture in particular, is often characterised as an enduring aspect of the organisation with trait-like properties and not easily changed" (p. 114)
Cox and Flin (1998)	"The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organisation's health and safety management" (p. 191)
Craig, Das, and Khago (2010)	"Safety culture is a concept defined at group or higher level and reflects on the shared values among all the . . . organization members [and] . . . is concerned with formal safety issues with an organization (p. 1).
Currie and Watterson (2010)	"The term 'safety culture' refers to the way people commit to a personal responsibility for safety; the way they act to enhance and maintain safety; the way they are willing to learn about safety; and the ways in which they will communicate their concerns about safety" (p. 36).
de Castro, Gracia, Peiró, Pietrantoni, and Hernandez (2013)	"[Safety culture is] that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance" (p. 232)
dos Santos Grecco, Vidal, Cosenza, dos Santos, and de Carvalho (2014)	"[Safety culture is related to] personal attitudes and habits of thought and to the style of organizations" (p.73)

Edwards and Armstrong (2013)	"Safety culture can be viewed as the assembly of underlying assumptions, beliefs, values and attitudes shared by members of an organisation, which interact with an organisation's structures and systems and the broader contextual setting to result in those external, readily-visible, practices that influence safety" (p. 77)
Fang and Wu (2013)	"[T]he safety culture of an organization is the product of individual and group values, attitudes perceptions, competencies and patterns of behavior that determine the commitment to and the style and proficiency of an organization's health and safety management" (p. 139)
Fernandez-Muniz, Montes-Peon, and Vazquez-Ordas (2007)	"Safety culture can be viewed as a component of the organizational culture that refers to the individuals, jobs, and organizational characteristics that affect employees' health and safety" (p. 627)
Fleming (2007)	"Safety culture determines the accepted norms and behavior. . . such as adherence to safety rules and procedures" (p. 7).
Frazier et al. (2013)	"Safety culture is just one of many within an overall organizational culture . . . Organizational culture encompasses the central beliefs, values and assumptions of the organization . . . [safety culture is] the values, attitudes, beliefs, risk-perceptions and behaviors as they relate to employee safety" (p. 16)
Geller (1994)	"In a [total safety culture], everyone feels responsible for safety and pursues it on a daily basis; employees go beyond "the call of duty" to identify unsafe conditions and behaviors, and intervene to correct them" (p. 18)
Guldenmund (2000)	"[O]rganisational culture is a relatively stable, multidimensional, holistic construct shared by (groups of) organisational members that supplies a frame of reference and which gives meaning to and/or is typically revealed in certain practices" (p. 225) "Safety culture is defined as: those aspects of the organisational culture which will impact on attitudes and behaviour related to increasing or decreasing risk" (p. 251)
Gutierrez (2012)	"Organisational culture refers to the set of values, beliefs and accepted behaviors that employees share through symbolic means such as myths, stories, rituals, and specialized language. These values and beliefs are the social 'norms' within an organization and influence the way an individual acts when operating the social context of that organisation" (p. 4). "Safety culture is the value and priority placed on safety across all levels within an organisation. It refers to the extent to which individuals commit to their personal safety (independence) and to safeguarding others (interdependence)" (p. 4).
Hellings, Schrooten, Klazinga, and Vleugels (2007)	"An integrated pattern of individual and organisational behaviour based upon shared beliefs and values that continuously seek to minimise patient harm that may occur from the process of care delivery" (p. 621)
Kennedy and Kirwan (1998)	"[Safety culture] is an abstract concept which is underpinned by the amalgamation of individual and group perceptions, thought processes, feelings and behaviour which in turn gives rise to the particular way of doing things in the organisation (p. 251)
Mariscal, Herrero, and Otero (2012)	"[S]afety culture is reserved to the basic assumptions of the organisation, in other words to "traits" that are stable and deep-rooted" (p. 1238) "{S]afety culture concept has been amplified beyond classic features of safety management, such as technical attention to hazards, the deployment of operational procedures, and regulatory compliance programmes, to incorporate principles of leadership and value-sharing, enhanced communications and organisational learning, and knowledge about the factors which shape individual and group behaviours" (p. 1238)

Mearns et al. (2003)	"Most definitions of safety culture invoke shared norms or attitudes so that the level of aggregation is considered to be the group" (p. 642)
Mearns and Flin (1999)	"From a theoretical perspective, safety culture has been described in terms of values, beliefs, attitudes, social mores, norms, rules, practices, competencies, and behavior" (p. 7).
Mohamed (2003)	"[S]afety culture is a subfacet of organizational culture, which affects workers' attitudes and behavior in relation to an organization's on-going safety performance" (p. 81)
Nielsen et al. (2013)	"The concept of safety culture is often used to describe the many factors related to organizational processes and management practices that have the potential to influence safety performance" (p. 81)
O'Toole (2002)	"Safety culture is often seen as a subset of organizational culture, where the beliefs and values refer specifically to matters of health and safety" (p. 234) "Safety culture has been identified as a critical factor that sets the tone for importance of safety within an organization" (p. 231)
Olive et al. (2006)	"Safety culture can be viewed as the overarching policies and goals set by an organization relating to the overall safety of their facility or environment" (p. 133).
Ostrom, Wilhelmsen, and Kaplan (1993)	"[Safety culture includes the] concept that the organisation's beliefs and attitudes, manifested in actions, policies, and procedures, affect its safety performance" (p. 163)
Parker, Lawrie, and Hudson (2006)	"At the heart of a safety culture is the way in which organisational intelligence and collective imagination regarding safety issues are deployed" (p. 553) "The beliefs and values that refer specifically to health and safety form the subset of organisational culture referred to as safety culture" (p. 552)
Pidgeon (1991)	"[S]afety culture can be conceived of as the constructed systems of meanings through which a given worker, or group of workers, understands the hazards of their world . . .focuses on the organizational level" (p. 135)
Pronovost and Sexton (2005)	"Definitions of culture commonly refer to values, attitudes, norms, beliefs, practices, policies, and behaviors of personnel" (p. 230)
Rollenhagen (2010)	"'Culture' concerns what and how people believe, feel, think and behave (over time) and how this is reflected in collective habits, rules, norms, symbols and artefacts. How and to what extent such patterns of cognition, behaviour and associated norms influence safety are indeed interesting and important issues – some cultural patterns might be helpful whereas other might be less so" (p. 269)
Singer et al. (2003)	"[Safety culture is] commitment to safety articulated at the highest levels of the organization and translated into shared values, beliefs, and behavioral norms at all levels" (p.113)
Sorra and Dyer (2010)	"Patient safety culture refers to management and staff values, beliefs, and norms about what is important in a health care organization, how organization members are expected to behave, what attitudes and actions are appropriate and inappropriate, and what processes and procedures are rewarded and punished with regard to patient safety" (p. 1)
Turner, Pidgeon, Blockley, and Toft (1989)	"The set of beliefs, norms, attitudes, roles and social and technical practices concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious" (p. 7)
Uttal (1983)	"[Organizational culture is] shared values (what is important) and beliefs (how things work) that interact with a company's people, organizational structures and control systems to produce behavioral norms (the way we do things around here)" (p. 69)

Wiegmann, Zhang, Von Thaden, Sharma, and Gibbons (2004)	"Safety culture is a concept defined at the group level or higher that refers to the shared values among all the group or organization members. Safety culture is concerned with formal safety issues in an organization and closely related to, but not restricted to, the management and supervisory systems. Safety culture emphasizes the contribution from everyone at every level of an organization. The safety culture of an organization has an impact on its members' behavior at work. Safety culture is usually reflected in the contingency between reward systems and safety performance. Safety culture is reflected in an organization's willingness to develop and learn from errors, incidents, and accidents. Safety culture is relatively enduring, stable, and resistant to change" (p. 123).
Wu et al. (2010)	"Safety culture is a subset of organizational culture. It is thought to affect the attitudes and safety-related behavior of the members of an organization" (p. 423).

Appendix B: List of Safety Climate Definitions

Safety climate definitions

Reference	Definition
Allen et al. (2010)	"Safety climate refers to a type of organizational climate in which employees perceive that management rewards, supports, and expects safe practices" (p. 750)
Brown and Holmes (1986)	"Climate is defined as a set of perceptions or beliefs held by an individual and/or group about a particular entity" (p. 455)
Cabrera et al. (1997)	"[Safety climate] is defined by the shared perceptions of organisational members about their work environment and, more precisely, about their organisational safety policies" (p. 257)
Choudhry et al. (2007b)	"[S]afety climate is a product of safety culture, and is dependent on the prevailing safety culture" (p. 1009)
Colla et al. (2005)	"[Safety climate is the] measurable components of "safety culture" such as management behaviors, safety systems, and employee perceptions of safety" (p. 364)
Cooper and Phillips (2004)	"Safety climate refers to the degree to which employees believe true priority is given to organizational safety performance, and its measurement is thought to provide an early warning of potential safety system failure(s)" (p. 497) "[Safety climate is] is a term used to describe shared employee perceptions of how safety management is being operationalized in the workplace, at a particular moment in time" (p.497)
Cox and Cheyne (2000)	"Climate, on the other hand, can be conceived of as a manifestation of organisational culture . . . exhibiting more state-like properties. . . viewed as a temporal manifestation of culture, which is reflected in the shared perceptions of the organisation at a discrete point in time" (p. 114)
Coyle, Sleeman, and Adams (1996)	"Safety climate is best considered a subset of organizational climate. Safety climate could be further divided to include such areas as: work practices, work style, operator training, and industrial hygiene" (p. 248)
Currie and Watterson (2010)	"Organisational climate, on the other hand, is perceived as staff perceptions and attitudes, which are shaped by the way people feel about the leadership, management, information exchange, communication and support in the organisations in which they work" (p. 36).
Dedobbeleer and Béland (1991)	"[C]limate was viewed as molar perceptions people have of their work settings" (p. 97)
Denison (1996)	"[Climate is the] perceptions of "observable" practices and procedures that are closer to the "surface" of organizational life" (p. 622)
Flin et al. (2000)	"Safety climate can be regarded as the surface features of the safety culture discerned from the workforce's attitudes and perceptions at a given point in time . . . It is a snapshot of the state of safety providing an indicator of the underlying safety culture of a work group, plant or organisation" (p. 178)
Fugas, Silva, and Meliá (2012)	"[Safety climate is} workers' perceptions of organizational safety policies and management safety practices" (p. 469)
Gutierrez (2012)	"[S]afety climate is more about the *perception* of safety in the workplace. . . and subject to change, based on management practices" (p. 4).
Hon, Chan, and Yam (2012)	"Safety climate, the current-state reflection of the underlying safety culture, highlights areas for safety improvement" (p. 4)
Kennedy and Kirwan (1998)	"The safety climate is . . . a more tangible expression of the safety culture in the form of symbolic and political aspects of the organisation" (p. 251)

Mariscal et al. (2012)	"Safety climate is used to address "states" of the organisation that are shallow, expressed within the context of and influenced by external and temporary circumstances" (p. 1238)
Mearns et al. (2003)	"Safety climate is regarded as a manifestation of safety culture in the behaviour and expressed attitude of employees" (p. 642)
Nielsen et al. (2013)	"[S]afety climate is defined as the workers impression of safety resources, and based on existing policies and procedures, and how they are enacted, workers will assess whether the organization truly prioritize safety" (p. 81)
Niskanen (1994)	"Safety climate refers to a set of attributes that can be perceived about particular work organizations (maintenance, construction, and central repair shops) and which may be induced by the policies and practices that those organizations impose upon their workers and supervisors" (p. 241)
Olive et al. (2006)	"[S]afety climate generally refers to the attitude the people in the organization have towards safety. It describes the prevailing influences on safety behaviors and attitudes at a particular time" (p. 133).
Tholen, Pousette, and Torner (2013)	"Safety climate is often described as the organisational members' perceptions of the value placed on safety by management" (p. 62) "[S]afety climate is considered a phenomenon at the group level" (p. 63)
Williamson, Feyer, Cairns, and Biancotti (1997)	"Safety climate is argued to be one of the contributors to the climate in organisation . . . of the beliefs and perceptions of employees about safety in the workplace . . . safety climate is a summary concept describing the safety ethic in an organisation or workplace which is reflected in employees' beliefs about safety and is thought to predict the way employees behave with respect to safety in that workplace" (p. 16)
Zohar (1980)	"[C]limate was viewed as a summary of molar perceptions that employees share about their work environments" (p. 96).

Appendix C: Safety Culture and Climate Matrix for Theoretical Definition Analysis

This matrix provides an example of two safety culture definitions and three safety climate definitions and their conceptual analysis. The numbers 1 to 27 in the first row correspond to the first 27 aspects illustrated in Appendix D: Descriptions for Safety Culture and Climate Aspects.

Reference	Definition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Carroll (1998)	"[S]afety culture refers to a high value (priority) placed on worker safety and public (nuclear) safety by everyone in every group and at every level of the plant. It also refers to expectations that people will act to preserve and enhance safety, take personal responsibility for safety, and be rewarded consistent with these values" (p. 10)				X	X											X										X
Choudhry, Fang, and Mohamed (2007)	"[S]afety culture could be defined as: the product of individual and group behaviors, attitudes, norms and values, perceptions and thoughts that determine the commitment to, and style and proficiency of, an organization's system and how its personnel act and react in terms of the company's on-going safety performance within construction site environments" (p. 1008)				X	X	X								X	X	X		X			X	X				X
Allen, Baran, and Scott (2010)	"Safety climate refers to a type of organizational climate in which employees perceive that management rewards, supports, and expects safe practices" (p. 750)		X		X						X			X		X						X					
Brown and Holmes (1986)	"Climate is defined as a set of perceptions or beliefs held by an individual and/or group about a particular entity" (p. 455)				X	X	X							X													
Colla, Bracken, Kinney, and Weeks (2005)	"[Safety climate is the] measurable components of "safety culture" such as management behaviors, safety systems, and employee perceptions of safety" (p. 364)			X			X				X									X		X					

Appendix D: Descriptions of Safety Culture and Climate Aspects

1. **Subcomponent of organizational culture:** definition states that safety culture refers to or is a part of organizational culture
2. **Subcomponent of organizational climate:** definition states that safety climate refers to or is a part of organizational climate
3. **Subcomponent of safety culture:** definition states that safety climate refers to or is a part of safety culture
4. **Individual-centered:** definition states that safety climate/culture is held by an individual or it involves the employee's (*singular*) perceptions, attitudes, behaviors, etc.
5. **Group-centered/Shared:** definition states that safety climate/culture is held by a group, is *shared* by organizational members, or involves staff, workers, or employees (*plural*) perceptions, attitudes, behaviors etc.
6. **Perception about an entity/safety:** employees *perceptions* or *impressions* about safety or their general perceptions
7. **Perception about policies:** employees perceptions about safety policies
8. **Perception about work environment:** employees' perceptions about their work environment, work setting, or work organization
9. **Perception about management attitudes**: employees' perceptions about management attitudes, values, or operationalizations
10. **Perception about management behavior:** employees' perceptions about management practises, rewards, or actions in regards to safety
11. **Perception about behavior:** perceptions of practises or behavior (does not mention management behavior)
12. **Attention:** involves giving attention to safety or hazards or where the employees direct their attention
13. **Beliefs:** the definition mentions beliefs about importance of safety
14. **Attitudes:** the definition mentions attitudes about safety
15. **Norms:** safety culture/climate is defined as norms or refers to habits of thought
16. **Values:** definition mentions values or the value placed on safety
17. **Feelings:** refers to feelings and how people feel
18. **Thoughts/Cognition:** refers to cognitions, how people think, thought processes or habit of thought
19. **Management:** definition mentions management, safety systems, leadership
20. **Psychological:** involves psychological aspect
21. **Behavioral:** definition mentions behaviors, practises, or procedures (does not mention perception of behavior)
22. **Organizational:** definition mentions organizational members, organizational life, organizational safety practises, work organization, organization
23. **Situational:** safety culture/climate involves the situational aspect or contextual setting or social context
24. **Implicit:** safety culture/climate involves habits of thought and underlying assumptions
25. **Symbolic Meaning:** definition mentions symbolic aspects or use of symbols

26. **Improve Safety Performance:** improving or enhancing safety, provides early warning of system failure
27. **Prioritize safety:** safety is given priority or valued
28. **Reward:** rewards are given for safe behavior
29. **Commitment/Responsibility:** employees have a personal responsibility to safety or commitment to safety
30. **Stable:** safety culture/climate is long lasting
31. **Transient:** safety climate/culture is temporary or subject to change, only observable at a particular moment in time, short period of time, current-state reflections
32. **Superficial:** safety climate/culture is superficial (*not* that the definition itself is superficial or trivial), safety climate/culture is closer to the surface or surface or manifest features.
33. **Multiple/Holistic:** involves multiple interactions, or holistic construct
34. **Abstract:** safety culture/climate is an abstract construct
35. **Policies:** definition mentions safety policy or policies
36. **Work Environment:** definition mentions work environment, industrial hygiene, or work setting
37. **Jobs:** the definition states that safety culture/climate refers to jobs
38. **Communication**: definition mentions communication or information exchange or the ways in which people communicate about safety or involves enhanced communication
39. **Training:** definition mentions safety training of any kind
40. **Public safety:** refers to members of the public or public safety
41. **Goal-directed:** refers to goal-directed or setting goals
42. **Learn about safety:** involves learning about safety or organizational learning or learning from errors
43. **Other**: Whatever else you can come up with as a theme or category that I may have missed

Appendix E: Instructions for the Definitions Analyses

The Excel document includes a list of 64 safety culture and safety climate definitions, and I ask you to analyze these definitions regarding presence or absence of their particular aspects.

These definitions need to be analyzed based on aspects (e.g. perception about management actions, attitudes, beliefs, policies, etc.)

