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Organizational Practices Leading to a Positive Safety Culture: A Delphi Approach

Andrew Matthew Cwalina
Nova Southeastern University, cwalina@mynsu.nova.edu

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By
Andy M. Cwalina

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Andy M. Cwalina

We hereby certify that this Dissertation submitted by Andy M. Cwalina conforms to acceptable standards, and as such is fully adequate in scope and quality. It is therefore approved as the fulfillment of the Dissertation requirements for the degree of Doctor of Business Administration

Approved:

Regina Greenwood, D.B.A. — 5/15/13
Chairperson — Date

Ronald J. Chenail, Ph.D. — 5/29/13
Committee Member — Date

Terrell G. Manyak, Ph.D. — 5/15/2013
Committee Member — Date

Suri Weisfeld-Spolter, Ph.D. — 6/24/13
Chair, Doctoral Program — Date

J. Preston Jones, D.B.A. — 6/25/13
Interim Dean — Date

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A. M. Cwalina

Andy M. Cwalina

ABSTRACT

Organizational Practices Leading to a Positive Safety Culture: A Delphi Approach

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A positive safety culture has been shown to contribute to a firm's ability to avoid or reduce the occurrence of occupational accidents and injuries. In American workplaces alone 3,582 people died and 5.1 million people were disabled in 2009 and the cost to corporate America was $169 billion and an additional productivity loss of 95 million work days. The economic cost to each American household is about $1,200. Firms that establish and maintain a positive safety culture are able to achieve a competitive advantage in the market.

While much research exists showing the relationship between safety culture and accident reduction, less guidance is found on how companies might achieve such improvement through cultural change. Attempts have been made to determine the factor structure of safety culture, that is, the identification of the antecedents of a positive safety culture. However, to date no general consensus has emerged among researchers about the exact elements of the factor structure. Research methodologies have been blamed for biasing the research results and thereby causing the lack of consensus. This dissertation uses a different methodology, the Delphi method combined with Hofstede's well-known onion model of organizational culture, to determine those organizational practices that lead to a positive safety culture.

Delphi is a mixed methodology that begins with an exploratory approach followed by the more traditional quantitative method. The exploratory front-end was deemed appropriate given that prior traditional survey instruments most likely introduced researcher bias through a myopic view of safety culture. Delphi also differs by utilizing purposeful sampling versus random sampling which provides a high level of expertise to inform the research.

After four rounds of inquiry with a panel of experts, a consensus was reached on 18 organizational practices that lead to a positive safety culture. This research adds to the understanding of safety culture, provides useful information for both practitioners and academic researchers, and offers launch points for extensions of the research.

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INTRODUCTION

Introduction to the Chapter

Occupational fatalities across the globe number 350,000 annually and the International Labor Organization estimates that 300,000 of those fatalities could be prevented by well-managed safety programs (ILO, 2011). Such programs include the establishment and maintenance of an organizational culture that values accident and injury avoidance, i.e., a positive safety culture. The importance of safety culture could not be more apparent than by the accident investigation of British Petroleum's (BP) Texas City refinery explosion in 2005. Fifteen people were killed and 180 people injured in that accident. The Chemical Safety Board's Manager of Investigations noted that while "BP had a low recordable injury rate by OSHA reporting standards; their safety culture was in shambles" (Johnson, 2010, p. 39). OSHA fined BP $21 million for the accident. However, BP's failure to correct those safety culture issues in a timely manner resulted in an additional $87 million fine in 2009, just one year before the Deep Water Horizon drilling rig accident killed 11 people and is costing billions of dollars. Firms that possess a positive safety culture are able to avoid costs associated with workers compensation, litigation, and productivity loss resulting in a competitive advantage in the market (Rechenthin, 2004). Reason (1998) argues that a positive safety culture can, indeed, be engineered by adjusting those interacting elements that drive accident avoidance. Understanding the nature of those "interacting elements" and how they influence safety culture is the essence of this study.