1. Please read through the descriptions for the aspects of safety culture and safety climate definitions.
2. Read the first definition and mark an X in the appropriate box if the definition includes a particular aspect (e.g. if a definition mentions that "safety is a phenomenon at the group level" then mark an **X** under the aspect "Group centered/shared")
3. Please continue to refer to the list of descriptions of the definitional aspects to ensure that each aspect of the definition is being classified appropriately.
4. If you are unsure if a definition has a particular aspect then insert a "?" in the corresponding cell. I will clarify this concern with you later.
5. If you notice any aspect that is not already included then create a new category at the end of the excel sheet.
6. Lastly, save the Excel spreadsheet with your included checkmarks and send it back to me

Please let me know if you have any questions or if the descriptions provided are not clear!

Appendix F: Frequency of Aspects for Safety Culture

Safety Culture Aspects	**4s**	**3s**	**2s**	**1s**
Subset of organizational culture	9	-	-	-
Subset of organizational climate	-	-	-	-
Subset of safety culture	-	-	-	-
Individual-centered	13	3	3	6
Group-centered/shared	19	11	2	1
Perception about entity	6	-	-	-
Perception about policies	-	-	-	-
Perceptions about work environment	-	-	-	-
Perception about management attitudes	-	-	-	-
Perceptions about management behavior	-	-	-	1
Perceptions about behavior	-	-	-	-
Attention	3	-	-	-
Beliefs	14	-	-	-
Attitudes	17	1	-	-
Norms	12	-	-	-
Values	17	1	-	-
Feelings	2	-	-	-
Thoughts/Cognitions	4	-	-	-
Management	6	1	-	-
Psychological	1	-	1	-
Behavioral	27	1	-	-
Organizational	23	11	-	-
Situational	4	-	-	-
Implicit	5	-	-	1
Symbolic meaning	3	-	-	1
Improve safety performance	12	1	2	4
Prioritize safety	5	-	1	2
Reward	3	-	-	-
Commitment/Responsibility	7	-	-	4
Stable	6	-	-	-
Transient	-	-	-	-
Manifest	-	-	-	-
Multiple/Holistic	1	-	1	-
Abstract	1	-	-	-
Policies	4	-	-	3
Work environment	2	-	-	-
Jobs	3	-	-	-
Communication	2	-	-	-
Training	-	-	-	-
Public safety	2	-	-	-
Goal-directed	2	-	-	-
Learn about safety	3	-	-	-

Appendix G: Frequency of Aspects for Safety Climate

Safety Climate Aspects	**4s**	**3s**	**2s**	**1s**
Subset of organizational culture	-	-	-	-
Subset of organizational climate	4	-	-	-
Subset of safety culture	7	-	-	-
Individual-centered	1	-	-	2
Group-centered/shared	17	-	1	-
Perception about entity	7	1	1	-
Perception about policies	2	-	-	-
Perceptions about work environment	3	1	1	-
Perception about management attitudes	1	-	-	1
Perceptions about management behavior	2	1	-	-
Perceptions about behavior	1	-	-	-
Attention	-	-	-	-
Beliefs	2	-	-	-
Attitudes	4	-	-	-
Norms	-	-	-	-
Values	1	-	-	-
Feelings	1	-	-	-
Thoughts/Cognitions	-	-	-	-
Management	4	-	1	-
Psychological	-	-	-	-
Behavioral	7	-	-	2
Organizational	4	8	1	3
Situational	-	-	1	-
Implicit	-	-	-	-
Symbolic meaning	1	-	-	-
Improve safety performance	2	-	-	-
Prioritize safety	2	-	-	-
Reward	1	-	-	-
Commitment/Responsibility	-	-	-	-
Stable	-	-	-	-
Transient	7	-	-	-
Manifest	4	-	-	-
Multiple/Holistic	-	-	-	-
Abstract	-	-	-	-
Policies	2	-	-	2
Work environment	4	-	1	2
Jobs	-	-	-	1
Communication	-	1	-	-
Training	1	-	-	-
Public safety	-	-	-	-
Goal-directed	-	-	-	-
Learn about safety	-	-	-	-

Appendix H: Congruency of Safety Theoretical and Operational Definitions

Reference	Definition	Operationalization	Congruency
Amirah, Asma, Muda, and Amin (2013)	"Safety culture can be viewed as a component of the organizational culture that refers to the individuals, jobs and organizational characteristics that affect employees' health and safety" (p.283)	N/A	N/A 0%
Allen et al. (2010)	"Safety climate refers to a type of organizational climate in which employees perceive that management rewards, supports, and expects safe practices" (p. 750)	My direct supervisor: Makes sure we receive all the equipment needed to do the job safely, Frequently checks to see if we are all obeying the safety rules, Discusses how to improve safety with us, Uses explanations (not just compliance) to get us to act safely, Emphasizes safety procedures when we are working under pressure, Frequently tells us about the hazards in our work, Refuses to ignore safety rules when work falls behind schedule, Is strict about working safely when we are tired or stressed, Reminds workers who need reminders to work safely, Makes sure we follow *all* the safety rules, Insists that we obey safety rules when fixing equipment or machines, Says a "good word" to workers who pay special attention to safety, Is strict about safety at the end of the shift, when we want to go home, Spends time helping us learn to see problems *before* they arise, Frequently talks about safety issues throughout the work week, Insists we wear our protective equipment even if it is uncomfortable	50% Organizational climate: No Employees perceive: Somewhat, only in relation to supervisor. Management rewards and supports safe practices: Yes, my supervisor makes sure was receive all equipment needed to do job safely and says a good word to workers who pay special attention to safety
Cabrera et al. (1997)	"[Safety climate] is defined by the shared perceptions of organisational members about their work environment and, more precisely, about their organisational safety policies" (p. 257)	Safety climate and safety level scales were developed (Isla & Cabrera, in press) Could not find	N/A 0%

Cappuccio, Collins Jr, and Eason (1997)	N/A	Safety and Health Opinion survey Majority of personnel can explain policy, Majority personnel can give examples of management's active commitment to safety and health, Management follows the rules and occasionally addresses the safety behavior of others, Majority of personnel feel they have a positive impact on identifying and resolving S&H issues, Majority of personnel believe they have the necessary resources to do their job, Comprehensive safety surveys are conducted; but updates and corrective action sometimes lags, A hazard analysis program exists; but few are aware of results, Inspection are conducted by trained personnel and all items are corrected, repeat hazards seldom found, All incidents are investigated and effective prevention is implemented	N/A 0%
Cappuccio et al. (1997)	N/A	Safety and Health Opinion survey **See Appendix for survey example** Majority of personnel can explain policy, Majority personnel can give examples of management's active commitment to safety and health, Management follows the rules and occasionally addresses the safety behavior of others, Majority of personnel feel they have a positive impact on identifying and resolving S&H issues, Majority of personnel believe they have the necessary resources to do their job, Comprehensive safety surveys are conducted; but updates and corrective action sometimes lags, A hazard analysis program exists; but few are aware of results, Inspection are conducted by trained personnel and all items are corrected, repeat hazards seldom found, All incidents are investigated and effective prevention is implemented	N/A 0%
Carroll (1998)	"[S]afety culture refers to a high value (priority) placed on worker safety and public (nuclear) safety by everyone in every group and at every level of the plant. It also refers to	*Safety Culture Questionnaire* The goals for the safety culture assessment: "to assess the strength of the safety culture within Engineering, and to encourage discussion of safety culture and human performance that will	70% High priority on worker safety: Somewhat, Too many people at the plant are worried about being blamed for mistakes

	expectations that people will act to preserve and enhance safety, take personal responsibility for safety, and be rewarded consistent with these values" (p. 10)	increase awareness and reinforce positive aspects." "Too many people at the plant are worried about being blamed for mistakes," "We try hard to avoid conflicts and public differences of opinion," "Talking about near-misses and minor problems just wastes time and gets people in trouble," "Senior Management makes workers feel uncomfortable about raising concerns," "I feel personally responsible for the safety of the whole plant, not just for doing my job," and "The safety culture has substantially improved over the last few years." The two open-ended questions were: (1) Think of something that happened at the plant recently that shows how strong or weak the safety culture is. If you were the Vice President in charge of nuclear operations, what would you do to improve the plant safety culture?	and Talking about near-misses and minor problems just wastes time and gets people in trouble High priority on public safety: No By everyone in every group: No, seems more individual People will preserve and enhance safety: Yes, Think of something that happened at the plant recently that shows how strong or weak the safety culture is and The safety culture has substantially improved over the last few years. Take responsibility for safety: Yes, I feel personally responsible for the safety of the whole plant, not just for doing my job. Be rewarded: No
Choudhry, Fang, and Mohamed (2007)	"[S]afety culture could be defined as: the product of individual and group behaviors, attitudes, norms and values, perceptions and thoughts that determine the commitment to, and style and proficiency of, an organization's system and how its personnel act and react in terms of the company's on-going safety performance within construction site environments" (p. 1008)	N/A	N/A 0%
Choudhry et al. (2007b)	"[S]afety climate is a product of safety culture, and is dependent on the	N/A	N/A 0%

	prevailing safety culture" (p. 1009)		
Colla et al. (2005)	"[Safety climate is the] measurable components of "safety culture" such as management behaviors, safety systems, and employee perceptions of safety" (p. 364)	N/A **See Colla_2005 Word Doc for Table** Provides overview of safety questionnaires, doesn't provide survey questions	N/A 0%
M. D. Cooper (2000)	"[Organizational culture is the] product of multiple goal-directed interactions between people (psychological), jobs (behavioural) and the organisation (situational)" (p. 118) "[Safety culture is] that observable degree of effort with which all organisational members direct their attention and actions towards improving safety on a daily basis" (p. 115) (S climate?) "Safety culture is a sub-facet of organisational culture, which is thought to affect members' attitudes and behaviour in relation to an organisation's ongoing health and safety performance" (p. 111).	Checklist: the degree to which members consistently confront others about their unsafe acts, the degree to which members report unsafe conditions, the speed with which members implement remedial actions, the degree to which members give priority to safety over production Psychological Aspect: safety climate questionnaire, group interviews and discussion groups, perhaps using the 'Cultural Web' as the starting point, archival data, Repertory Grids, and Twenty Statement Tests, and document analysis Behavioral Aspect: peer observations, self-report measures and/or outcome measures, risk assessment documentation, standard operating procedures, permits to work, group discussions, number of completed remedial actions, risk assessments and/or the number of reported near-misses, the numbers of people receiving safety training, the number of weekly inspections completed, the number of safety audits conducted Situational Aspect: audits of safety management systems or weekly inspections or environmental surveys **N/A assessment suggestions, not actual survey**	N/A 0%
SJ Cox and Cheyne (2000)	"Culture in general, and safety culture in particular, is often characterised as an enduring aspect of the organisation with trait-like properties and not easily changed. Climate, on the	**Safety Climate (Climate?) assessment toolkit** In my workplace management acts quickly to correct safety problems, Management acts only after accidents have occurred, I believe that safety issues are not assigned a high priority, My line manager/supervisor does not always	15% Safety Culture: No, assessment is measuring safety climate Climate is manifestation of

	other hand, can be conceived of as a manifestation of organisational culture . . . exhibiting more state-like properties. . . viewed as a temporal manifestation of culture, which is reflected in the shared perceptions of the organisation at a discrete point in time" (p. 114)	inform me of current concerns and issues, Some safety rules and procedures do not need to be followed to get the job done safely, Personally I feel that safety issues are not the most important aspect of my job, I am sure it is only a matter of time before I am involved in an accident, There are always enough people available to get the job done safely	organizational culture: No State-like properties: Unknown Shared perceptions: No, assessing individual perceptions Discrete point in time: Unsure, participants make think about event that occurred two months ago Many items that do not relate to the theoretical definition
Sue Cox and Flin (1998)	"The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organisation's health and safety management" (p. 191)	Case studies: organizations with either very low or very high accident rates and study factors of that organization Comparative studies: comparison of the characteristics of high and low accident plants/departments Psychometric surveys: employees attitudes and opinions on safety **N/A provides overall ways of assessing safety in organization, but not a specific assessment of safety culture with questions**	N/A 0%
Coyle et al. (1996)	"Safety climate is best considered a subset of organizational climate. Safety climate could be further divided to include such areas as: work practices, work style, operator training, and industrial hygiene" (p. 248)	ORG1 Questionnaire. See page 250. How would you rate the induction (pre-job) training you received? How safe are the normal operating procedures for the equipment you operate? To what extent do supervisors enforce safe working procedures? How noisy are the premises? To what extent are there ongoing safety training programs in the Village? How likely is it that you would be reprimanded for not using safety equipment or protective clothing? How satisfactory is the lighting in the section of the Village you work in?	55% Work practice: Somewhat, To what extent do supervisors enforce safe working procedures? Work style: No Operator training: Yes, How would you rate the induction training you received? How safe are the normal operating procedures for the equipment you operate? Industrial hygiene: Yes, How noisy are the premises? How satisfactory is the lighting in the section

			of the Village you work in?
Craig, Das, and Khago (2010) Safety culture	"Safety culture is a concept defined at a?group or higher level and reflects on the shared values among all the . . . organization members [and] . . . is concerned with formal safety issues with an organization (p. 1).	**Safety Questionnaire** Management takes corrective action, crew member and employees are encouraged to improve safety, the company cares about my health and safety, safety briefings and training are never overlooked, I do not bend the rules to achieve a target, etc. ect.	45% Group or higher level: Somewhat, includes both group and individual questions: employees are encouraged to improve safety and I do not bend the rules to achieve a target Shared values among all members: No Formal safety issues: Somewhat, safety briefings and training are never overlooked
Currie and Watterson (2010)	"The term 'safety culture' refers to the way people commit to a personal responsibility for safety; the way they act to enhance and maintain safety; the way they are willing to learn about safety; and the ways in which they will communicate their concerns about safety" (p. 36).	Safety Climate (again, 'climate"? Questionnaire (SCQ) This is a safer place to work than other trusts I have worked for, ect. Cannot find further questions	N/A 0% Theoretical definition is "culture" but items are "climate"
de Castro, Gracia, Peiró, Pietrantoni, and Hernandez (2013)	"[Safety culture is] that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance" (p. 232)	International Atomic Energy Agency (IAEA) safety culture model It is composed of 37 attributes clustered into five dimensions, referred to as characteristics by the IAEA: (1) safety is a clearly recognized value; (2) leadership for safety is clear; (3) accountability for safety is clear; (4) safety is integrated into all activities; (5) and safety is learning driven. Examples: The high priority given to safety is shown in documentation, communications and decision making, Individuals are convinced that safety and production go hand in hand, Senior management is clearly committed to safety, There is a high level of compliance with regulations and procedures, Good working conditions exist with regard to time pressures,	70% Assembly of characteristics: Yes, characteristics include, safety is a value, leadership, accountability, integrated, and learning driven Assembly of attitudes: Yes somewhat: questions asked relate to employee attitudes Organizations and individuals: Mostly individuals, ask about employee attitudes about management and organization operations

		workload and stress, The quality of documentation and procedures is good, A questioning attitude prevails at all organizational levels, Learning is facilitated through the ability to recognize and diagnose deviations, to formulate and implement solutions and to monitor the effects of corrective actions, ect.	Safety receives priority significance: Yes Definition is vague and many questions that do not relate to definition
dos Santos Grecco, Vidal, Cosenza, dos Santos, and de Carvalho (2014)	"[Safety culture is related to] personal attitudes and habits of thought and to the style of organizations" (p.73)	Fuzzy Assessment Model Top-level commitment to safety, organizational learning, organizational flexibility, awareness, just culture, emergency preparedness. The availability of sufficient workforce is ensured in order to ensure that time pressure does not compromise quality in safety-critical tasks, There is adequate information dissemination on safety issues and information that is relevant to work, There is a system for analysis of internal incidents that takes into account technical, human and organizational factors in equal measure, The extent to which there is an open atmosphere concerning reporting of errors, deviations and problems encountered during the execution of tasks, Superiors provide fair treatment of subordinates, understanding that some errors are inevitable, There is regular training for emergencies on site, ect.	60% Personal attitudes: Yes, questions asked are about personal safety attitudes Habits of thought: No Style of organization: Yes, There is a system for analysis of internal incidents that takes into account technical, human and organizational factors in equal measure and There is regular training for emergencies on site Many questions that do not relate to definition
Edwards and Armstrong (2013)	"Safety culture can be viewed as the assembly of underlying assumptions, beliefs, values and attitudes shared by members of an organisation, which interact with an organisation's structures and systems and the broader contextual setting to result in those external, readily-visible, practices that influence safety" (p. 77)	N/A	N/A 0%
Fang and Wu (2013)	"[T]he safety culture of an organization is the product	Safety Climate Survey Questionnaire. See Fang et al., (2006)	85%

	of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to and the style and proficiency of an organization's health and safety management" (p. 139)	Some health and safety procedures do not need to be followed to get the job done quickly, people who work here often have to take risks, my job is repetitive and boring, Accidents which happen here are always reported, I fully understand the health and safety risks of my work, senior management take health and safety very seriously, Not all health and safety instructions are followed here, health and safety is not my problem, people here are sometimes pressured to work unsafely by their coworkers, management does enough to follow-up safety inspections, ect.	Individual values: Yes some, I fully understand the health and safety risks of my work and my job is repetitive and boring Group values: Yes some, people who work here often have to take risks and Not all health and safety instructions are followed here Attitudes: Yes some, health and safety is not my problem Perceptions: Yes some, people here are sometimes pressured to work unsafely by their coworkers Competencies: No Patterns of behavior: Yes, people who work here often have to take risks Commitment to safety: Sort of, Some health and safety procedures do not need to be followed to get the job done quickly Proficiency to safety management: Yes, but only perceptions of management commitment to safety
Fernandez-Muniz, Montes-Peon, and Vazquez-Ordas (2007)	"Safety culture can be viewed as a component of the organizational culture that refers to the individuals, jobs, and organizational characteristics that affect employees' health and safety" (p. 627)	Safety culture measurement Includes questions on safety policy, employee incentives, training in occupational hazards, communication in prevention matters, preventative planning, emergency planning, internal control, benchmarking techniques, managers' attitudes, managers' behavior, employee involvement, safety performance. My Firm coordinates its health and safety policies with other HR policies to	40% Component of organizational culture: No evidence Individuals: No, asks more about general employee behavior, not the specific individual taking the survey Jobs: Not really Organizational characteristics: Yes,