Statement of the Problem

The management of safety culture requires an understanding of the specific underlying elements of that subculture, i.e. the "factor structure" of safety culture. This factor structure includes the breakdown of the manifestations of shared beliefs, values, and attitudes that are the antecedents to safety culture. Research to that end began in earnest in the late 1970's and the literature contains a plethora of studies aimed at identifying the factor structure of safety culture. However, the results taken as a whole present a wide variation in the factor structure (Clarke, 2000). In his review of the prominent literature, Guldenmund (2000) concluded that no general consensus of safety culture factor structure exists and that this variance is due primarily to context and methodology. Context-driven variances generally refer to the environment under which the research was conducted, for example, whether the sample was drawn from the construction worker population versus from a manufacturing population. Methodology refers to the research procedures or instruments used. To address the problem, this dissertation author uses an alternative methodology, namely the Delphi methodology, and Hofstede's onion model to determine factors that contribute to a positive safety culture.

Background of the Problem

The term "safety culture" gained notoriety in 1986 from the investigation of the Chernobyl disaster. The International Atomic Energy Agency (IAEA) determined that a faulty safety culture was the root cause of the accident (Glendon & Stanton, 2000). Further interest in the concept emerged from formal investigations of subsequent major accidents (e.g., Zeebrugge ferry capsizing, Piper Alpha accident, Clapham Junction disaster, Bhopal disaster) in which organizational and social factors were found to be key

contributors to the accidents and a deficient safety culture was frequently used as an all-encompassing explanation of such causal factors (Clarke, 2000). Additionally, regulatory agencies like the United Kingdom Health and Safety Executive (HSE) and the United States Occupational Safety and Health Administration (OSHA) have issued directives and guidelines (HSE, 1997; OSHA, 2003) encouraging the development of a "positive safety culture" to reduce the incidence of workplace accidents and injuries.

In the 1940's, Heinrich (1941) posited the idea that social and organizational factors influence safe behaviors. His model of accident causation asserted that human error, the root of all accidents, was the result of our ancestry and social environment (cultural factors). In later studies, researchers reported a range of factors from two (Dedobbeleer & Beland, 1991) to as many as 46 factors (Lee, 1998) as the underlying determinants of safety culture. In short, researchers have demonstrated that no clear consensus has been found for a complete factor structure. However, evidence suggests that organizational practices defined under the umbrella of safety culture appear to influence safety behaviors.

Purpose of the Study

The purpose of this study is to identify those organizational practices (independent variables) that lead to the establishment and maintenance of a positive safety culture (dependent variable). This study differs from the previous research by using a mixed-methodology, namely the Delphi technique. Reid (1988) describes the Delphi technique as a systematic collection and aggregation of informed judgments from a panel of experts on specific issues within a specific field. As previously discussed, numerous quantitative studies (Barling, Loughlin, & Kelloway, 2002; Bottani, Monica, &

Vignali, 2009; Brown & Holmes, 1986; Gillen, Baltz, Gassel, Kirsch, & Vaccaro, 2002; Hofmann & Stetzer, 1998; Lee, 1998; Lee & Harrison, 2000; McFadden, Henagan & Gowen, 2009; and Zohar 2000, 2002a, 2002b) have been conducted to determine the dimensions that make up safety culture and their relationships to safety performance. However, Clarke (2000) notes: "There remains no universal agreement on the definition of safety culture … and little theoretical underpinning for much of the empirical work" (p. 65). Cooper (2000) suggests that much of the empirical confusion is indicative of a need to examine the safety culture construct under a wider range of context.

By their design, the investigators who conducted the majority of these previous studies examined the applicable relationships of a pre-determined set of safety culture dimensions. In contrast, the Delphi methodology in this dissertation study contains an element of exploratory research on the front-end which opens the study to previously unreported insights and thus eliminates the bias from a priori knowledge. A broader context is more readily accommodated by using a Delphi approach. For example, the panel of experts can be configured with professionals from a broader range of industries, thereby removing industry-specific bias that has been shown to influence the results (Smith, Chen, Ho, & Huang, 2006).

Inaki, Landin, and Fa (2006) noted in their studies on quality management (QM) that empirical research using quantitative methods based on surveys produced results distorted by organizational position bias of the informants. Managers were expected to conform to the "party line" with regard to QM. Again, a purposefully configured panel of experts, combined with the iterative rounds in the Delphi protocol, can minimize this position bias. In short, the use of a Delphi methodology for this dissertation study

provides an opportunity to make a unique research contribution to understanding the safety culture.