		ensure commitment and well-being of workers, Incentives frequently offered to workers to put in practice principles and procedures of action (e.g., correct use of protective equipment), There is a fluent communication embodied in periodic and frequent meetings, campaigns or oral presentations to transmit principles and rules of action, Worker given sufficient training period when entering firm, changing jobs or using new technique, Systematic inspections conducted periodically to ensure effective functioning of whole system, Firm's accident rates regularly compared with those of other organizations from same sector using similar production processes, Managers consider that it is fundamental to monitor activities in order to maintain and improve safety activities, Firm managers take responsibility for health and safety as well as quality and productivity, Employees comply with safety regulations, etc. ect.	asks about management's attitudes and behavior, and the overall organization's workings Affect health and safety: Yes Many questions that do not relate to definition
Fleming (2007)	"Safety culture determines the accepted norms and behavior. . . such as adherence to safety rules and procedures" (p. 7).	**Safety Culture Maturity Assessment** Managers receive safety training, safety performance is not monitored at the department level, Departmental safety performance is tracked, managers do not visit worksite to specifically discuss safety, Supervisors are trained to be effective safety leaders, Supervisors safety performance is not evaluated, there are no formal systems to involve workers in safety, injury incidents are investigated by a team, extensive safety rules written by engineering and management, Maintenance only happens when equipment is no longer useable, ect.	65% Accepted norms: Sort of Behavior: Sort of, but focuses more on policies and training Adherence to safety rules: Yes, broadly Adherence to procedures: Somewhat Many questions that do not relate to definition
Frazier, Ludwig, Whitaker, and Roberts (2013)	"Safety culture is just one of many (many cultures?)within an overall organizational culture . . . Organizational culture encompasses the central beliefs, values and	The 2010 revision of the **Safety Culture Survey** Four broad scales: (a) management concern for safety (16 questions), (b) peer support for safety (10 questions), (c) personal responsibility for safety (7	55% Subcomponent of organizational culture: No evidence for this Values: No Assumptions: No

	assumptions of the organization . . . [safety culture is] the values, attitudes, beliefs, risk-perceptions and behaviors as they relate to employee safety" (p. 16)	questions), and (d) safety management systems (54 questions). Safety is not compromised when determining production schedules, overtime, and staffing, When I see a coworker working at-risk, I caution him/her, Employees often "short cut" safe work practices, Managers, supervisors, and employees all know what behaviors will result in discipline, All incidents, even minor ones, are thoroughly investigated if they have potential for serious injury, Safety is considered when changes are made to rules and procedures, When asked to do a new job or task, I receive enough training to be able to do it safely, I am comfortable raising safety concerns to my supervisor and manager, Safety audits/inspections are conducted regularly in my area, Employees are involved in conducting safety audits and inspections, Safety meetings help improve safety. Ect.	Attitudes: Yes, Safety is not compromised when determining production schedules, overtime, and staffing Beliefs: Yes, Safety is not compromised when determining production schedules, overtime, and staffing Risk-perceptions: No Behaviors: Yes, when I see a co-worker working at-risk, I caution him/her
Geller (1994)	"In a [total safety culture], everyone feels responsible for safety and pursues it on a daily basis; employees go beyond "the call of duty" to identify unsafe conditions and behaviors, and intervene to correct them" (p. 18)	N/A	N/A 0%
Guldenmund (2000)	"[O]rganisational culture is a relatively stable, multidimensional, holistic construct shared by (groups of) organisational members that supplies a frame of reference and which gives meaning to and/or is typically revealed in certain practices" (p. 225) "Safety culture is defined as: those aspects of the organisational culture which will impact on	N/A	N/A 0%

	attitudes and behaviour related to increasing or decreasing risk" (p. 251)		
Gutierrez (2012)	"Organisational culture refers to the set of values, beliefs and accepted behaviors that employees share through symbolic means such as myths, stories, rituals, and specialized language. These values and beliefs are the social 'norms' within an organization and influence the way an individual acts when operating the social context of that organization" (p. 4). "Safety culture is the value and priority placed on safety across all levels with and organization. It refers to the extent to which individuals commit to their personal safety (independence) and to safeguarding others (interdependence)" (p. 4).	N/A	N/A 0%
Hellings, Schrooten, Klazinga, and Vleugels (2007)	"An integrated pattern of individual and organisational behaviour based upon shared beliefs and values that continuously seek to minimise patient harm that may occur from the process of care delivery" (p. 621)	**The Patient Safety Culture Hospital questionnaire** Hospital units do not coordinate well with each other, Hospital managers seem interested in patient safety only after an adverse event happens, Things fall between the cracks when transferring patients from one unit to another, "Staff worry that mistakes they make are kept in their personnel file, We work in crisis mode, trying to do too much, too quickly, ect.	50% Individual: No, questions are broad and ask about hospital and staff Organizational behavior: Yes, Hospital units do not coordinate well with each other Shared beliefs: No, can only assess each individual individually Minimize patient harm: Yes, Hospital managers seem interested in patient safety only after an adverse event happens
ISAG (1991)	"Safety culture is that assembly of characteristics and attitudes in	N/A	N/A 0%

	organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance" (p. 380)		
Kennedy and Kirwan (1998)	"[Safety culture] is an abstract concept which is underpinned by the amalgamation of individual and group perceptions, thought processes, feelings and behaviour which in turn gives rise to the particular way of doing things in the organisation (p. 251)	Safety Culture and Operability (SCHAZOP) approach Day-to-day activities, including safety management, real roles, and the personnel fulfilling these roles The SCHAZOP technique will attempt to identify: 1. areas where the safety management process is `vulnerable' to failures (these are defined in terms of safety management error modes); 2. the potential consequences of the safety management failure; 3. the potential (safety culture) `failure mechanisms' associated with the safety management failure; and 4. the factors which influence the likelihood of the safety management failures manifesting themselves. **N/A doesn't have specific questions, I think it is individually tailored to each organization**	N/A 0%
Mariscal, Herrero, and Otero (2012)	"[S]afety culture is reserved to the basic assumptions of the organisation, in other words to "traits" that are stable and deep-rooted, while safety climate is used to address "states" of the organisation that are shallow, expressed within the context of and influenced by external and temporary circumstances" (p. 1238) "[S]afety culture concept has been amplified beyond classic features of safety management, such as technical attention to	RADAR matrix for safety culture Safety is a clearly recognized value, accountability for safety is clear, safety is integrated into all activities, leadership process with regard to safety, safety is learning driven. A policy has been put in place for obtaining and using information through publications, sharing with other Information on the socio-economic environment is obtained systematically. The organization has efficient processes for providing information on its products and services, such as The organization has internal channels for providing information and communicating that are both formal Workers have access to the media	5% <u>Basic assumptions:</u> No <u>Stable and deep-rooted:</u> No This definition and operationalization do not match well

	hazards, the deployment of operational procedures, and regulatory compliance programmes, to incorporate principles of leadership and value-sharing, enhanced communications and organisational learning, and knowledge about the factors which shape individual and group behaviours" (p. 1238)	There is an effective, two-way communication process that ensures the correct communication of safety The good working and effectiveness of the communication system is assessed systematically All workers are informed of the hazards/risks found in their work posts on completion of risk and hazard	
K. Mearns, Whitaker, and Flin (2003)	"Most definitions of safety culture invoke shared norms or attitudes so that the level of aggregation is considered to be the group" (p. 642)	Offshore Safety Questionnaire (OSQ) When decisions are being made about safety issues which may affect you, how involved do you feel? My line manager/supervisor does not always inform me of current concerns and issues I don't get praise for working safely My supervisor cares about safety more than the average worker Senior management show a lack of commitment to health and safety I ignore safety regulations to get the job done The written safety rules and instructions are easy for people to follow Incentives encourage me to break the rules	45% <u>Shared norms:</u> No, assesses individual attitudes <u>Attitudes:</u> Yes, My supervisor cares about safety more than the average worker <u>Safety climate is manifestation of safety culture</u>: No evidence for <u>Behavior:</u> Yes, I ignore safety regulations to get the job done Many questions that do not relate to definition
K. J. Mearns and Flin (1999)	"From a theoretical perspective, safety culture has been described in terms of values, beliefs, attitudes, social mores, norms, rules, practices, competencies, and behavior" (p. 7).	N/A	N/A 0%
Mohamed (2003)	"[S]afety culture is a subfacet of organizational culture, which affects workers' attitudes and behavior in relation to an organization's on-going safety performance" (p. 81)	N/A	N/A 0%

Nielsen, Eid, Hystad, Saetrevik, and Saus (2013)	"The concept of safety culture is often used to describe the many factors related to organizational processes and management practices that have the potential to influence safety performance" (p. 81) "[S]afety climate is defined as the workers impression of safety resources, and based on existing policies and procedures, and how they are enacted, workers will assess whether the organization truly prioritize safety" (p. 81)	**Norwegian offshore risk and safety climate inventory'' (NORSCI)** Individual intention and motivation, management prioritization, and safety routines I report any dangerous situations I see, Safety is my number one priority when I work, I ask my colleagues to stop work which I believe is performed in an unsafe manner, I stop work if I believe that it may be dangerous for me or others to continue, In practice, production takes priority over health, environment and safety, Reports about accidents or dangerous situations are often ''embellished'', here are often concurrent work operations which lead to dangerous situations, Deficient maintenance has caused poorer safety, I have the necessary competence to perform my job in a safe manner, I have easy access to personal protective equipment, The management takes input from the safety delegates seriously	70% Climate scale Workers impressions of resources: Yes, In practice, production takes priority over health, environment and safety Based on policies and procedures: Somewhat, Reports about accidents or dangerous situations are often ''embellished'' Prioritize safety: Yes, Safety is my number one priority when I work
O'Toole (2002)	"Safety culture is often seen as a subset of organizational culture, where the beliefs and values refer specifically to matters of health and safety" (p. 234) "Safety culture has been identified as a critical factor that sets the tone for importance of safety within an organization" (p. 231)	A **41-item safety perception survey** was distributed to all employees, including plant office employees. Have your company's efforts encouraged you to work more safely? Are employees adequately informed about the results of their exposure monitoring? Are employees checked on a routine basis to see whether they are doing their job safely? Do your coworkers support the company's safety program? Are employees who are using drugs or alcohol on the job able to work undetected? Have you been properly trained to respond to an emergency situation in your work area? Is off-the-job safety a part of your company's safety program?	55% Subcomponent of organizational culture: No evidence of this Beliefs: Yes, but also attitudes Values: No Sets the tone for safety: Yes but vague Many questions that do not relate to definition,
Olive, O'Connor, and Mannan (2006)	"Safety culture can be viewed as the overarching policies and goals set by an organization relating to the overall safety of their	N/A	N/A 0%

	facility or environment" (p. 133).		
Ostrom, Wilhelmsen, and Kaplan (1993)	"[Safety culture includes the] concept that the organisation's beliefs and attitudes, manifested in actions, policies, and procedures, affect its safety performance" (p. 163)	**EG&G Idaho Safety Norm Survey** See Appendix Around here people don't think much about safety, Safety personnel are unavailable when we need help, Around here, people take pride in how safely we operate, In this company people work safely even when the boss isn't looking, The way we work now is safe enough, Timely feedback is seldom provided when a safety hazard is reported, There are so many procedures that get in the way of doing the job safely, people carefully follow the written procedures, People are willing to expend a great deal of effort to get a job done safely, ect	65% Organization's beliefs: No, it's the individual employees' beliefs Attitudes: Yes, Around here people don't think much about safety, Actions: Yes, People are willing to expend a great deal of effort to get a job done safely Policies: Sort of, people carefully follow the written procedures
Parker, Lawrie, and Hudson (2006)	"At the heart of a safety culture is the way in which organisational intelligence? and collective imagination? regarding safety issues are deployed" (p. 553) "The beliefs and values that refer specifically to health and safety form the subset of organisational culture referred to as safety culture" (p. 552)	Have both concrete and abstract measures for Pathological: You look out for yourself Reactive: After accident work-site hazard management is brought in, but there is little systematic use Calculative: Commercially available technique is used to meet management requirements, but this leads to little action Proactive: Job safety observation techniques are accepted by the workforce and regarded as standard practice Generative safety culture: Job safety analysis is revised regularly and employees and supervisors are not afraid to tell each other about hazards **See Figure 2 for breakdown of traits**	20% Beliefs and values: Yes, but also attitudes, behaviors, training, management policies, ect Many questions that are not covered in the limited definition
Pidgeon (1991)	"[S]afety culture can be conceived of as the constructed systems of meanings through which a given worker, or group of workers, understands the hazards of their world . . .focuses on the organizational level" (p. 135)	N/A	N/A 0%

Pronovost and Sexton (2005)	"Definitions of culture commonly refer to values, attitudes, norms, beliefs, practices, policies, and behaviors of personnel" (p. 230)	**The Safety Climate Survey (SCSu)** The culture of this clinical area makes it easy to learn from the mistakes of others. The senior leaders in my hospital listen to me and care about my concerns. Medical errors are handled appropriately in this clinical area. Management/leadership does not knowingly compromise safety concerns for productivity. I receive appropriate feedback about my performance. I am satisfied with the availability of physician clinical leadership. I believe that most adverse events occur as a result of multiple system failures and are not attributable to one individual's actions. Ect.	60% Using safety climate survey to assess safety culture Values: No Attitudes: Yes, I believe that most adverse events occur as a result of multiple system failures and are not attributable to one individual's actions Norms: No Beliefs: Yes, I believe that most adverse events occur as a result of multiple system failures and are not attributable to one individual's actions Practises: Yes, I receive appropriate feedback about my performance Policies: No Behaviors: Yes, I receive appropriate feedback about my performance
Reiman and Pietikäinen (2012)	N/A	Provides examples of drive indicators and monitor indicators for safety. E.g. Drive indicators: management is actively committed to, and visibly involved in, safety activities, (2) number of management walk arounds per month, (3) number of times safety is a topic in the management meetings Monitor indicators: the extent to which the personnel report that their work is meaningful and important, (2) the extent to which human performance tools are utilized in daily practice and (3) the extent to which personnel consider safety as a value that guides their everyday work	N/A 0%
Rollenhagen (2010)	"'Culture' concerns what and how people believe, feel, think and behave	N/A	N/A 0%

	(over time) and how this is reflected in collective habits, rules, norms, symbols and artefacts. How and to what extent such patterns of cognition, behaviour and associated norms influence safety are indeed interesting and important issues – some cultural patterns might be helpful whereas other might be less so" (p. 269)		
Singer et al. (2003)	"[Safety culture is] commitment to safety articulated at the highest levels of the organization and translated into shared values, beliefs, and behavioral norms at all levels" (p.113)	**Stanford/PSCI Culture Survey** Organization, Department, Production, Reporting/seeking help, Shame/self-awareness **See Table 3 for sample survey**	N/A 0%
Sorra and Dyer (2010)	"Patient safety culture refers to management and staff values, beliefs, and norms about what is important in a health care organization, how organization members are expected to behave, what attitudes and actions are appropriate and inappropriate, and what processes and procedures are rewarded and punished with regard to patient safety" (p. 1)	**AHRQ *Hospital Survey on Patient Safety Culture*** Patient safety issues, medical error and event reporting and includes 42 items that measure 12 dimensions or composites of patient safety culture **See Table 4 for survey composites** I am rewarded for taking quick action to identify a serious mistake, Senior management has a clear picture of the risk associated with patient care, In my department, disregarding policy and procedure is rare, I have witnessed a coworker do something that appeared to me to be unsafe patient care, In the last year I have done something that was not safe for the patient, Asking for help is a sign of incompetence, I will suffer negative consequences if I report a patient safety problem, I am asked to cut corners to get the job done, Senior management considers patient safety when program changes are discussed, etc.	80% Management values: Yes, Senior management considers patient safety when program changes are discussed Staff values: No Beliefs: Yes, I will suffer negative consequences if I report a patient safety problem Norms: No Expected behavior: Yes, I am asked to cut corners to get the job done Attitudes: Yes, I will suffer negative consequences if I report a patient safety problem Actions: Yes, In the last year I have done something that was not safe for the patient

			Rewards: Yes, I am rewarded for taking quick action to identify a serious mistake
Turner, Pidgeon, Blockley, and Toft (1989)	"The set of beliefs, norms, attitudes, roles and social and technical practices concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious" (p. 7)	N/A	N/A 0%
Uttal (1983)	"[Organizational culture is] shared values (what is important) and beliefs (how things work) that interact with a company's people, organizational structures and control systems to produce behavioral norms (the way we do things around here)" (p. 69)	N/A	N/A 0%
Wiegmann, Zhang, Von Thaden, Sharma, and Gibbons (2004)	"Safety culture is a concept defined at the group level or higher that refers to the shared values among all the group or organization members. Safety culture is concerned with formal safety issues in an organization and closely related to, but not restricted to, the management and supervisory systems. Safety culture emphasizes the contribution from everyone at every level of an organization. The safety culture of an organization has an impact on its members' behavior at work. Safety culture is usually reflected in the contingency between	Tools for assessing safety culture can be classified as either qualitative or quantitative methods. Qualitative methods include employee observations, focus group discussions, historical information reviews, and case studies. In contrast, quantitative approaches attempt to numerically measure or score safety culture using procedures that are often highly standardized and calibrated such as highly structured interviews, surveys and questionnaires, and Q-sorts. **N/A provides suggestions for ways of assessment safety culture, but no actual assessments**	N/A 0%

	reward systems and safety performance. Safety culture is reflected in an organization's willingness to develop and learn from errors, incidents, and accidents. Safety culture is relatively enduring, stable, and resistant to change" (p. 123).		
Wu, Lin, and Shiau (2010)	"Safety culture is a subset of organizational culture. It is thought to affect the attitudes and safety-related behavior of the members of an organization" (p. 423).	Employer safety leadership scale Operations manager safety leadership scale Safety professional safety leadership scale Safety Culture Scale **See Table 5 for items of Safety Culture Scale** All colleagues understand emergency response equipment, All colleagues understand injury reporting procedures, Colleagues often fall or slip at work, Colleagues regularly attend safety training, Colleagues participate in the setting of safety policy	75% <u>Subcomponent of organizational culture:</u> No evidence for this <u>Attitudes:</u> Yes, All colleagues understand injury reporting procedures <u>Behavior:</u> Yes, Colleagues often fall or slip at work