Justification of the Study

Occupational fatalities across the globe are estimated to be 350,000 annually and, according to the International Labor Organization, 300,000 of those fatalities could have been prevented by well-managed safety programs (ILO, 2011). In American workplaces alone 3,582 people died and 5.1 million people were disabled in 2009 (NSC, 2011). The National Safety Council estimates these accidents cost corporate America $169 billion and an additional productivity loss of 95 million work days (NSC, 2011). The economic cost is about $1,200 to each American household (NSC, 2011). Clearly, firms that establish and maintain a positive safety culture that supports the reduction or elimination of occupational accidents and injuries are able to achieve a competitive advantage in the market (Rechenthin, 2004). Clarke (1999) points out that "while some research evidence suggests that a positive safety culture will improve safety performance, there is less guidance on how companies might achieve such improvement through cultural change" (p. 186). Reason (1998) argues that a positive safety culture can, indeed, be engineered:

> Achieving a safe culture does not have to be akin to a religious conversion – as it is sometimes represented. There is nothing mystical about it. It can be acquired through the day-to-day application of practical down-to-earth measures. Nor is safety culture a single entity. It is made up of a number of interacting elements, or ways of doing, thinking, and managing, that have enhanced resistance to operational dangers as their natural by-product. (p. 305)

Understanding the nature of those "interacting elements" and how they influence safety culture is the essence of this dissertation.

Applicable Theoretical Model

Hofstede's (2001) "onion" model of cultural manifestations will be used as the theoretical lens in this study to examine the practices that support a positive safety culture. Hofstede's model, which is based upon the works of mid-twentieth century anthropologists and sociologists, posits that shared values are at the core of organizational cultures. Hofstede further notes that values are not directly observable but rather manifest themselves outwardly through the organization's practices, namely rituals, symbols, and heroes. He likens these practices to individual layers of an onion, concentrically wrapped around values at the core. Figure 1 depicts the onion model graphically, where rituals, symbols, and heroes are the practices that manifest the core values of the organization. As the onion model is applied in this dissertation study, the core organizational culture is safety culture and the surrounding layers are the manifestations, or practices, that are identified in this study.

Research Questions

The statement of the problem noted that occupational accidents can be reduced by the establishment of a positive safety culture and that certain organizational practices are related to the establishment of safety culture. Therefore, the following questions are pertinent to addressing the problem stated for this dissertation;

Question #1: What practices are used by the members of organizations to establish or maintain a positive safety culture within those organizations?

Question #2: Does consensus exist among a panel of safety experts for the set, or subset, of the practices discovered by the first research question?

Definition of Terms

Organizational culture: "A pattern of shared basic assumptions learned by a group as it solved its problems of external adaptation and internal integration, which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems" (Schein, 2010, p. 18).

Subculture: The fraction of the organizational culture that is defined by a specific assumption or specific set of assumptions aimed at solving a specific problem of adaptation and integration (Schein, 2009, 2010).

Safety Culture: "The shared attitudes, values, beliefs, and practices of people at work concerning not only the magnitude of the risks that they encounter but also the necessity, practicality, and effectiveness of preventive measures" (Booth, 1996, p. 313).

Safety Program: The systematic set of physical and organizational controls used to intervene in the accident causation process and to break the causation chain (Bottani, Monica & Vignali, 2009).

Delphi Method: A process to achieve a consensus opinion among knowledgeable respondents through repetitive and iterative inquiries (Dressel, Consoli, Kim, & Atkinson, 2007). These knowledgeable respondents comprise the "panel of experts" that is queried on three or more separate instances. Each inquiry reiterates the results of the previous inquiry such that a subsequent response of the panel converges on consensus results.

Practices: Following Hofstede (2001), practices are subdivided into: symbols, heroes, and rituals. Symbols are the words, gestures, pictures, and objects that carry the meanings of the culture and are recognized only by those who share the culture. Heroes are persons, alive or dead, real or imaginary, who outwardly possess the characteristics that are highly prized by those who share the culture. Rituals are the collective activities that are technically unnecessary for achievement of the organization's goals, but are considered socially essential by those who share the culture.

Onion Model: Hofstede's (2001) pictorial representation of culture's observable manifestations. At the core of culture are the shared values with the organizational practices, namely the rituals, heroes, and symbols that surround the core values like the layers of an onion. Figure 1 illustrates Hofstede's (2001) Onion Model.