Appendix I: List of Safety Culture and Climate Assessment Tools

Safety Climate Assessment Tools	Author	Info about Questionnaire/Items	Reliability	Validity
Reliability and validity of a safety climate questionnaire	Arghami, S., Nouri Parkestani, H., & Alimohammadi, I. (2013).	The factors on the scale included: management commitment to safety, safety communication, supportive environment, work environment, formal training, priority of safety, and personal priorities and need for safety (descending order in amount of variance) My company values in the workers correct observation of safety rules and procedures	Cronbach's alpha coefficient was calculated to measure the internal consistency of the instrument with 0.70 specified as an acceptable level [16]and was found to be equal to 0.93 for the entire questionnaire. The alphas were also calculated separately for each factor as .954 for the first, .830 for the second, .793 for the third, .803 for the fourth, .774 for the fifth, .740 for the sixth and .547 for the seventh	As the initial instrument, a questionnaire was formed on the basis of Table 1 and translated into Persian via linguistic validity approach. Correlations of subscales with the total scale score was calculated to show the validity of the instrument. Since the main purpose of exploratory factor analysis is data reduction to define a set of common underlying dimensions known as factors, priori criteria should be established in order to get a certain number of factors extracted. The most commonly criteria include: eigenvalues higher than 1 latent root criteria), and scree test criterion
The safety attitudes questionnaire - ambulatory version: psychometric properties of	Bondevik, G. T., Hofoss, D., Hansen, E. H., & Deilkås,	Nurse input is well received in this office. In this office, it is difficult to speak up if I perceive a problem with patient care. Disagreements in this office are resolved appropriately (i.e., not who is right but what is best for the patient). I have the support I need from other personnel to care for patients. It is easy for personnel in this office to ask questions when there is something that they do not understand.	The Cronbach alphas ranged from 0.67 to 0.83 for the factor scores Teamwork climate, Safety climate, Working conditions, Job	Since several studies find that the factor Stress recognition does not vary significantly between organizational units [21, 26], and also has problems regarding

the Norwegian translated version for the primary care setting	E. C. T. (2014).	The physicians and nurses here work together as a well-coordinated team. Safety climate I would feel safe being treated here as a patient. Medical errors are handled appropriately in this office. I receive appropriate feedback about my performance. In this office, it is difficult to discuss errors. I am encouraged by my colleagues to report any patient safety concerns I may have. The culture in this office makes it easy to learn from the errors of others. I know the proper channels to direct questions regarding patient safety in this office. This office does a good job of training new personnel. All the necessary information for diagnostic and therapeutic decisions is routinely available to me. This office deals constructively with problem personnel. Trainees in my discipline are adequately supervised. Job satisfaction I like my job. Working in this office is like being part of a large family. This office is a good place to work. I am proud to work at this office. Morale in this office is high. Perceptions of management The management of this office supports my daily efforts. Office management does not knowingly compromise the safety of patients. The levels of staffing in this office are sufficient to handle the number of patients. I am provided with adequate, timely information about events in the office that might affect my work. When my workload becomes excessive, my performance is impaired. I am less effective at work when fatigued. I am more likely to make errors in tense or hostile situations. Fatigue impairs my performance during emergency situations (e.g. code or cardiac arrest).	satisfaction and Perceptions of management (Table 4)	construct validity [27], it cannot be considered a valid factor for measuring patient safety The factors reflect the correlation structure in the item responses. Valid factors should thus reflect a thematic logic that is coherent with the purpose of the questionnaire. CFA provides goodness-of-fit indices, which show how the survey responses comply with the pre-hypothesised factor model.
Development and validation of an Integrated Organizational Safety	Brondino, M., Pasini, M., & da Silva, S.	Safety Communication 1.02. Space to discuss in meeting 1.05. Management attention to workers ideas to improve safety 1.12. Workers consultation on safety issues Information supply on safety issues Safety Training	In this case it's better to use construct reliability (the degree to which the scale indicators reflect an underlying factor),	To test construct validity in multilevel confirmatory factor analysis the five steps described above, from the CFA to the final

Climate questionnaire with multilevel confirmatory factor analysis	C. A. (2013)	1.09. Investments on safety training 1.16. Quality of safety training Safety values 1.07. Management care about safety in production schedule 1.10. Management care about safety in moving-promoting people 1.14. Management care about safety on a delay in production schedule Safety systems 1.08. Management effort on safety improvement 1.11. Management reaction to solve safety hazard 1.17. Power given to safety officers Supervisor safety climate scale Supervisor's effort to improve safety 2.01. Supervisor's care about safety rules when a delay in production schedule occurs 2.06. Supervisor's show care to provide workers needed safety equipment 2.08. Supervisor's care about the use of safety equipment 2.09. Supervisor's care concerning safety rules when workers are tired 2.10. Supervisor's care about all safety rules 2.11. Supervisor controls the compliance of all the workers Supervisor's reactions to workers behaviours 2.02. Supervisor discusses with workers on safety improvement 2.03. Supervisor's care concerning workers safety awareness 2.04. Supervisor's coaching about safety care 2.05. supervisor praise to very careful safety behaviours Co-workers' safety climate scale Safety communication 3.05. Team members' speaking on safety on the week 3.06. Team members' discussing about incident prevention 3.09. Team members' discussion about safety hazard Safety mentoring 3.01. Team members' emphasis to peer on safety care when under pressure 3.03. Team members care about peers safety awareness 3.04. Team members mentoring to peer about working safely Safety values 3.02. Team members care about safety at the shift end 3.08. Team members care about safety when tired 3.12. Team members care about safety when a delay in production schedule occurs Safety systems 3.07. Team members care about other workers' safety equipment 3.10. Team members remind safety equipment use 3.11. Team members care about other members' safety compliance	and average variance extracted (AVE, the average percentage of variation explained among the items) The factors composite reliability coefficients of the four-factor covariance model and of the second-order factor model were in both cases above the threshold value for acceptable reliability: For the four correlated factor model, construct reliability and variance extracted (AVE) were: Values (.81; AVE .59), Safety System (.78; AVE .54), Safety Communication (.79; AVE .56) and Training (.82; AVE .60); for the second-order factor model construct reliability and variance extracted were: Values (.81; AVE .59), Safety System (.78; AVE .54), Safety Communication (.79; AVE .56) and Training (.82; AVE .60).	MCFA, were performed. Table 2 shows models' fit indexes, step by step, for the chosen final models for each scale. The Criterion-related validity appears good: the more the safety climate scores, the less the self-report number of injuries and micro-accidents

Safety Climate Survey	Cappuccio, W. R., Collins Jr, G. E., & Eason, C. A. (1997)	Management Leadership and Employee Participation A. Clear worksite safety and health policy 1. (4) Work force can explain, and fully embraces, S & H policy (3) Majority of personnel can explain policy (2) Some personnel can explain policy (1) Management can provide or state policy (0) There is no apparent policy B. Management leadership and example 2. (4) All personnel can give examples of management's active commitment to safety and health (3) Majority personnel can give examples of management's active commitment to safety and health (2) Some personnel can give examples of management's active commitment to safety and health (1) Some evidence exists that management is committed to safety and health (0) Safety and health does not appear to be a management value or significant concern 3. (4) Personnel report management always follows the rules and addresses the safety behavior of others (3) Management follows the rules and usually addresses the safety behavior of others (2) Management follows the rules and occasionally addresses the safety behavior of others (1) Management generally appears to follow basic safety and health rules (0) Management does not appear to follow the basic safety and health rules set for others C. Employee involvement 4. (4) All personnel have ownership of safety and health and can describe their active roles (3) Majority of personnel feel they have a positive impact on identifying and resolving S&H issues (2) Some personnel feel they have a positive impact on identifying and resolving S&H issues (1) Employees frequently feel that their safety and health input will be considered by supervision (0) Employee involvement in safety and health issues is not encouraged or rewarded D. Resources for safety and health 5. (4) All personnel believe they have the necessary resources to meet their responsibilities	The reliability of the survey was examined by selecting a small group of individuals (n=5) and performing a test-retest examination (data not shown) on the survey instrument.	Content validity of the survey was examined by having a group of ERDEC safety engineers and specialists review the survey questions and responses for appropriateness to this facility

		(3) Majority of personnel believe they have the necessary resources to do their job (2) Resources are spelled out for all; but there may be a reluctance to use them (1) Resources exist, but most appear to be out of the control of the employee (0) Personnel do not have adequate authority and resources to perform assigned responsibilities II. Workplace Analysis A. Hazard identification (safety survey) 6. (4) In addition to corrective action, regular safety surveys result in updated hazard inventories (3) Comprehensive safety surveys are conducted periodically and drive appropriate corrective action (2) Comprehensive safety surveys are conducted; but updates and corrective action sometimes lags (1) Safety or health professionals survey in response to accidents, complaints, or compliance activity (0) There is no evidence of any comprehensive hazard survey having been conducted B. Routine hazard analysis 7. (4) Employees have had input to the hazard analysis for their jobs (3) A current hazard analysis exists for all jobs, processes, or phases and is understood by all employees (2) A current hazard analysis exists for all jobs, processes, or phases and is understood by many employees (1) A hazard analysis program exists; but few are aware of results (0) There is no routine hazard analysis system in place at this facility C. Hazard identification (inspection) 8. (4) Well trained employees at all levels conduct frequent and varied inspections, hazards of any kind are rare (3) Inspection are conducted by trained personnel and all items are corrected, repeat hazards seldom found (2) Inspection are conducted by trained personnel, most items corrected, but some hazards still in evidence (1) An inspection program exists; but coverage and corrective action is not complete; hazards are in evidence		

		(0) There is no routine inspection program at this facility; many hazards can be found D. Hazard reporting system 9. (4) Employees feel comfortable identifying and self correcting hazards (3) A comprehensive system for gathering hazard information exists; is positive, rewarding and effective (2) A system exists for hazard reporting; employees feel they can use it; but it may be slow to respond (1) A system exists for hazard reporting; but employees may find it unresponsive or be unclear on its use (0) No formal hazard reporting system exists and/or employees do not appear comfortable reporting hazards E. Accident/incident investigation 10. (4) All loss-producing incidents and "near misses" are investigated for root cause with effective prevention (3) All incidents are investigated and effective prevention is implemented (2) Incidents generally investigated; cause identification/correction maybe inadequate (1) Some investigation of incidents takes place, but root cause is seldom identified, correction is spotty (0) Injuries are either not investigated or investigation is limited to report writing required for compliance F. Injury/illness analysis 11. (4) All employees are fully aware of incident trends, causes, and means of prevention (3) Trends fully analyzed and displayed, common causes communicated, management ensures prevention (2) Data is centrally collected and analyzed; common causes communicated to concerned supervisors (1) Data is centrally collected and analyzed; but not widely communicated for prevention (0) Little or no effort is made to analyze data for trends, causes, and prevention		

		III. Hazard Prevention and Control A. Awareness of facility/equipment maintenance 12. (4) Operators are trained to recognize maintenance needs and perform/order maintenance on schedule (3) An effective preventive maintenance schedule is in place and applicable to all equipment (2) A preventive maintenance schedule is in place and is usually followed except for higher priorities (1) A preventive maintenance schedule is in place; but is often allowed to slide (0) There is little or no attention paid to preventive maintenance; break-down maintenance is the rule B. Emergency equipment 13. (4) Facility is fully equipped for emergencies, all systems and equipment in place and regularly tested, all personnel know how to use equipment and communicate during emergencies (3) Well equipped with appropriate emergency phones and directions, most people know what to do (2) Emergency phones, directions, and equipment in place; but only emergency teams know what to do (1) Emergency phones, directions, and equipment in place; but employees show little awareness (0) There is little evidence of an effective effort at providing emergency equipment and information C. Medical program (emergency care) 14. (4) Personnel fully trained in emergency medicine are always available on-site (3) Personnel with basic first aid skills are always available on-site (2) Personnel with basic first aid skills are usually available with community assistance near-by (1) Either on-site or near-by community aid is always available on every shift (0) Neither on-site nor community aid can be ensured at all times IV. Safety and Health Training A. Employees learn hazards, and how to protect themselves and others 15. (4) Employees can demonstrate proficiency in, and support of, all areas covered by training		

		(3) Facility committed to high quality employee hazard training, ensures all participate, regular updates (2) Facility provides legally required training, makes effort to include all personnel (1) Training is provided when need is apparent, experienced personnel assumed to know material (0) Facility depends on experience and informal peer training to meet needs B. Supervisors learn responsibilities, and underlying reasons 16. (4) All supervisors assist in worksite analysis, ensure physical protections, reinforce training, enforce discipline, and can explain work procedures, based on training provided to them (3) Most supervisors assist in worksite analysis, ensure physical protections, reinforce training, enforce discipline, and can explain work procedures, based on training provided to them (2) Supervisors have received basic training, appear to understand and demonstrate importance of worksite analysis, physical protections, training reinforcement, discipline, knowledge of procedures (1) Supervisors make reasonable effort to meet safety and health responsibilities; but have limited training (0) There is no formal effort to train supervisors in safety and health responsibilities		
Content validity and internal consistency of the Dutch translation of the safety attitudes questionnaire: An observational study.	Devrient, E., Van den Heede, K., Coussement, J., Dejaeger, E., Surmont, K., Heylen, D., ... &	1. Nurse input is well received in this clinical area (1) 2. In this clinical area, it is difficult to speak up if I perceive a problem with patient care (1) 3. Disagreements in this clinical area are resolved appropriately (i.e.; not who is right but what is best for the patient) (1) 4. I have the support I need from other personnel to care for patients (1) 5. It is easy for personnel here to ask questions when there is something that they do not understand (1) 6. The physicians and nurses here work together as a well-coordinated team (1) 7. I would feel safe being treated here as a patient (2) 8. Medical errors are handled appropriately in this clinical area (2) 9. I know the proper channels to direct questions regarding patient safety in this clinical area (2)	Several studies measured the internal consistency of the instrument and the scales in different settings, with Cronbach's alpha values for the different scales ranging from 0.68 to 0.89	The Dutch translation of the SAQ was tested for content validity (Lynn, 1986 and Polit et al., 2007). Content validity was examined by the same expert panel as in phase 1. Content validity indexes were rated as good when I-CVI, S-CVI_{Ave} and S-CVI_{UA}were at least 0.78, 0.90, and 0.80, respectively