Delimitations

The following areas and discussion of each defines the boundaries of the research included in this dissertation.

Work Setting Risk. Panel experts were selected from organizations that have been deemed to have sufficient risk to warrant a formalized occupational safety program specified by the firm. Accidents can, however, occur in any work setting, but certain work contexts make formalized safety programs impractical or unreasonable. For example, telecommuters, sales representatives, and similar remote workers may not interact sufficiently with their corporate peers to establish a safety culture, or at least a shared set of values regarding safety.

Similarly, many jobs do not inherently entail enough risk to warrant a formalized safety program. Data processors are subjected to much less risk and sustain far fewer

injuries than construction workers. Consequently, data processors are frequently not included in rigorous safety programs. Therefore, job settings with low safety risk are not specifically included in this study.

Industry differentiation. Hazards differ according to industry type. In this dissertation study, no attempt was made to drill down and delineate industry specific practices. For example, prior safety culture research demonstrated that the practice of hazard training is an antecedent to positive safety culture (Fang et al., 2006; Faringtон-Darby et al., 2005; Silva et al, 2004). However, the content and frequency of the training can differ significantly according to the uniqueness of the job hazards. In this dissertation study, I address the broader category of training and exclude job or industry specifics. Other organizational practices identified by this research are similarly limited to the same broader categories.

Background of Delphi Panel Experts. Panel members originate from four groups of people: (a) principal corporate officers, i.e., CEO, COO, presidents, and equivalent, (b) safety professionals, (c) auditors or inspectors, and (d) external consultants. These groups were selected because they most likely possess a wide cross-sectional view of the organization. Positions with narrower views, such as shop floor operators or trades specialists, have been excluded. Consequently, job specifics within the firm are not examined.

Assumptions

The concepts of safety climate and safety culture are assumed to be interchangeable when the ultimate outcome is accident avoidance. While the literature

does contain arguments for separateness, an equal number of precedent cases exist within the same literature for interchangeability.

Chapter I Conclusion

Management practitioners can improve organizational safety performance (accident and injury reduction) by instilling and maintaining a positive safety culture. Researchers have demonstrated that the foundational elements of safety culture (the antecedents) vary widely depending on the context and methodology of the study. Hofstede's (2001) Onion Model provides a theoretical base from which organizational practices can be viewed as the manifestations of safety culture and serve as the proxy to measure its existence. Also, in this dissertation, the Delphi technique was used as a methodological alternative to traditional survey instruments organizational and contextual bias is minimized. These biases are thought to be major contributors to the lack of consensus of the factor structure in prior published research.

Organization of the Remainder of the Dissertation

The remainder of this dissertation is organized as follows: In Chapter II, a review of the literature is provided that examines the Hofstede Onion Model, accident prevention, safety culture and its factor structure, and the Delphi methodology; in Chapter III the Delphi research methodology, the expert panel, the rounds of inquiry, and the research design are discussed; Chapter IV provides a summary presentation of the data and an analysis thereof; and Chapter V provides a discussion of the results, conclusions, implications for practitioners, limitations, and extensions for further research.