	Milisen, K. (2012).	10. I receive appropriate feedback about my performance (2) 11. In this clinical area, it is difficult to discuss errors (2) 12. I am encouraged by my colleagues to report any patient safety concerns I may have (2) 13. The culture in this clinical area makes it easy to learn from the errors of others (2) 14. My suggestions about safety would be acted upon if I expressed them to management (2) 15. I like my job (5) 16. Working here is like being part of a large family (5) 17. This is a good place to work (5) 18. I am proud to work in this clinical area (5) 19. Morale in this clinical area is high (5) 20. When my workload becomes excessive, my performance is impaired (3) 21. I am less effective at work when fatigued (3) 22. I am more likely to make errors in tense or hostile situations (3) 23. Fatigue impairs my performance during emergency situations (e.g. emergency resuscitation, seizure) (3) 24. Management supports my daily efforts: unit management and hospital management (6) 25. Management does not knowingly compromise pt safety: unit management and hospital management (6) 26. Management is doing a good job: unit management and hospital management (6) 27. Problem personnel are dealt with constructively by our: unit management and hospital management (4) 28. I get adequate, timely info about events that might affect my work, from: unit management and hospital management (6) 29. The staffing levels in this clinical area are sufficient to handle the number of patients (6) 30. This hospital does a good job of training new personnel (4) 31. All the necessary information for diagnostic and therapeutic decisions is routinely available to me (4) 32. Trainees in my discipline are adequately supervised (4) 33. Communication breakdowns that lead to delays in delivery of care are common (4)		Face validity was evaluated by two nurses and two physicians who assessed the Dutch version of the SAQ.
Swedish translation and psychometric testing of the	Göras, C., Wallentin, F. Y.,	Disagreements in the ORs here are resolved appropriately (i.e., what is best for the patient). –The physicians and nurses here work together as a well- coordinated team. Job satisfaction: positivity about the work experience	The internal consistency of the six factors and 30 items of the translated	To assess content validity, a validation review was performed by an expert committee,

safety attitudes questionnaire (operating room version)	Nilsson, U., & Ehrenberg, A. (2013).	–I like my job. –This hospital is a good place to work. Perceptions of management: approval of managerial action –Hospital administration supports my daily efforts. –Hospital management is doing a good job. Safety climate: perceptions of a strong and proactive organizational commitment to safety –I would feel perfectly safe being treated here as a patient. –Personnel frequently disregard rules or guidelines that are established for the OR. Working conditions: perceived quality of the OR's work environment and logistical support (staffing, equipment, etc.) –Our levels of staffing are sufficient to handle the number of patients. –Medical equipment in the ORs here is adequate. Stress recognition: acknowledgement of how performance is influenced by stressors –I am less effective at work when fatigued.	version of the SAQ had Cronbach's alpha values of 0.59 to 0.83.	including relevance and intelligibility, to highlight any items that may be inappropriate at a conceptual or cultural level. An approach to construct validation, CFA, was used for conclusions about the conceptual and semantic equivalence of a translated questionnaire [32], as well as to create other aspects of psychometric evaluation [34].
University safety climate questionnaire	Gutierrez, 2012	N/A	Internal consistency was good except for the risk management dimension (below .70).	Eigen-values were used as a measure of construct validity and four of the five dimension were good (greater than 1). Content validity was addressed with a review of the literature
A means for measuring safety climate in the university work setting	Gutiérrez, J. M., Emery, R. J., Whitehead, L. W., & Felknor, S. A. (2013).	Perceptions of risk management Employee's safety commitment Department and supervisor's commitment Acknowledgement of safety performance Administration's safety commitment	Reliability analysis was performed to assess the internal consistency within each group or dimension having more than one question. The Cronbach alpha coefficient was appropriate for Likert level responses to attitude surveys, while the Kuder–Richardson formula	For the construct validity, a correlation matrix was produced and factor analysis was performed. The sum of Eigen-values by the five safety climate dimensions obtained from the factor analysis is shown in Table 5. Four of the five safety climate dimensions had Eigen-values greater than one, thus, following the Kaiser Guttman rule,

			was a special case of the alpha coefficient that is used when the response categories are dichotomous rather than multi-level. The Cronbach alpha for the perceptions of risk management dimension was lower than 0.7, indicating these questions were not internally consistent and may need to be reworded.	these four dimensions can be used as indicators of safety climate. Content validity analysis was addressed by a comprehensive review of the literature regarding safety climate dimensions or factors.
Determining Safety Climate Factors in the Repair, Maintenance, Minor Alteration, and Addition Sector of Hong Kong	Hon, C. K., Chan, A. P., & Yam, M. C. (2012).	Management Commitment B8 The company really cares about the health and safety of the people who work here. B21 There is good communication here between management and workers about health and safety issues. B15 The company encourages suggestions on how to improve health and safety. B19 I am clear about what my responsibilities are regarding health and safety. B38 I think management here does enough to follow up on recommendations from safety inspection and accident investigation reports. B13 All the people who work in my team are fully committed to health and safety. B16 There is good preparedness for emergencies here. B30 Accidents that happen here are always reported. B9 Most of the job-specific safety trainings I receive are effective. B3 I fully understand the health and safety risks associated. B28 Safety inspection here is helpful to improve the health and safety of workers. B34 Staff are praised for working safely. Safety Rules and Work Practices B29 Some jobs here are difficult to do safely. B32 Not all the health and safety rules or procedures are strictly followed here. B20 Some of the workforces pay little attention to health and safety.	Reliability measures the internal consistency of the latent factors. As shown in Appendix II, three values of CR were above the recommended level of 0.7 (Hair et al. 2010). All factors achieved good internal consistency	Fig. 3 shows that convergent validity was achieved because all the paths in the CFA model were significant. Results of the discriminant validity test in Appendix II show that the structure has dissimilar constructs for the three factors because no pairs of 95% confidence interval of factor correlation pass through 1.

		B11 Some health and safety rules or procedures are difficult to follow. B35 Supervisors sometimes turn a blind eye to people who are not observing the health and safety procedures. B17 Sometimes it is necessary to take risks to get the job done Responsibility for health and safety B10 People are just unlucky when they suffer from an accident. B37 Accident investigations are mainly used to identify who should be blamed. B26 Work health and safety are not my concern. B14 Little is done to prevent accidents until someone gets injured.		
Use of a safety climate questionnaire in UK health care: factor structure, reliability and usability	Hutchinson, A., Cooper, K. L., Dean, J. E., McIntosh, A., Patterson, M., Stride, C. B., ... & Smith, C. M. (2006).	Teamwork factor Input into decisions and collaboration with other staff(Cronbach's α=0.84) Nurse input is well received where I work. Decision making where I work uses input from relevant staff The doctors and nurses here work together as a well-coordinated team Disagreements where I work are resolved appropriately (i.e. not who is right, but what is best for the patient) It is easy for staff here to ask questions when there is something that they do not understand I have the support I need from other staff to care for patients I am satisfied with the quality of collaboration that I experience with senior doctors where I work Safety climate factor Attitudes to safety within own team; capacity to learn from errors (Cronbach's α=0.73) I am encouraged by my colleagues to report any patient safety concerns I may have The culture where I work makes it easy to learn from the errors of others I receive appropriate feedback about my performance Medical errors are handled appropriately here I know the proper channels to which I should direct questions regarding patient safety The levels of staffing where I work are sufficient to handle the number of patients I would feel safe being treated as a patient in this service Management does not knowingly compromise the safety of patients This organisation is doing more for patient safety now than it did one year ago Leadership is driving us to be a safety centred organisation My suggestions about safety would be acted upon if I expressed them to management	Internal consistency reliabilities (how clearly a set of items measure a single theme) were satisfactory to good, with Cronbach's alpha 0.69 or above in all five factors (tables 1 and 2). Removing a further item from the initial five items forming teamwork factor 2 improved the internal consistency reliability of this factor. This item ("Briefing staff on handovers between shifts is important for patient safety")	Face validity: As a result of the "thinking aloud" exercise, minor adaptations were made to the questionnaire wording before it was used in the survey. For example, "institution" was changed to "organisation" and "physicians" to "doctors". However, care was taken not to alter the underlying meaning of the items and, for this reason, some wording was left unchanged—for example, the term "briefings" (which was unfamiliar to a number of respondents) and "medical error" (which several respondents associated only with doctors/medical interventions).

The Turkish version of the safety attitudes questionnaire: psychometric properties and baseline data	Kaya, S., Barsbay, S., & Karabulut, E. (2010).	Nurse input is well received in this clinical area In this clinical area, it is difficult to speak up if I perceive a problem with patient care (reversed scores presented='higher is better') Disagreements in this clinical area are appropriately resolved (ie, not who is right but what is best for the patient) I have the support I need from other personnel to care for patients It is easy for personnel in this clinical area to ask questions when there is something that they do not understand The physicians and nurses here work together as a well-coordinated team Safety climate I would feel safe being treated here as a patient Medical errors are handled appropriately in this clinical area I receive appropriate feedback about my performance In this clinical area, it is difficult to discuss errors (reversed scores presented='higher is better') I am encouraged by my colleagues to report any patient safety concerns I may have. The culture in this clinical area makes it easy to learn from the errors of others I know the proper channels to direct questions regarding patient safety in this clinical area Job satisfaction I like my job Working in this hospital is like being part of a large family This hospital is a good place to work I am proud to work at this hospital Morale in this clinical area is high Stress recognition Fatigue impairs my performance during emergency situations (eg, emergency resuscitation, haemorrhaging) When my workload becomes excessive, my performance is impaired I am less effective at work when fatigued I am more likely to make errors in tense or hostile situations Perceptions of management Hospital administration supports my daily efforts Hospital management does not knowingly compromise the safety of patients The levels of staffing in this clinical area are sufficient to handle the number of patients I am provided with adequate, timely information about events in the hospital that might affect my work Working conditions	Composite scale reliability for the SAQ (0.89) was as strong as the SAQ reliability (0.90) found in the international benchmark data.22 Cronbach alphas for all factors were greater than 0.60.	The construct validity of the SAQ containing 30 items, as judged by the goodness-of-fit indices from the CFA, was generally satisfactory. The p value of less than 0.001 speaks against the fit of the model to the data, but the TLI (0.969) and CFI (0.974) exceeded the recommended cut-off values of 0.90, the RMSEA (0.069) was less than the critical value of 0.08, and the SRMR (0.061) was below the suggested criteria of 0.10.

		This hospital does a good job of training new personnel All the necessary information for diagnostic and therapeutic decisions is routinely available to me This hospital constructively deals with problem physicians and employees Trainees in my discipline are adequately supervised		
Nordic Safety Climate questionnaire (NOSACQ-50): A new tool for diagnosing occupational safety climate.	Kines, P., Lappalainen, J., Mikkelsen, K. L., Olsen, E., Pousette, A., Tharaldsen, J., ... & Törner, M. (2011).	Management accepts workers taking risks when the work schedule is tight We who work here have confidence in the management's ability to deal with safety Management encourages workers to participate in decisions which affect their safety Management looks for causes, not guilty persons, when an accident occurs Workers' perceptions of how they themselves relate to safety at work concerning if they generally: show commitment to safety and are active in promoting safety care for each others' safety We who work here take no responsibility for each others' safety Workers' perceptions of how they themselves relate to safety at work concerning if they generally: prioritize safety before production goals do not resign to hazardous conditions or accept risk-taking do not show fearlessness We who work here accept dangerous behavior as long as there are no accidentsa Workers' perceptions of how they themselves relate to safety at work concerning if they generally: discuss safety whenever such issues emerge and learn from experience help each other to work safely treat safety suggestions from each other seriously and try to work out solutions trust each others' ability to ensure safety in everyday work We who work here can talk freely and openly about safety Workers' perceptions of how they themselves relate to safety at work concerning if they in general: consider formal safety systems as effective, e.g. safety officers, safety representatives, safety committees, safety rounds see benefit in early planning see benefit in safety training see benefit in clear safety goals and objectives We who work here consider that safety rounds have no effect on safety	Management safety priority, commitment and competence 0.87 Management safety empowerment 0.73 Management safety justice 0.71 Workers' safety commitment 0.77 Workers' safety priority and risk non-acceptance 0.80 Safety communication, learning, and trust in co-worker safety competence 0.79 Workers' trust in the efficacy of safety systems 0.82	The CFA reported above supported the construct validity of the seven safety climate scales. Table 2 shows the inter-correlations between the scales. Even though the scales are highly related to each other, suggesting the possibility of a second order safety climate factor, all but one of the scales had a unique component. The exception was *workers' safety commitment*, which was highly correlated with *safety communication, learning and trust.* As an indication of the criterion validity with regard to *safety motivation* and *safety violations*, the bivariate correlations between the seven safety climate variables and the two criterion variables were calculated
Ranking of working shift groups in an	Khandan, M., Maghsou	Its categories are (1) management commitment and actions for safety (shown as F1 in Table 2), (2) workers' knowledge and compliance to safety (F2), (3) workers' attitudes toward safety (F3), (4) workers' participation and commitment	Questionnaire's reliability assessed by	N/A

Iranian petrochemical company using ELECTRE method based on safety climate assessment results	dipour, M., & Vosoughi, S. (2011).	to safety (F4), (5) safeness of work environment (F5), and (6) emergency preparedness in the organization (F6).	Cronbach's alpha was 0.928	
Safety Climate Survey: reliability of results from a multicenter ICU survey	Kho, M. E., Carbone, J. M., Lucas, J., & Cook, D. J. (2005).	1) The culture of this clinical area makes it easy to learn from the mistakes of others. (2) Medical errors are handled appropriately in this clinical area. 6 6 (3) The senior leaders in my hospital listen to me and care about my concerns. (4) The physician and clinical leaders in my areas listen to me and care about my concerns. (5) Leadership is driving us to be a safety centered institution. 6 6 (6) My suggestions about safety would be acted upon if I expressed them to management. (7) Management/leadership does not knowingly compromise safety concerns for productivity. (8) I am encouraged by my colleagues to report any safety concerns I may have. (9) I know the proper channels to direct questions regarding patient safety. (10) I receive appropriate feedback about my performance. (11) I would feel safe being treated here as a patient. (12) Briefing personnel before the start of a shift is an important part of patient safety. (Briefing is defined as informal/formal communication regarding unit specifics, in order to plan for possible contingencies.) (13) Briefings are common here. (14) I am satisfied with the availability of physician clinical leadership. (15) I am satisfied with the availability of nursing clinical leadership. (16) I am satisfied with the availability of pharmacy clinical leadership. (17) I am satisfied with the availability of registered respiratory care practitioner clinical leadership (18) This institution is doing more for patient safety now than it did 1 year ago. (19) I believe that most adverse events occur as a result of multiple system failures and are not attributable to one individual's actions. (20) The personnel in this clinical area take responsibility for patient safety.	Test-retest reliability analysis was evaluated on data from 31 respondents who completed the instrument in duplicate. Using the ICC, the test re-test reliability of the SCSu was 0.92 (95% CI 0.82 to 0.97) and of the SCSc was 0.92 (95% CI 0.82 to 0.96). Using Cronbach's alpha, the internal consistency of the SCSu was 0.86, of the SCSc was 0.80, and 0.51 for the SCM.	N/A

		(21) Personnel frequently disregard rules or guidelines that are established for this clinical area. (22) Patient safety is constantly reinforced as the priority in this clinical area. (23) I am aware that patient safety has become a major area for improvement in this institution.		
Railway safety climate scales	Miyachi, Murakoshi, Akatsuka, & Suzuki, 2010	Job responsibilities are clear The job strongly demands promptness Autonomous behavior is demanded High income/stable job prospects Etc.	N/A	N/A
A brief safety climate inventory for petro-maritime organizations	Nielsen, M. B., Eid, J., Hystad, S. W., Sætrevik, B., & Saus, E. R. (2013).	Individual intention and motivation 1. I report any dangerous situations I see 2. Safety is my number one priority when I work 3. I ask my colleagues to stop work which I believe is performed in an unsafe manner 4. I stop work if I believe that it may be dangerous for me or others to continue Management prioritization 5. In practice, production takes priority over health, environment and safety 6. Reports about accidents or dangerous situations are often ‘‘embellished’’ 7. There are often concurrent work operations which lead to dangerous situations 8. Deficient maintenance has caused poorer safety Safety routines 9. I have the necessary competence to perform my job in a safe manner 10. I have easy access to personal protective equipment 11. The management takes input from the safety delegates seriously	The overall scale demonstrated strong internal reliability (Cronbach’s a = .94). This measure of authentic leadership has also been established as a valid and reliable instrument in other studies	The concurrent and predictive validity of the safety climate scales were investigated by means of correlation analyses. Table 2 shows Pearson product-moment correlations between the safety climate scales and subjective risk perception, authentic leadership, and subjective health complaints. The predictive validity of the instrument was supported by meaningful correlations with validity indicators such as leadership, risk perception, health problems, and affective and attitudinal outcomes.
Identifying and addressing the limitations of safety	O'Connor, P., Buttrey, S. E., O'Dea,	Item 18 — I am not comfortable reporting a safety violation, because people in my command would react negatively toward me; • Item 23 — Command leaders permit cutting corners to get a job done; • Item 24 — Lack of experienced personnel has adversely affected my command's ability to operate safely; • Item 30 — My command has increased the chances of a mishap due to inadequate or	N/A	Given this fact, it was our original intention to conduct a confirmatory factor analysis in order to establish the construct

climate surveys	A., & Kennedy, Q. (2011).	incorrect risk assessment; and • Item 34 — Based upon my command's personnel and other assets, the command is over-committed.		validity of the CSAS. Once a stable factor structure was established, researchers could begin to evaluate the predictive validity of the instrument or model the factor structure for comparison within and across industries. However, during the initial data screening process (described in this paper), it quickly became evident that there were some serious threat to the validity of the data collected using the instrument.
Aviation safety climate questionnaire	O'Connor, O'Dea, Kennedy, & Buttery, 2011	This paper reviews 23 studies that have examined safety climate within commercial and military aviation. The safety climate factors identified in the aviation safety climate questionnaires were found to be consistent with the literature examining safety climate in non-aviation high reliability organizations	N/A	Therefore, it was concluded that the aviation safety climate tools had some construct validity (the extent to which the questionnaire measures what it is intended to measure). However, the majority of the studies made no attempt to establish the discriminate validity (the ability of the tool to differentiate between organizations or personnel with different levels of safety performance) of the tools. It is recommended that rather than constructing more

				aviation safety climate questionnaires, researchers should focus on establishing the construct and discriminate validity of existing measures by correlating safety climate with other metrics of safety performance
Safety Climate Survey	Sexton, J. B., Helmreich, R., Pronovost, P., & Thomas, E. (2003).	1. The culture of this clinical area makes it easy to learn from the mistakes of others. 2. Medical errors are handled appropriately in this clinical area. 3. The senior leaders in my hospital listen to me and care about my concerns. 4. The physician and nurse leaders in my areas listen to me and care about my concerns. 5. Leadership is driving us to be a safety-centered institution. 6. My suggestions about safety would be acted upon if I expressed them to management. 7. Management/leadership does not knowingly compromise safety concerns for productivity. 8. I am encouraged by my colleagues to report any safety concerns I may have. 9. I know the proper channels to direct questions regarding patient safety. 10. I receive appropriate feedback about my performance. 11. I would feel safe being treated here as a patient. 12. Briefing personnel before the start of a shift (i.e., to plan for possible contingencies) is an important part of safety. 13. Briefings are common here. 14. I am satisfied with the availability of clinical leadership (please respond to all three): Physician Nursing Pharmacy 15. This institution is doing more for patient safety now, than it did one year ago. 16. I believe that most adverse events occur as a result of multiple system failures, and are not attributable to one individual's actions. 17. The personnel in this clinical area take responsibility for patient safety. 18. Personnel frequently disregard rules or guidelines that are established for this clinical area. 19. Patient safety is constantly reinforced as the priority in this clinical area	N/A	N/A

Workforce perceptions of hospital safety culture: development and validation of the patient safety climate in healthcare organizations survey	Singer, S., Meterko, M., Baker, L., Gaba, D., Falwell, A., & Rosen, A. (2007).	Senior management provides a climate that promotes patient safety Q8 Senior management has a clear picture of the risk associated with patient care Q19 Senior management considers patient safety when program changes are discussed Q11 Senior management has a good idea of the kinds of mistakes that actually occur in this facility Q17 Good communication flow exists up the chain of command regarding patient safety issues Q4 Patient safety decisions are made at the proper level by the most qualified people Q6 Reporting a patient safety problem will not result in negative repercussions for the persons reporting it Q1 I am provided with adequate resources (personnel, budget, and equipment) to provide safe patient care Q30 I have enough time to complete patient care tasks safely Q29 Loss of experienced personnel has negatively affected my ability to provide high-quality patient care Q38 Overall, the level of patient safety at this facility is improving Q22 Compared with other facilities in the area, this facility cares more about the quality of patient care it provides Q28 I am asked to cut corners to get the job done In my unit, disregarding policy and procedures is rare Q7 In my unit, anyone who intentionally violates standard procedures or safety rules is swiftly corrected Q12 My unit does a good job managing risks to ensure patient safety Q9 My unit takes the time to identify and assess risks to ensure patient safety Q2 My unit emphasizes patient safety procedures and goals to new hires in their first 6 months of work Q32 In my unit, there is significant peer pressure to discourage unsafe patient care Q27 Individuals in my unit are willing to report behavior that is unsafe for patient care Q35 I am rewarded for taking quick action to identify a serious mistake Q14 My unit recognizes individual safety achievement through rewards and incentives Q37 My unit provides training on teamwork in order to improve	Cronbach's a coefficients ranged from 0.50 to 0.89.	Convergent item–scale correlations were substantial in magnitude, ranging from 0.20 to 0.77 across the nine proposed dimensions (median 0.51). Examination of the correlations between each item and its hypothesized scale in contrast to other scales revealed good item discriminant validity. For example, the first row of Table 3 (Q5) shows a significantly higher correlation between the item and its hypothesized scale (0.77) in contrast to other scales (0.00–0.62). C

		patient care performance and safety Q24 My unit follows a specific process to review performance against defined training goals Q13 If I make a mistake that has significant consequences and nobody notices, I do not tell anyone about it Q10 Asking for help is a sign of incompetence Q15 Telling others about my mistakes is embarrassing Q21 I will suffer negative consequences if I report a patient safety problem Q36 I have made significant errors in my work that I attribute to my own fatigue In the last year, I have witnessed a coworker do something that appeared to me to be unsafe for the patient Q33 I have never witnessed a coworker do something that appeared to me to be unsafe patient care Q34 In the last year, I have done something that was not safe for the patient Q18 I am less effective at work when I am fatigued Q20 Personal problems can adversely affect my performance Q23 I have learned how to do my own job better by learning about mistakes made by my coworkers Q26 If people find out that I made a mistake, I will be disciplined Q31 Clinicians who make serious mistakes are usually punished		
The development of a measure of safety climate: The role of safety perceptions and attitudes	Williamson, A. M., Feyer, A. M., Cairns, D., & Biancotti, D. (1997).	It would help me to work more safely if my supervisor praised me on safe behaviour It would help me to work more safely if safety procedures were more realistic It would help me to work more safely if management listened to my recommendations It would help me to work more safely if we were given safety training more often It would help me to work more safely if the proper equipment was provided more often It would help me to work more safely if management carried out more workplace safety checks It would help me to work more safely if my workmates supported safe behaviour It would help me to work more safely if I was rewarded (paid more) for safe behaviour Our management supplies enough safety equipment Our management checks equipment to make sure it is free of faults	With all 62 items, the obtained Cronbach alpha was 0.81 (n = 543) which was judged to be good.	The relationship between the two validation questions was not strong. While study participants who reported no dangers in their workplace were less likely to have experienced an accident (29.5% accidents compared to 70.5% no accidents), the group who reported dangers in their workplace were equally likely to have experienced an accident

		There is adequate safety training in my workplace Management in my workplace is as concerned with people's safety as it is with profits Everybody works safely in my workplace All the safety rules and procedures in my workplace really work Safety works until we are busy then other things take priority If I worried about safety all the time I would not get my job done I cannot avoid taking risks in my job Accidents will happen no matter what 1 do I can't do anything to improve safety in my workplace It is not likely that I will have an accident because I am a careful person Not all accidents are preventable, some people are just unlucky People who work to safety procedure will always be safe In the normal course of my job, I do not encounter any dangerous situations		(48.0% accidents compared to 52.0% no accidents).
Safety climate in industrial organizations: theoretical and applied implications.	Zohar (1980)	Based on the industrial safety literature described above, seven organizational dimensions were included in the initial version of the safety climate questionnaire. Factors: Perceived importance of safety training programs Perceived management attitudes toward safety Perceived effects of safe conduct on promotion Perceived level of risk at work place Perceived effects of required work pace on safety Perceived status of safety officer Perceived effects of safe conduct on social status Perceived status of safety committee	An attempt to test the second hypothesis directly by correlating safety climate scores with standard safety measures such as accident-frequency rate and accident-severity rate was terminated due to the apparent lack of reliability of these measures. This lack of reliability resulted from the fact that these measures were based on reports used for workers' compensation purposes.	Workers were interviewed by a team of three interviewers who read each item aloud and recorded subjects' agreement to it on the 5-point scale. These data were then factor analyzed using a principal-components factor analysis with varimax rotation. This procedure resulted in eight factors that largely overlapped the original ones, thus confirming the validity of the theoretical considerations for developing these questionnaire items.

Appendix J: Classification of Items based on Safety Climate Definition

Items that fit	Items that do not fit	Uncertain
I have the necessary competence to perform my job in a safe manner (Nielsen et al., 2013)	Worker given sufficient training period when entering firm, changing jobs or using new technique (Fernandez-Muniz et al., 2007)	"Students" learn hazards, and how to protect themselves and others (Cappucci et al., 1997)
Most of the job-specific safety trainings I receive are effective (Hon et al., 2012)	Management supports my daily efforts (Devriend et al., 2012)	My "department" follows a specific process to review performance against defined training goals (Singer et al., 2007)
It would help me to work more safely if we were given safety training more often (Williamson et al., 1997)	Management does not knowingly compromise patient safety: unit management and hospital management (Devriend et al., 2012)	This hospital does a good job of training new personnel (Devriend et al., 2012)
Our training program ensures all "students" who do the same job learn to do it the same way (Frazier et al., 2013)	Management is doing a good job: unit management and hospital management (Devriend et al., 2012)	All "students" can give examples of management's active commitment to safety and health (Cappucci et al., 1997)
When asked to do a new job or task, I receive enough training to be able to do it safely (Frazier et al., 2013)	Problem personnel are dealt with constructively by our: unit management and hospital management (Devriend et al., 2012)	I get adequate, timely info about events that might affect my work, from: unit management and hospital management (Devriend et al., 2012)
There is follow-up of training needs and of efficacy or repercussion of training previously given (Fernandez-Muniz et al., 2007)	The staffing levels in this clinical area are sufficient to handle the number of patients (Devriend et al., 2012)	The "university" really cares about the health and safety of the people who work here (Hon et al., 2012)
I tend to work more risky when supervisors aren't present. (Frazier et al., 2013)	Hospital management does not knowingly compromise the safety of patients (Kaya et al., 2010)	The "university" encourages suggestions on how to improve health and safety (Hon et al., 2012)
I also wear all the individual safety protection equipment when nobody supervises my work (Wang & Liu, 2012)	The levels of staffing in this clinical area are sufficient to handle the number of patients (Kaya et al., 2010)	Management does not knowingly compromise the safety of patients (Hutchins, 2006)
This "university" is doing more for "student" safety now than it did one year ago (Hutchins, 2006)	I am provided with adequate, timely information about events in the hospital that might affect my work (Kaya et al., 2010)	Leadership is driving us to be a safety centred organisation (Hutchins, 2006)

“Instructors” accepts “students” taking risks when the work schedule is tight (Kines et al., 2011)	Hospital administration supports my daily efforts (Kaya et al., 2010)	My suggestions about safety would be acted upon if I expressed them to “my instructor” (Hutchins, 2006)
Management looks for causes, not guilty persons, when an accident occurs (Kines et al., 2011)	The senior leaders in my hospital listen to me and care about my concerns (Kho et al., 2005)	We who work here have confidence in the management’s ability to deal with safety (Kines et al., 2011)
My suggestions about safety would be acted upon if I expressed them to management. (Kho et al., 2005)	The physician and clinical leaders in my areas listen to me and care about my concerns. (Kho et al., 2005)	Management encourages “students” to participate in decisions which affect their safety (Kines et al., 2011)
Management/leadership does not knowingly compromise safety concerns for productivity. (Kho et al., 2005)	Senior management has a clear picture of the risk associated with patient care (Singer et al., 2007)	Leadership is driving us to be a safety centered institution. (Kho et al., 2005)
Senior management has a good idea of the kinds of mistakes that actually occur in this facility (Singer et al., 2007)	Senior management considers patient safety when program changes are discussed (Singer et al., 2007)	The management takes input from the safety delegates seriously (Nielsen et al., 2013)
It would help me to work more safely if management listened to my recommendations (Williamson et al., 1997)	I know the proper channels to direct questions regarding patient safety in this clinical area (Devriend et al., 2012)	“Instructors” permit cutting corners to get a job done (O’Connor et al., 2011)
In my “department” management acts quickly to correct safety problems (Cox & Cheyne, 2000)	I know the proper channels to which I should direct questions regarding patient safety (Hutchins 2006)	Management acts decisively when a safety concern is raised (Cox & Cheyne, 2000)
In my “department” management turn a blind eye to safety issues (Cox & Cheyne, 2000)	Briefing personnel before the start of a shift is an important part of patient safety. (Kho et al., 2005)	Management acts only after accidents have occurred (Cox & Cheyne, 2000)
Corrective action is always taken when management is told about unsafe practices (Cox & Cheyne, 2000)	Things "fall between the cracks" when transferring patients from one unit to another (Smits et al., 2008)	It is easy for “students” here to ask questions when there is something that they do not understand (Devriend et al., 2012)
In my “department” “instructors” show interest in my safety (Cox & Cheyne, 2000)	Problems often occur in the exchange of information across hospital units (Smits et al., 2008)	We who work here can talk freely and openly about safety (Kines et al., 2011)
“Instructors” and supervisors express concern if safety procedures are not adhered (Cox & Cheyne, 2000)	My unit emphasizes patient safety procedures and goals to new hires in their first 6 months of work (Singer et al., 2007)	Safety decisions are made at the proper level by the most qualified people (Singer et al., 2007)

There is good communication here between “instructors” and “students” about health and safety issues (Hon et al., 2012)	Standard operating procedures have been developed for all critical tasks (Frazier et al., 2013)	Management operates an open door policy on safety issues (Cox & Cheyne, 2000)
Good communication flow exists up the chain of command regarding safety issues (Singer et al., 2007)	Firm coordinates its health and safety policies with other HR policies to ensure commitment and well-being of workers (Fernandez-Muniz et al., 2007)	Lessons learned from incidents and injuries are communicated to all relevant people. (Frazier et al., 2013)
Management clearly considers the safety of “students” of great importance (Cox & Cheyne, 2000)	Written declaration is available to all workers reflecting management's concern for safety, principles of action and objectives to achieve (Fernandez-Muniz et al., 2007)	People who work to safety procedure will always be safe (Williamson et al., 1997)
There is good communication here about safety issues which affect me (Cox & Cheyne, 2000)	Management has established in writing the functions of commitment and participation and the responsibilities in safety questions for all organization members (Fernandez-Muniz et al., 2007)	Sometimes it is necessary to depart from safety requirements for production's sake (Cox & Cheyne, 2000)
Safety information is always brought to my attention by my “instructor” (Cox & Cheyne, 2000)	Safety policy contains commitment to continuous improvement, attempting to improve objectives already achieved (Fernandez-Muniz et al., 2007)	I do not simplify any standard operation procedure because of being familiar with the operation of any equipment (Wang & Liu, 2012)
My “instructor” does not always inform me of current concerns and issues (Cox & Cheyne, 2000)	In this clinical area, it is difficult to speak up if I perceive a problem with patient care (Devriend et al., 2012)	My suggestions about safety would be acted upon if I expressed them to management (Devriend et al., 2012)
When rules or procedures are changed, the changes are promptly communicated to all affected “students” (Frazier et al., 2013)	In this clinical area, it is difficult to discuss errors (Devriend et al., 2012)	I am not comfortable reporting a safety violation, because people in my command would react negatively toward me (O’Connor et al., 2011)
My “department” values in the “students” correct observation of safety rules and procedures (Arghami et al., 2013)	When a mistake is made, but has no potential to harm the patient, how often is this reported? (Smits et al., 2008)	Reports about accidents or dangerous situations are often ‘‘embellished’’ (Nielsen et al., 2013)
“Students” can explain, and fully embraces, health and safety policy (Cappucci et al., 1997)	When a mistake is made that could harm the patient, but does not, how often is this reported? (Smits et al., 2008)	Telling others about my mistakes is embarrassing (Singer et al., 2007)

Not all the health and safety rules or procedures are strictly followed here (Hon et al., 2012)	When a mistake is made, but is caught and corrected before affecting the patient, how often is this reported? (Smits et al., 2008)	"Students" feel free to report safety hazards (Colarossi, 2012)
Some health and safety rules or procedures are difficult to follow (Hon et al., 2012)	In addition to corrective action, regular safety surveys result in updated hazard inventories (Cappucci et al., 1997)	I think management here does enough to follow up on recommendations from safety inspection and accident investigation reports (Hon et al., 2012)
In my "department", disregarding policy and procedures is rare (Singer et al., 2007)	Employees have had input to the hazard analysis for their jobs (Cappucci et al., 1997)	Accident investigations are mainly used to identify who should be blamed (Hon et al., 2012)
It would help me to work more safely if safety procedures were more realistic (Williamson et al., 1997)	Well trained employees at all levels conduct frequent and varied inspections, hazards of any kind are rare (Cappucci et al., 1997)	All incidents, even minor ones, are thoroughly investigated if they have potential for serious injury. (Frazier et al., 2013)
All the safety rules and procedures in my "department" really work (Williamson et al., 1997)	All loss-producing incidents and "near misses" are investigated for root cause with effective prevention (Cappucci et al., 1997)	All factors (e.g., inadequate training, production pressure, excessive overtime) are adequately considered during incident analyses (Frazier et al., 2013)
Safety procedures are carefully followed (Cox & Cheyne, 2000)	Our levels of staffing are sufficient to handle the number of patients (Goras et al., 2013)	"Instructors" regularly visit workplace to check work conditions or to communicate with "students" (Fernandez-Muniz et al., 2007)
Some safety rules and procedures do not need to be followed to get the job done safely (Cox & Cheyne, 2000)	Medical equipment in the ORs here is adequate (Goras et al., 2013)	I am less effective at work when fatigued (Kaya et al., 2010)
Some health and safety rules and procedures are not really practical (Cox & Cheyne, 2000)	I am satisfied with the availability of physician clinical leadership. (Kho et al., 2005)	Safety is considered when purchasing new tools/equipment (Frazier et al., 2013)
When people ignore safety procedures here, I feel it is none of my business (Cox & Cheyne, 2000)	I am satisfied with the availability of nursing clinical leadership. (Kho et al., 2005)	The people who lead safety efforts (e.g., safety reps, safety managers) have enough influence and staffing to adequately support safety. (Frazier et al., 2013)
Safety is considered when changes are made to rules and procedures (Frazier et al., 2013)	I am satisfied with the availability of pharmacy clinical leadership. (Kho et al., 2005)	We have enough staff to handle the workload (Smits et al., 2008)
"Students" feel comfortable identifying and self-correcting hazards (Cappucci et al., 1997)	I am satisfied with the availability of registered respiratory care	We work in "crisis mode" trying to do too much, too quickly (Smits et al., 2008)

	practitioner clinical leadership (Kho et al., 2005)	
I am encouraged by my "fellow students" to report any safety concerns I may have (Devriend et al., 2012)	Lack of experienced personnel has adversely affected my command's ability to operate safely (O'Connor et al., 2011)	Deficient maintenance has caused poorer safety (Nielsen et al., 2013)
Accidents that happen here are always reported (Hon et al., 2012)	Based upon my command's personnel and other assets, the command is over-committed (O'Connor et al., 2011)	All personnel have ownership of safety and health and can describe their active roles (Cappucci et al., 1997)
Supervisors sometimes turn a blind eye to people who are not observing the health and safety procedures (Hon et al., 2012)	I am provided with adequate resources (personnel, budget, and equipment) to provide safe patient care (Singer et al., 2007)	Employees are involved in conducting safety audits and inspections. (Frazier et al., 2013)
Reporting a safety problem will not result in negative repercussions for the persons reporting it (Singer et al., 2007)	I have enough time to complete patient care tasks safely (Singer et al., 2007)	Employees involved in creating guidelines for procedures and instruction manuals (Fernandez-Muniz et al., 2007)
I report any dangerous situations I see (Nielsen et al., 2013)	Loss of experienced personnel has negatively affected my ability to provide high-quality patient care (Singer et al., 2007)	Employees participate actively in devising, executing and monitoring safety plans (Fernandez-Muniz et al., 2007)
If I make a mistake that has significant consequences and nobody notices, I do not tell anyone about it (Singer et al., 2007)	The levels of staffing where I work are sufficient to handle the number of patients (Hutchins, 2006)	Colleagues participate in the setting of safety policy (Wu et al., 2010)
Trainees in my discipline are adequately supervised (Kaya et al., 2010)	Fatigue impairs my performance during emergency situations (eg, emergency resuscitation, haemorrhaging) (Kaya et al., 2010)	Employees are encouraged to fix safety hazards (Colarossi, 2012)
Sometimes conditions here hinder my ability to work safely (Cox & Cheyne, 2000)	Shift changes are problematic for patients in this hospital (Smits et al., 2008)	I am never involved in the ongoing review of safety (Cox & Cheyne, 2000)
All personnel believe they have the necessary resources to meet their responsibilities (Cappucci et al., 1997)	Important patient care information is often lost during shift changes (Smits et al., 2008)	Staff feel free to question the decisions or actions of those with more authority (Smits et al., 2008)
I have easy access to personal protective equipment (Nielsen et al., 2013)	Staff in this unit work longer hours than is best for patient care (Smits et al., 2008)	The culture where I work makes it easy to learn from the errors of others (Hutchins, 2006)
It would help me to work more safely if the proper equipment was	We use more agency/temporary staff than is best for patient care (Smits et al., 2008)	My "department" recognizes individual safety achievement