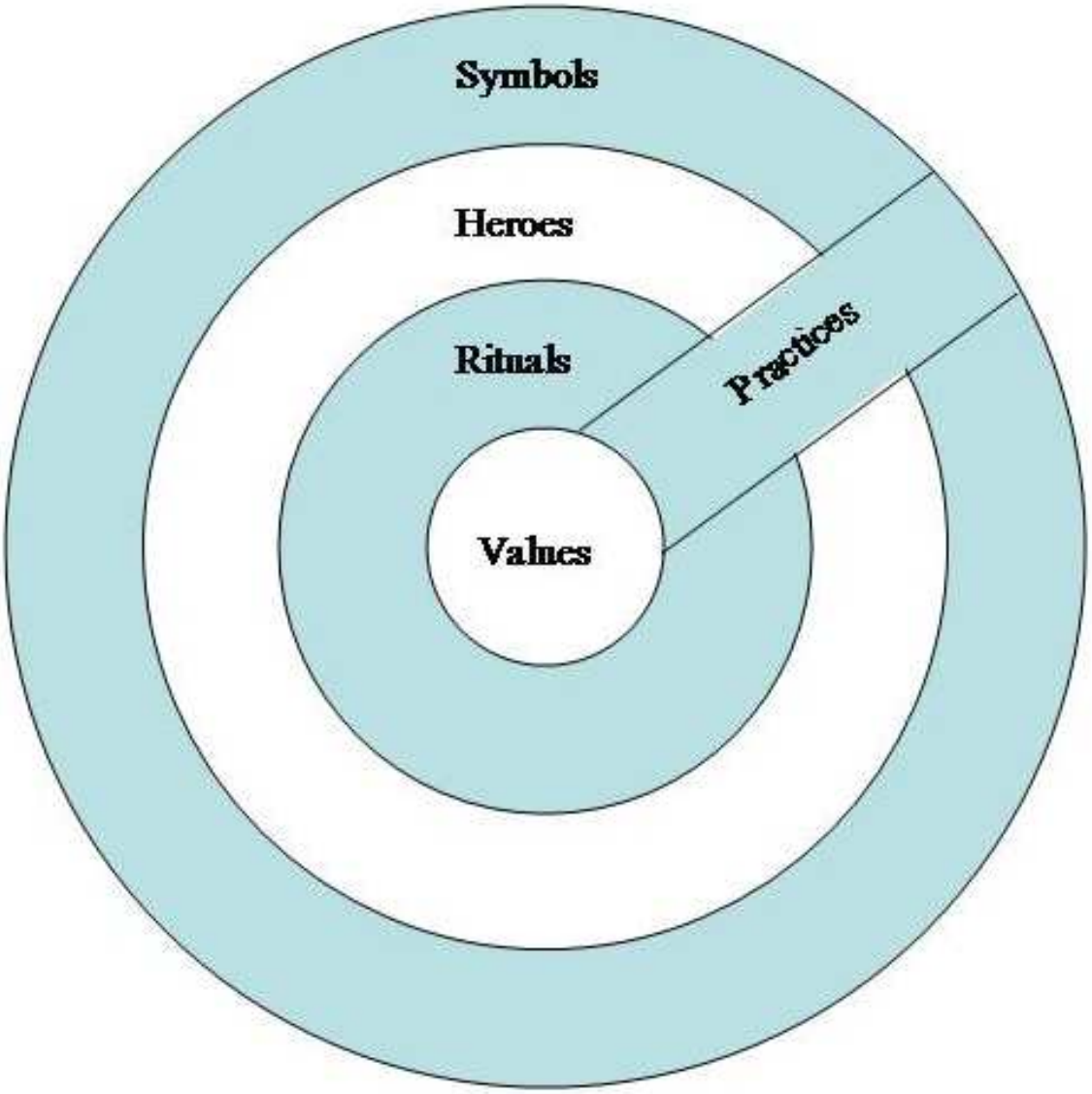

Figure 1: Hofstede's (2001) Onion Model showing the manifestations of culture as they are related to core values. Adapted from *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations across Nations* (p. 11), by G. Hofstede, 2001, Thousand Oaks, CA: Sage. Copyright 2001 by Geert Hofstede.

CHAPTER II

LITERATURE REVIEW

Introduction to the Chapter

The objective of this chapter is to examine the existing research on organizational culture, safety culture, the practical application of safety culture to avoid injuries and accidents, the measurements of safety culture, and the Delphi methodology. Five streams of literature are reviewed: (a) the literature that leads to the selection of Hofstede's onion model of culture as the theoretical basis for this study and the onion model broken down into the elements that manifest culture; (b) the body of literature that supports the existence of an organizational subculture commonly called safety culture; (c) the body of literature supporting the positive correlation between safety culture and safety performance; (d) the body of literature that contains the analyses of the social and organizational elements that comprise the structure of safety culture and the lack of consensus on that structure; and (e) the final literature stream in which research methodologies are compared, and more specifically, the application of the Delphi technique.

Culture and Hofstede's Onion Model

The survival of mankind thus far has, to a large extent, depended on the ability of individual people to act together as a social unit or organization. Social scientists Meyerson and Martin (1987) place those abilities, and their underlying elements, under the umbrella of the culture of an organization. They called it "the social or normative glue

that holds together a potentially diverse group of organizational members" (p. 623). Organizational culture research has a long history with researchers producing a number of definitions for culture. Some prominent examples include Deal and Kennedy (1982) who used the definition as norms, values, and beliefs of the group. Moran and Volkwein (1992) defined culture as an "ideational system focused on the patterns of meaning represented through values, norms, formal knowledge, beliefs, and expressive forms" (p. 33). O'Reilly and Chatman (1996), whose definition of culture is consistent with Kotter and Heskett (1992) and with Rousseau (1990), conceptualize it as a "system of shared values (that define what is important) and norms that define appropriate attitudes and behaviors for organizational members (how to feel and behave)" (p. 160). Schein's (1990) definition states that culture is "a pattern of shared basic assumptions that the group has learned as it solved problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems" (p. 111). These more frequently cited definitions, and the many others in the literature, share some common threads. The most common is that "values" are at the core of culture, and they are "shared" by the members. Even Schein (2009), who did not include values in his initial definition, points out later in his writings that values are derived from the tacit assumptions used in his definition of culture.

Hofstede's (2001) onion model of culture has the concept of values at its core, with three observable manifestations of culture (symbols, heroes, and rituals) surrounding values like layers of an onion (see Figure 1). Symbols are "words, gestures, pictures, and objects that carry complex meanings recognized uniquely by the members of the culture"

(Hofstede, 2001, p. 11). Heroes are "persons, alive or dead, real or imaginary, who are highly prized by the members of the culture and serve as behavioral models" (Hofstede, 2001, p. 11). Rituals are the "collective activities which may not be technically essential to the desired goals but are considered socially essential by the members of the culture" (Hofstede, 2001, p. 11). Hofstede (2001) subsumes these three observable manifestations under the term "practices." He posits that at the core of culture, values are invisible until they are observed through overt practices.

Safety culture researchers have made extensive use of the Hofstede onion model. In their analysis of the development of safety culture, McDonald and Ryan (1992) noted that employees do not act in a vacuum but exercise the practices of the safety culture to which they belong. In his work on organizational adoption of lessons learned from serious accidents, Reason (1998) suggests that Hofstede's onion model best illustrates how a safety culture can be engineered via regimented practices aimed at goal behavior. Mearns, Flin, Gordon, and Fleming (1998) studied safety cultures of off-shore oil rigs and used the practices described by the Hofstede onion model as variables that differentiated strategic versus tactical management of safety culture. They concluded that senior management (strategists) was more involved with "symbols" and "rituals" while the work force (the tacticians) placed more importance on their immediate supervisors, the "heroes." Cooper (2000) posited a model for future safety culture research using Bandura's Social Cognitive Theory that relied heavily on the layered approach, frequently citing Hofstede's onion model. In his analysis of making changes (strengthening) to safety culture, DeJoy (2005) points to Hofstede's onion model to illustrate how the manifestations of culture are the most accessible structural elements

that can be adjusted for the purpose of modifying the safety culture. Finally, Guldenmund (2000) analyzed 20 years of safety culture research literature to conclude that a broad consensus existed among the authors about using Hofstede's multi-layered concentric model of safety culture to justify safety culture's influences and consequences.

Safety Culture

History

A brief literature review of the evolutionary history of occupational safety is appropriate as a prelude to the discussion of safety culture. Allen and Ritzel (1996) point out that in the *Pentateuch* (the initial five books of the Western Bible), written between 1500 BC and 1400 BC, Moses directed the establishment of three separate cities of refuge. This action suggested an attempt to avoid fatalities and improve survival by providing "redundancy," a common modern engineering approach to hazardous consequence mitigation. Gaius Plinius Secundus, a.k.a. Pliny the Elder, a philosopher and student of rhetoric, precautioned miners in about 50 AD to wear a veil over their faces to guard against breathing airborne dust (Allen & Ritzel, 1996). While curiously interesting, this early evidence of concern for worker safety is at best anecdotal and more likely reflects a purpose other than a business-oriented motivation for occupational safety.