provided more often (Williamson et al., 1997)		through rewards and incentives (Singer et al., 2007)
Our management supplies enough safety equipment (Williamson et al., 1997)	My supervisor/manager seriously considers staff suggestions for improving patient safety (Smits et al., 2008)	If people find out that I made a mistake, I will be disciplined (Singer et al., 2007)
Our management checks equipment to make sure it is free of faults (Williamson et al., 1997)	Clinicians who make serious mistakes are usually punished (Singer et al., 2007)	Discipline for safety violations is fair and consistent. (Frazier et al., 2013)
When my workload becomes excessive, my performance is impaired (Kaya et al., 2010)	Managers, supervisors, and employees all know what behaviors will result in discipline. (Frazier et al., 2013)	Our safety reward/recognition program(s) encourage "students" to work safely and participate in safety activities. (Frazier et al., 2013)
Sometimes I am not given enough time to get the job done safely (Cox & Cheyne, 2000)	We are given feedback about changes put into place based on event reports (Smit et al., 2008)	Incentives frequently offered to workers to put in practice principles and procedures of action (e.g., correct use of protective equipment). (Fernandez-Muniz et al., 2007)
There are always enough people available to get the job done safely (Cox & Cheyne, 2000)	Patient safety is constantly reinforced as the priority in this clinical area. (Kho et al., 2005)	When an event is reported, it feels like the person is being written up, not the problem (Smit et al., 2008)
I cannot always get the equipment I need to do the job safely (Cox & Cheyne, 2000)	There are often concurrent work operations which lead to dangerous situations (Nielsen et al., 2013)	"Students" feel like their mistakes are held against them (Smit et al., 2008)
Employees frequently offer ideas and suggestions to improve safety (Frazier et al., 2013)	Management in my workplace is as concerned with people's safety as it is with profits (Williamson et al., 1997)	Sometimes it is necessary to take risks to get the job done (Hon et al., 2012)
Employees provide written suggestions in event of any deficiencies in working conditions (Fernandez-Muniz et al., 2007)	Safety is not compromised when determining production schedules, overtime, and staffing (Frazier et al., 2013)	Little is done to prevent accidents until someone gets injured (Hon et al., 2012)
Colleagues contribute to decisions to improve safety (Wu et al., 2010)	The actions of hospital management show that patient safety is a top priority (Smit et al., 2008)	I am aware that safety has become a major area for improvement in this institution. (Kho et al., 2005)
I only get involved in safety activities because I'm required to do so. (Frazier et al., 2013)	Hospital management seems interested in patient safety only after an adverse event happens (Smit et al., 2008)	Safety is my number one priority when I work (Nielsen et al., 2013)

I receive appropriate feedback about my performance (Hutchins, 2006)	Patient safety is never sacrificed to get more work done (Smit et al., 2008)	In practice, production takes priority over health, environment and safety (Nielsen et al., 2013)
"Students" are praised for working safely (Hon et al., 2012)	Life safety and physical health are priceless (Wang & Liu, 2012)	If I worried about safety all the time I would not get my job done (Williamson et al., 1997)
In my unit, there is significant peer pressure to discourage unsafe "practices" (Singer et al., 2007)	Medical errors are handled appropriately here (Hutchins, 2006)	Safety is not sacrificed for production during a job (Colarossi, 2012)
I am rewarded for taking quick action to identify a serious mistake (Singer et al., 2007)	Asking for help is a sign of incompetence (Singer et al., 2007)	Safety is more important than productivity (Colarossi, 2012)
It would help me to work more safely if my supervisor praised me on safe behaviour (Williamson et al., 1997)	When one area in this unit gets really busy, others help out (Smits et al., 2008)	Management considers safety to be equally as important as production (Cox & Cheyne, 2000)
I do not receive praise for working safely (Cox & Cheyne, 2000)	In this unit, people treat each other with respect (Smits et al., 2008)	"The Department" provides a work climate that promotes safety (Smit et al., 2008)
A no-blame approach is used to persuade people acting unsafely that their behaviour is inappropriate (Cox & Cheyne, 2000)	I will remind my colleagues about rectification when they violate safety rules (Wang & Liu, 2012)	Safety at work is as important as safety at home (Colarossi, 2012)
My supervisor often gives me positive feedback when s/he sees me working safely (Frazier et al., 2013)	I would feel safe being treated as a patient in this service (Hutchins, 2006)	I think safety is the responsibility of not only safety management personnel but also everybody (Wang & Liu, 2012)
My supervisor/manager says a good word when he/she sees a job done according to established safety procedures (Smit et al., 2008)	I am more likely to make errors in tense or hostile situations (Kaya et al., 2010)	My "department" does a good job managing risks to ensure safety (Singer et al., 2007)
Some of the "students" pay little attention to health and safety (Hon et al., 2012)	Mistakes have led to positive changes here (Smits et al., 2008)	My "department" takes the time to identify and assess risks to ensure safety (Singer et al., 2007)
We who work here take no responsibility for each others' safety (Kines et al., 2011)	All colleagues understand emergency response plans (Wu et al., 2010)	Accidents will happen no matter what 1 do (Williamson et al., 1997)
We who work here accept dangerous behavior as long as there are no accidents (Kines et al., 2011)	All colleagues understand emergency first aid (Wu et al., 2010)	There are systems in place to evaluate risks detected in all job positions. (Fernandez-Muniz et al., 2007)
I ask my colleagues to stop work which I believe is performed in an	Colleagues often fall from high places at work (Wu et al., 2010)	When a lot of work needs to be done quickly, we work together as a

unsafe manner (Nielsen et al., 2013)		team to get the work done (Smits et al., 2008)
I stop work if I believe that it may be dangerous for me or others to continue (Nielsen et al., 2013)	Colleagues regularly receive health checks (Wu et al., 2010)	I will not actively teach my colleagues when they do not understand safety operation procedures (Wang & Liu, 2012)
Safety works until we are busy then other things take priority (Williamson et al., 1997)	Everybody works safely in my workplace (Williamson et al., 1997)	In the last year, I have witnessed a co-worker do something that appeared to me to be unsafe (Singer et al., 2007)
Safety is not sacrificed for speed during a job (Colarossi, 2012)		I have never witnessed a co-worker do something that appeared to me to be unsafe (Singer et al., 2007)
Safety is not sacrificed for quality during a job (Colarossi, 2012)		In the last year, I have done something that was not safe (Singer et al., 2007)
The most important part of completing a job is being safe (Colarossi, 2012)		Not all accidents are preventable, some people are just unlucky (Williamson et al., 1997)
I believe that safety issues are not assigned a high priority (Cox & Cheyne, 2000)		After we make changes to improve safety, we evaluate their effectiveness (Smits et al., 2008)
I do not skip any safety step even for increasing work efficiency (Wang & Liu, 2012)		We are actively doing things to improve safety (Smits et al., 2008)
I cannot avoid taking risks in my job (Williamson et al., 1997)		Colleagues often fall or slip at work (Wu et al., 2010)
My coworkers look out for my safety (Colarossi, 2012)		Colleagues often cut themselves with equipment at work (Wu et al., 2010)
When I see a co-worker working at-risk, I caution him/her. (Frazier et al., 2013)		Colleagues often receive electric shocks at work (Wu et al., 2010)
Some jobs here are difficult to do safely (Hon et al., 2012)		
I pride myself on my ability to work safely (Colarossi, 2012)		
I hope to be known as a safe worker (Colarossi, 2012)		

Appendix K: Safety Policies Subscale Item Analysis

Items	Mean	Std. Dev.	Omitted Alpha	Frequency and (Percentage)					Pearson Correlation
				Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1. When safety rules or procedures are changed, the changes are promptly communicated to all affected students.	3.60	1.23	.781	2 (1)	23 (9)	46 (18)	122 (47)	51 (20)	.551**
2. My college values students' correct observation of safety rules and procedures.	4.14	.74	.788	-	7 (3)	23 (9)	150 (58)	77 (30)	.437**
3. Students can explain health and safety policies in the College.	3.07	1.07	.785	10 (4)	44 (17)	106 (41)	74 (29)	16 (6)	.487**
4. Not all the health and safety rules or procedures are strictly followed here.	3.11	1.20	.786	8 (3)	64 (25)	65 (25)	85 (33)	26 (10)	.501**
5. Some health and safety rules or procedures are difficult to follow.	3.10	1.27	.777	8 (3)	47 (18)	70 (27)	92 (36)	24 (9)	.589**
6. In my college, disregarding safety policies and procedures is rare.	3.57	1.21	.777	5 (2)	25 (10)	43 (17)	128 (50)	45 (17)	.585**
7. It would help students to work more safely if safety procedures were more realistic.	2.76	1.23	.791	22 (9)	59 (23)	91 (35)	55 (21)	16 (6)	.451**
8. All the safety rules and procedures in my college really work.	3.33	1.22	.769	1 (1)	20 (8)	72 (28)	124 (48)	21 (8)	.666**
9. Safety procedures are carefully followed.	3.52	1.05	.768	4 (2)	18 (7)	66 (26)	135 (52)	26 (10)	.688**
10. Some safety rules and procedures do not need to be followed to get the task done safely.	2.94	1.17	.795	15 (6)	71 (28)	74 (29)	71 (28)	19 (7)	.389**
11. Some health and safety rules and procedures are not really practical.	2.77	1.22	.781	11 (4)	73 (28)	72 (28)	74 (29)	9 (4)	.549**
12. Safety is considered when changes are made to rules and procedures.	3.59	1.35	.792	1 (1)	6 (2)	34 (13)	150 (58)	42 (16)	.466**
13. Safety is not sacrificed for speed during a task.	3.66	1.05	.784	3 (1)	36 (14)	44 (17)	123 (48)	49 (19)	.505**
14. Safety is not sacrificed for quality during a task.	3.76	.95	.785	2 (1)	18 (7)	47 (18)	143 (55)	44 (17)	.481**

Appendix L: Safety Training Subscale Item Analysis

Items	Mean	Std. Dev.	Omitted Alpha	Frequency and (Percentage)					Pearson Correlation
				Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1. Students have the necessary competence to perform tasks in a safe manner because of the safety training they have received.	3.71	.936	.681	4 (2)	23 (9)	48 (19)	142 (55)	39 (15)	.712**
2. Most of the safety training students receive is effective.	3.67	.960	.688	2 (1)	23 (9)	53 (21)	139 (54)	37 (14)	.696**
3. It would help students to work more safely if we received more frequent safety training.	2.73	1.10	.743	32 (12)	82 (32)	70 (27)	62 (24)	10 (4)	.583**
4. It would help students to work more safely if we were given better quality safety training.	2.52	1.05	.712	39 (15)	87 (34)	81 (31)	41 (16)	6 (2)	.648**
5. Our safety training program ensures all students who do the same task learn to do it the same safe way.	3.53	.995	.711	1 (1)	19 (7)	73 (28)	132 (51)	25 (10)	.639**
6. When asked to do a new job or task, students receive enough training to be able to do it safely.	3.70	.926	.685	1 (1)	20 (8)	55 (21)	142 (55)	36 (14)	.702**

Appendix M: Safety Communication Subscale Item Analysis

Items	Mean	Std. Dev.	Omitted Alpha	Frequency and (Percentage)					Pearson Correlation
				Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1. Students are recognized for working safely.	2.81	1.00	.648	15 (6)	85 (33)	90 (35)	55 (21)	10 (4)	.402**
2. Reporting a safety problem will not result in negative repercussions for the persons reporting it.	1.89	.94	.674	50 (19)	139 (54)	35 (14)	11 (4)	2 (1)	.191**
3. Students are rewarded for taking quick action to identify a safety problem.	2.71	1.38	.602	7 (3)	47 (18)	90 (35)	66 (26)	13 (5)	.661**
4. It would help students to work more safely if the instructors recognized and praised our safe behaviour.	2.47	.97	.677	27 (11)	118 (46)	73 (28)	29 (11)	8 (3)	.172**
5. Students are not blamed for acting unsafely.	2.40	1.04	.668	16 (6)	110 (43)	79 (31)	33 (13)	3 (1)	.266**
6. If students violate safety regulations they will be disciplined.	2.83	1.52	.644	6 (2)	30 (12)	62 (24)	103 (40)	13 (5)	.500**
7. Students are not comfortable reporting a safety violation, because they will be disciplined.	3.03	1.50	.637	2 (1)	32 (12)	56 (22)	107 (42)	24 (9)	.526**
8. Students' suggestions about safety would be acted upon if they expressed them to the instructors.	3.33	1.30	.619	1 (1)	9 (4)	66 (26)	137 (53)	19 (7)	.587**
9. There is good communication in the College between instructors and students about health and safety issues.	3.31	1.10	.622	9 (4)	25 (10)	78 (30)	120 (47)	16 (6)	.570**
10. Safety information is always brought to our attention by our instructor.	3.79	.88	.647	2 (1)	18 (7)	47 (18)	147 (57)	42 (16)	.405**
11. Our instructor does not always inform us of current safety concerns and issues.	3.41	1.00	.662	5 (2)	39 (15)	73 (28)	113 (44)	25 (10)	.300**
12. Students frequently offer ideas and suggestions to improve safety.	2.42	1.02	.634	19 (7)	108 (42)	81 (31)	34 (13)	2 (1)	.500**
13. Accidents that happen here are always reported and discussed.	2.43	1.57	.632	6 (2)	44 (17)	71 (28)	66 (26)	11 (4)	.556**

Appendix N: Attitudes about Instructors Subscale Item Analysis

Items	Mean	Std. Dev.	Omitted Alpha	Frequency and (Percentage)					Pearson Correlation
				Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1. In my college, the instructor acts quickly to correct safety problems.	3.53	1.23	.767	1 (1)	7 (3)	45 (17)	159 (62)	25 (10)	.616**
2. Corrective action is always taken when the college is told about unsafe practices.	3.22	1.58	.771	-	6 (2)	39 (15)	142 (55)	27 (11)	.644**
3. In my college, instructors pay serious attention to the safety of students.	3.82	.925	.765	1 (1)	7 (3)	40 (16)	164 (64)	39 (15)	.628**
4. Instructors and supervisors express concern if safety procedures are not adhered to.	3.74	1.05	.760	1 (1)	8 (3)	34 (13)	169 (66)	34 (13)	.655**
5. The college clearly considers the safety of students of great importance.	4.03	.846	.765	1 (1)	4 (2)	30 (12)	154 (60)	65 (25)	.634**
6. Instructors sometimes turn a blind eye to people who are not observing the health and safety procedures.	3.46	1.18	.772	5 (2)	28 (11)	53 (21)	128 (50)	32 (12)	.579**
7. Our college supplies enough safety equipment.	3.60	1.03	.764	7 (3)	27 (11)	46 (18)	140 (54)	34 (13)	.630**
8. Our college checks equipment to make sure it is free of faults.	2.73	1.70	.794	7 (3)	22 (9)	53 (21)	95 (37)	23 (9)	.561**
9. Sometimes conditions here hinder my ability to work safely.	3.62	1.01	.779	6 (2)	26 (10)	43 (17)	147 (57)	32 (12)	.499**
10. I cannot always get the equipment I need to do the task safely.	3.59	1.08	.770	3 (1)	33 (13)	36 (14)	145 (56)	34 (13)	.582**

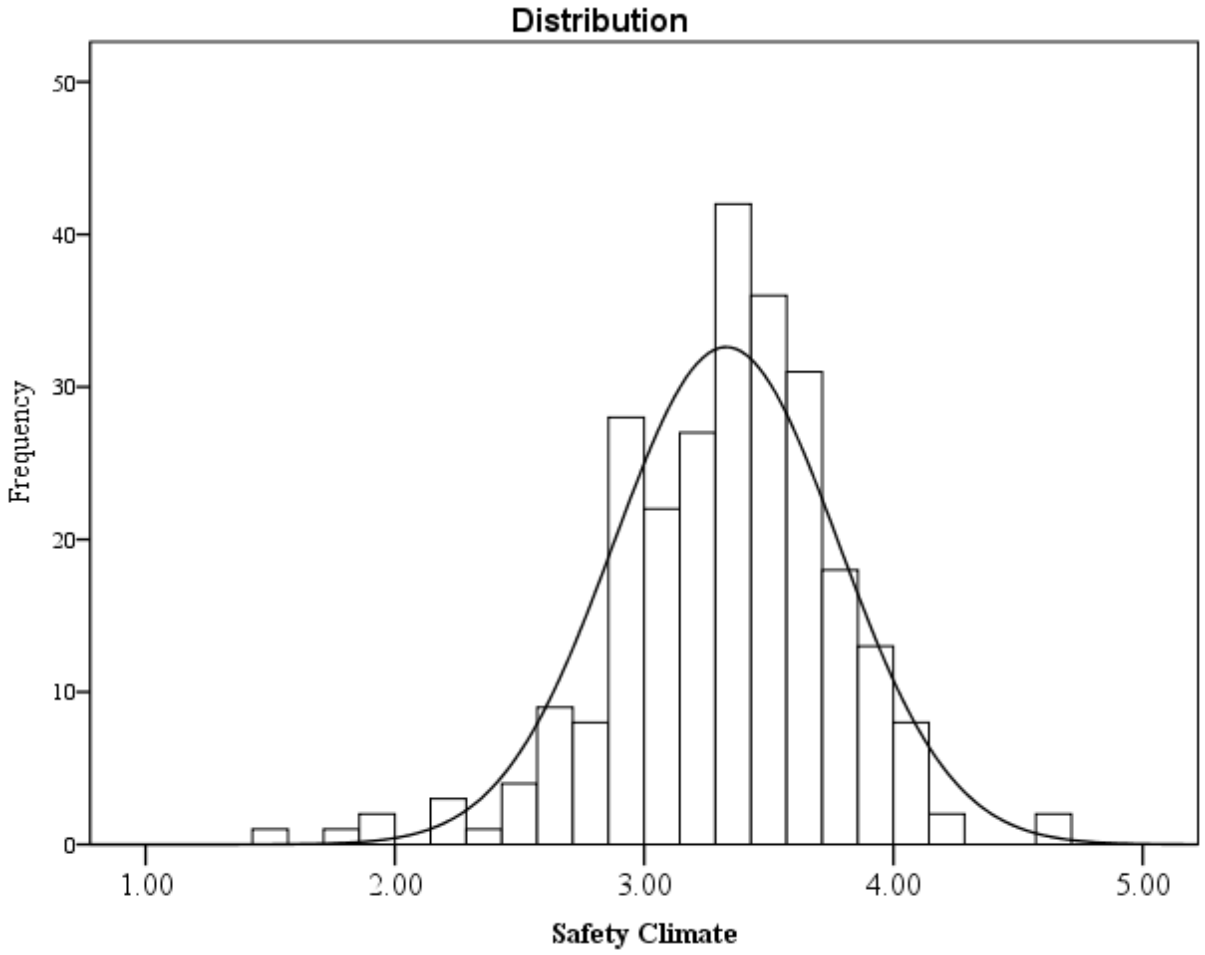
Appendix O: Attitudes about Fellow Students Subscale Item Analysis

Items	Mean	Std. Dev.	Omitted Alpha	Frequency and (Percentage)					Pearson Correlation
				Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1. I am encouraged by my fellow students to report any safety concerns I may have.	3.18	.935	.547	5 (2)	45 (17)	99 (38)	96 (37)	9 (4)	.603**
2. Students take no responsibility for each other's safety.	3.66	.837	.586	2 (1)	22 (9)	51 (20)	160 (62)	21 (8)	.485**
3. I ask my fellow students to stop work which I believe is performed in an unsafe manner.	3.62	.843	.548	-	20 (8)	58 (23)	159 (62)	17 (7)	.592**
4. My fellow students look out for my safety.	3.60	.891	.530	1 (1)	14 (5)	67 (26)	152 (59)	18 (7)	.638**
5. When I see a fellow student working at-risk, I caution him or her.	3.90	.749	.542	-	6 (2)	29 (11)	189 (73)	30 (12)	.607**
6. In my college, there is significant peer pressure to discourage unsafe practices.	2.91	1.12	.614	13 (5)	59 (23)	92 (36)	72 (28)	11 (4)	.501**
7. Students and instructors accept safety violations as long as there are no accidents.	3.29	1.27	.641	-	32 (12)	59 (23)	123 (48)	23 (9)	.505**

Appendix P: Reflections on One's Own Safety Attitudes Subscale Item Analysis

Items	Mean	Std. Dev.	Omitted Alpha	Frequency and (Percentage)					Pearson Correlation
				Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1. I tend to take more risks in my tasks when instructors aren't present.	3.33	1.06	.775	2 (1)	53 (21)	39 (15)	98 (38)	20 (8)	.547**
2. If I make a mistake that has significant safety consequences and nobody notices, I do not tell anyone about it.	3.36	1.11	.766	1 (1)	38 (15)	53 (21)	93 (36)	23 (9)	.623**
3. I believe the most important part of completing a task is being safe.	3.79	.967	.770	-	22 (9)	42 (16)	101 (39)	48 (19)	.575**
4. I believe that safety issues are not assigned a high priority in my College.	3.54	1.11	.777	5 (2)	23 (9)	44 (17)	106 (41)	31 (12)	.538**
5. I do not skip any safety step even to increase work efficiency.	3.39	.989	.763	2 (1)	37 (14)	57 (22)	98 (38)	18 (7)	.641**
6. I cannot avoid taking risks in my College.	3.43	1.13	.786	4 (2)	33 (13)	49 (19)	94 (36)	29 (11)	.468**
7. I believe some tasks here are difficult to do safely.	3.51	1.02	.780	1 (1)	40 (16)	42 (16)	101 (39)	29 (11)	.496**
8. I pride myself on my ability to work safely.	3.79	.836	.769	-	14 (5)	50 (19)	113 (44)	37 (14)	.589**
9. I hope to be known as a safe worker.	4.07	.736	.768	-	4 (2)	29 (11)	125 (48)	56 (22)	.610**
10. I only get involved in safety activities because I'm required to do so.	3.04	1.09	.792	16 (6)	56 (22)	57 (22)	71 (28)	14 (5)	.409**
11. When people ignore safety procedures here, I feel it is none of my business.	3.55	.862	.760	-	22 (9)	63 (24)	109 (42)	19 (7)	.668**
12. I practice the safety attitudes and behaviors I have learned in the College of Engineering in other contexts (i.e., home, work).	3.62	.996	.777	5 (2)	18 (7)	48 (19)	111 (43)	30 (12)	.522**

Appendix Q: Safety Climate Distribution Table



Appendix R: Safety Climate Questionnaire

University of Saskatchewan Department of Psychology

Participant Consent Form

You are invited to participate in a research study entitled:
Culture and Climate of Safety in Organizations: Conceptualization and Assessment
(BEH 16-204).

Researcher: Melanie Kaczur, Graduate Student, Applied Social Psychology, University of Saskatchewan, mek498@mail.usask.ca

Supervisor: Dr. Valery Chirkov, Applied Social Psychology, v.chirkov@usask.ca

Purpose and Objective of the Research:
The objectives of this study are to (1) gain a better understanding of the concept of safety climate and (2) to develop and test a safety climate questionnaire using participants from the College of Engineering.

The first set of questions you complete are intended to gather information about the current injury and accident rates you have experienced in the College of Engineering (including laboratories and other facilities), as this information is necessary to the further development of the questionnaire. This information about injuries and accidents will be kept strictly confidential. The next set of questions will be used to determine your perception and opinions about some of the safety practices and issues in the College of Engineering. The present study will help create a valid and reliable measure of safety climate that can be used by industry members to predict and prevent accidents. The combined results will be presented in academic journals and conference presentations.

Procedures:
- The first part of the questionnaire will ask questions about the number of injuries and accidents you have experienced. The following questions will ask about your safety perceptions, attitudes, and behaviors at the College of Engineering.
- Once you have completed the paper survey please place the questionnaire in the envelope provided to you.
- Upon completion of the questionnaire you will be provided with a Debriefing Form that will provide you with the contact information of the researchers if you have further questions. Please feel free to ask any questions regarding the procedures and goals of the study or your role.

Funded by: Funding for this project has been received from the Tri-Council SSHRC.

Potential Risks:
- There are no known or anticipated risks to you by participating in this research**.**
- You only need to answer questions that you are comfortable with, but try to answer all of them as incomplete data will not allow us to use your responses.

Confidentiality:

- Your data are completely confidential and no personally identifying information will be linked to your data. All data will be reported in aggregated form only. The data will be stored securely in electronic or hard-copy form in a secure laboratory at the University of Saskatchewan for a minimum of five years after completion of the study**.** When the data is no longer required, it will be permanently deleted and the questionnaires will be destroyed beyond recovery.

Right to Withdraw:

- Your participation is voluntary and you can answer only those questions with which you are comfortable. You may withdraw from the research project for any reason, at any time without explanation or penalty of any sort. Your right to withdraw data from the study will apply until surveys have been collected. After this time, it is not be possible to withdraw your data as it does not have any identifying information on it. At that point you will also be provided with a debriefing form.
- Whether you choose to participate or not will have no effect on your employment or class standing or how you will be treated.

Follow up:

- To obtain results from the study, please contact graduate researcher Melanie Kaczur, mek498@mail.usask.ca

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1
- This research project has been approved on ethical grounds by the University of Saskatchewan Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office ethics.office@usask.ca (306) 966-2975. Out of town participants may call toll free (888) 966-2975.

Consent:

By completing and submitting this questionnaire, **your free and informed consent is implied** and indicates that you understand the above conditions of participation in this study.

A copy of this consent will be left with you, and a copy will be taken by the researcher.

Safety Attitudes in the College of Engineering

The Department of Psychology together with the College of Engineering is conducting a survey about safety in the college. In this questionnaire we will ask you questions about your perceptions and attitudes regarding safety. There are no right or wrong answers as we are interested in your opinions. Please take the time to read the items and use the provided rating scales.

Section 1: Demographics *Please answer the following demographics questions.*

1. **What is your gender? Please checkmark your answer.**
   - ☐ Male
   - ☐ Female
   - ☐ Other

2. **What year were you born? Please write in the four digit year you were born (i.e., 1992).**

   _____

3. **What year of study are you currently in? Please checkmark your answer.**
   - ☐ First year
   - ☐ Second year
   - ☐ Third year
   - ☐ Fourth year
   - ☐ Fifth year or above

4. **Which engineering discipline are you in? Please checkmark your answer.**
   - ☐ Chemical & Biological Engineering (CBE)
   - ☐ Civil Engineering
   - ☐ Geological Engineering
   - ☐ Environmental Engineering
   - ☐ Electrical Engineering
   - ☐ Computer Engineering
   - ☐ Engineering Physics
   - ☐ Mechanical Engineering

5. **Do you have any previous industrial work experience (i.e., have you worked in the mining industry, construction industry, factory industry, manufacturing industry etc.) either as a permanent employee or as a summer student or intern? Please checkmark your answer. If yes, please state where you worked and what you did.**
   - ☐ Yes
   - ☐ No

   What kind of work experience? _____

Section 2: Safety Related Episodes in the College

Thinking back to your experiences at the university, which includes experiences that have occurred in the College of Engineering (i.e., does not include summer jobs or internships), answer the following questions. Please checkmark your answer.

Definition: ***A near miss is a narrowly avoided accident that could have resulted in an injury.***

1. While you have been at the College how many times have you personally ***experienced***:

	Never	1 to 5 times	6 to 9 times	Ten times or more
A near miss?				
A minor injury that required first aid?				
A major injury that required medical attention?				

2. While you have been at the College how many times have you ***witnessed***:

	Never	1 to 5 times	6 to 9 times	Ten times or more
A near miss?				
A minor injury that required first aid?				
A major injury that required medical attention?				
A fatality?				

Do you have any comments regarding <u>safety related episodes in the College</u>? Please write them below.

Section 3: Safety Attitude Questions

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to **your experiences at the College of Engineering**.

Safety Policies and Procedures

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
When safety rules or procedures are changed, the changes are promptly communicated to all affected students.						
My college values students' correct observation of safety rules and procedures.						
Students can explain health and safety policies in the College.						
Not all the health and safety rules or procedures are strictly followed here.						
Some health and safety rules or procedures are difficult to follow.						
In my college, disregarding safety policies and procedures is rare.						
It would help students to work more safely if safety procedures were more realistic.						
All the safety rules and procedures in my college really work.						
Safety procedures are carefully followed.						
Some safety rules and procedures do not need to be followed to get the task done safely.						
Some health and safety rules and procedures are not really practical.						
Safety is considered when changes are made to rules and procedures.						
Safety is not sacrificed for speed during a task.						
Safety is not sacrificed for quality during a task.						

Do you have any comments regarding <u>safety policies and procedures in the College</u>? Please write them below.

Safety Training

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
Students have the necessary competence to perform tasks in a safe manner because of the safety training they have received.						
Most of the safety training students receive is effective.						
It would help students to work more safely if we received more frequent safety training.						
It would help students to work more safely if we were given better quality safety training.						
Our safety training program ensures all students who do the same task learn to do it the same safe way.						
When asked to do a new job or task, students receive enough training to be able to do it safely.						

Do you have any comments regarding the safety training in the College? Please write them below.

Safety Communication

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
Students are recognized for working safely.						
Reporting a safety problem will not result in negative repercussions for the persons reporting it.						
Students are rewarded for taking quick action to identify a safety problem.						
It would help students to work more safely if the instructors recognized and praised our safe behaviour.						
Students are not blamed for acting unsafely.						
If students violate safety regulations they will be disciplined.						
Students are not comfortable reporting a safety violation, because they will be disciplined.						
Students' suggestions about safety would be acted upon if they expressed them to the instructors.						
There is good communication in the College between instructors and students about health and safety issues.						
Safety information is always brought to our attention by our instructor.						
Our instructor does not always inform us of current safety concerns and issues.						
Students frequently offer ideas and suggestions to improve safety.						
Accidents that happen here are always reported and discussed.						

Do you have any comments regarding the <u>safety communication in the College</u>? Please write them below.

Attitudes of Instructors and Supervisors

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Don't Know**
In my college, the instructor acts quickly to correct safety problems.						
Corrective action is always taken when the college is told about unsafe practices.						
In my college, instructors pay serious attention to the safety of students.						
Instructors and supervisors express concern if safety procedures are not adhered to.						
The college clearly considers the safety of students of great importance.						
Instructors sometimes turn a blind eye to people who are not observing the health and safety procedures.						
Our college supplies enough safety equipment.						
Our college checks equipment to make sure it is free of faults.						
Sometimes conditions here hinder my ability to work safely.						
I cannot always get the equipment I need to do the task safely.						

Do you have any comments regarding the <u>safety attitudes of instructors in your College</u>? Please write them below.

Students' Attitudes toward Safety

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Don't Know**
I am encouraged by my fellow students to report any safety concerns I may have.						
Students take no responsibility for each other's safety.						
I ask my fellow students to stop work which I believe is performed in an unsafe manner.						
My fellow students look out for my safety.						
When I see a fellow student working at-risk, I caution him or her.						
In my college, there is significant peer pressure to discourage unsafe practices.						
Students and instructors accept safety violations as long as there are no accidents.						

Do you have any comments regarding the <u>safety attitudes of fellow students in your College</u>? Please write them below.

Reflections on one's own Safety Attitudes and Behaviors

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
I tend to take more risks in my tasks when instructors aren't present.						
If I make a mistake that has significant safety consequences and nobody notices, I do not tell anyone about it.						
I believe the most important part of completing a task is being safe.						
I believe that safety issues are not assigned a high priority in my College.						
I do not skip any safety step even to increase work efficiency.						
I cannot avoid taking risks in my College.						
I believe some tasks here are difficult to do safely.						
I pride myself on my ability to work safely.						
I hope to be known as a safe worker.						
I only get involved in safety activities because I'm required to do so.						
When people ignore safety procedures here, I feel it is none of my business.						
I practice the safety attitudes and behaviors I have learned in the College of Engineering in other contexts (i.e., home, work).						

Do you have any comments regarding <u>your own safety attitudes and behaviors</u>? Please write them below.

THANK YOU!

University of Saskatchewan Department of Psychology

Participant Debriefing Form

Culture and Climate of Safety in Organizations: Conceptualization and Assessment **(BEH 16-204).**

Researcher: Melanie Kaczur, Graduate Student, Applied Social Psychology, University of Saskatchewan, mek498@mail.usask.ca

Supervisor: Dr. Valery Chirkov, Applied Social Psychology, v.chirkov@usask.ca

Safety culture and safety climate have been used as predictors of injuries and accidents for decades (Varonen & Mattila, 2000). However, current researchers are in disagreement over the definition and understanding of these terms (Cooper, 2000). This has lead of an abundance of safety questionnaires that are not accurately measuring the concept of safety culture and climate, leading to ineffective and misleading research. Due to this limitation, existing literature was analyzed in order to create a single, unified definition of safety culture and safety climate that was used to develop a valid and reliable assessment tool. This study was conducted in order to determine the validity and reliability of the developed questionnaire. It is hoped that it will be an applicable and effective measure of safety climate for industry members

Thank you very much for participating in our study. If you have any questions about the study or anything else you experienced in the study please feel free to email the researchers (mek498@mail.usask.ca or v.chirkov@usask.ca).

Thank you again for your help in conducting this study!

Appendix S: Shortened Version of the Safety Climate Scale

Section 3: Safety Attitude Questions

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to **your experiences at the College of Engineering**.

Safety Policies and Procedures

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Don't Know**
Some health and safety rules or procedures are difficult to follow.						
In my college, disregarding safety policies and procedures is rare.						
Safety procedures are carefully followed.						
Some health and safety rules and procedures are not really practical.						
Safety is not sacrificed for speed during a task.						
Safety is not sacrificed for quality during a task.						

Safety Training

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Don't Know**
Students have the necessary competence to perform tasks in a safe manner because of the safety training they have received.						
Most of the safety training students receive is effective.						
It would help students to work more safely if we received more frequent safety training.						
It would help students to work more safely if we were given better quality safety training.						
When asked to do a new job or task, students receive enough training to be able to do it safely.						

Safety Communication

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
Students are rewarded for taking quick action to identify a safety problem.						
Safety information is always brought to our attention by our instructor.						

Attitudes of Instructors and Supervisors

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
In my college, the instructor acts quickly to correct safety problems.						
Corrective action is always taken when the college is told about unsafe practices.						
Instructors and supervisors express concern if safety procedures are not adhered to.						
Sometimes conditions here hinder my ability to work safely.						
I cannot always get the equipment I need to do the task safely.						

Students' Attitudes toward Safety

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
Students take no responsibility for each other's safety.						
I ask my fellow students to stop work which I believe is performed in an unsafe manner.						
When I see a fellow student working at-risk, I caution him or her.						

Reflections on one's own Safety Attitudes and Behaviors

How strongly would you agree or disagree with the following statements? Please check the answer that you feel best applies to your experiences at the College of Engineering.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Don't Know**
I do not skip any safety step even to increase work efficiency.						
I cannot avoid taking risks in my College.						
I believe some tasks here are difficult to do safely.						
I pride myself on my ability to work safely.						
I hope to be known as a safe worker.						
When people ignore safety procedures here, I feel it is none of my business.						