Interest in the welfare of workers was seeded in the 1700's by the Industrial Revolution which brought about a new class of industrial workers who were being uprooted from their agrarian lifestyles. The supply of labor for this new labor-intensive environment was either short or sporadic due to the changing nature of employment (Wren, 2005). These workers had difficulty leaving the farm to work in crowded,

monotonous, and demanding factory environments. They frequently worked only the days needed to earn just enough pay to get them through the week, then remained absent until the next week or until the family needed more money. Factory owners found themselves continuously scrambling for productive labor. Those entrepreneurs who struggled to assemble a stable and reliable work force certainly did not want to lose them to job-related injuries. After arriving in the USA, E. I. du Pont recognized this need and posted safety rules at his gunpowder mills on the Brandywine River in Delaware. He cautioned employees that adherence to the rules was a condition of employment (DuPont, 1952). In Europe, Frederick the Great of Prussia, King Louis XVI, and Napoleon all established safety rules and inspections systems for miners (Allen & Ritzel, 1996) especially after the deployment of the Newcomen steam pump that significantly increased mine output (Wren, 2005). These were examples of individualized entrepreneurial efforts to promulgate workplace safety. The first significant institutional effort occurred in England in 1833 during the period of rapid industrialization, when the first laws governing industrial safety were passed. In the United States, after the conclusion of the civil war, Massachusetts passed laws in 1867 governing factory inspections and in 1877 required mechanical guards on rotating machinery (Hale & Hovden 1998).

These examples of the beginnings of occupational safety concern initiated what Hale and Hovden (1998) describe as distinct “eras” of management approaches to the problem. The beginning of each era is attributed to a specific hallmark in business or the social and behavioral sciences, but none of these eras has a clear endpoint. Nevertheless, the priorities in management thought clearly changes from one era to the next.

The engineered safeguards era began in the late 1800's as several states passed laws regarding occupational safety. The prevailing management thought during this era was that accidents were unpreventable and that safety emphasis would be placed on mitigating the consequences and compensation for the widows (Eastman, 1911). The engineered safeguards approach employed devices designed by engineers to keep workers out of harm's way. Typical devices included mechanical guards, energy relief devices (e.g., fuses, pressure-relief valves, and rupture discs), physical barriers (e.g., walls, banisters, and handrails), and personal protective equipment (e.g., air masks, safety glasses, ear plugs, dead man controls, and limit switches). These devices were intended to either separate the worker from dangerous energy and conditions or make it more difficult for the workers to put themselves into hazardous situations.

Meehan (1995) notes that engineered safeguards were an inevitable first approach during the 1800's when the rapid pace of industrialization and mechanization frequently overwhelmed the ill-prepared workers. They were already having difficulty with transitioning to the overcrowded factory environment and could only cope with a passive approach to safety.

Eastman (1911) notes that not all factories were equipped with engineered safeguards during this era. She points out that, while many laws required firms to provide a safe workplace, enforcement of these laws was minimal. Further, no requirements were in place for investigating accidents and reporting or maintaining safety statistics or data for performance evaluation. Eastman (1911) cites an example in 1909 where seven New York firms were prosecuted for violating accident prevention laws, but only two of those firms were fined a total of $35. While the institution of engineering

safeguards improved safety performance, the inability or unwillingness to establish the approach set the stage for transitioning to a new era that demanded changes in organizational cultures.

The safety culture era was ushered in with the publication of Heinrich's (1931) book, *Industrial Accident Prevention*. It was based on the analysis of thousands of accidents and the application of general management principles (Heinrich, 1941). He concluded that most accidents were preventable, which was in stark contrast to the management thought of the previous era. Heinrich viewed safety through a social organization paradigm in contrast to a technical view. It is this paradigmatic shift that demarcates the transition between eras. Engineered safeguards continued to be invented, engineered, and deployed, even to the present day. However, managements' thoughts were redirected toward the human side of accident prevention.

Heinrich (1941) posited the "domino model" for accident causation. He suggested that a series of connected evolutions/events, like dominos pushing one over after the other, led to a fatality or serious injury. He asserted that an injury or fatality, the fifth domino, is caused by an accident, the fourth domino, which in turn is caused by an unsafe act or unsafe condition, the third domino. He further asserts that the commission of an unsafe act, or setup of an unsafe condition, is the result of human error, the second domino, and that human error is caused by our ancestral culture or social environment, the first domino. Heinrich (1941) proposed that management thought should be focused on intervening between the first, second, and third dominos rather than between the fourth and fifth as was done in the previous era. This new focus ultimately brought about the concept of safety culture.

This new approach had a historic dark side. Because occupational safety legislation was weak and resided at the state level, an injured worker was required to sue the employer to establish fault and obtain compensation (Allen & Ritzel, 1996). However, upon close examination of the domino model, one might conclude that accidents are completely attributable to the worker's beliefs, attitudes, and actions and that management bears no causal responsibility for accidents or injuries. In the early development of this model, it was not uncommon for management to take this approach (Brown, Prussia, & Willis, 2003; Peters, 1986) and shirk accountability for injuries. Unions attempted to reverse this logic by including safety in their bargaining portfolio (Della-Giustina & Della-Giustina, 1992). However, the union approach backfired when some legal circles deemed that safety was perhaps the unions' responsibility (Della-Giustina & Della-Giustina, 1992; Hodson & Spigener, 1997). Had this paradigm been allowed to continue, management practices may never have evolved to a point where management takes ownership of the safety culture and plays a significant role in occupational safety. It took until the late 1900's with the passage of the Occupation Safety and Health Act (OSHA) at the federal level to dispel this employer-worker controversy (Safety, 2007).

The Culture

Safety culture is best understood as a subset of the more general concept of organizational culture (Mohamed, 2003). The definition of organizational culture varies widely depending on the field of study from which it historically evolved. For example, researchers studying the disciplines of psychology, sociology, and social anthropology all

provide theoretical, epistemological, and methodological approaches to culture with differing ontologies. According to Ashkanasy, Wilderom, and Peterson (2000) culture is reflected by three different ontologies: (a) structural realism is where an organization exists as a structure and culture is a property of that structure; (b) social construction emphasizes the regularity of events, of which a subset of events is grouped together into a culture; and (c) linguistic conveniences is where organizational attributes, including culture, serves heuristic purposes of helping members think and reason. In his seminal work on organizational culture, Schein (1990) simplifies this second ontology of social construction as "the way we do things around here," i.e. the organizational practices. In this dissertation study, the author applies the second ontology for which the regularity of events can be equated with established organizational practice and, more specifically, those organizational practices linked to establishing and reinforcing a positive safety culture.

The goal of a positive safety culture is the elimination of accidents (Clarke, 2006). Accident causation attributed to the socio-technical elements of culture was explored as early as the mid-twentieth century. However, the term safety culture was most notably popularized in the 1980's by the International Atomic Energy Agency's (IAEA) investigation of the accident at the Chernobyl nuclear power station in the Ukraine. The often-cited IAEA definition of safety culture is "that assembly of characteristics and attitudes in organizations and individuals which establish that, as an overriding priority, safety issues receive the attention warranted by their significance" (Cooper, 2000, p. 113). The Advisory Committee on the Safety of Nuclear Installations (ACSNI) working in parallel to the IAEA defines safety culture as "the product of individual and group

values, attitudes, perceptions, competencies, and behaviors that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (HSC, 1993, p. 23). Outside the realm of the nuclear industry, Clarke (2000) notes that "safety culture might simply be understood as putting safety first. However, this core assumption will be revealed in the way that organizational tasks are carried out" (p. 75).

Prior to the definitions set forth by the IAEA, behavioral safety studies driven by socio-technical elements came under the nomenclature of either safety climate or safety culture. Since the middle of the twentieth century, researchers have carried on a vigorous debate in the literature about whether safety climate and safety culture are distinctly different concepts. These debates derive motivation from a similar ongoing debate in the sociology literature regarding organizational climate and organizational culture.

Where the literature contains discussion about safety climate and safety culture separately, it is clear the two concepts are strongly related. Cheyne, Cox, Oliver, and Thomas (1998), in their discussion of safety climate and culture, conclude that "[safety] climate can be viewed as a temporal state measure of [safety] culture" (p. 256). In fact, Cox and Flin (1998) state that for the outcome of safe behavior, the two concepts are indistinguishable. More recently, Choudry, Fang, and Mohamed (2007) tested a model that accounts for safety climate and safety culture as simply two elements in the same model such that measurements of either produce the same outcome. Arboleda, Morrow, Crum, and Shelley (2003) and Back and Woolfson (1999) used the two terms interchangeably, while Bottani, Monica, and Vignali (2009), Cadieux, Roy, and Desmaris (2006), and Cardar and Ragan (2003) replaced the interchanged term with "safety

system" or "occupational health and safety". In keeping with the more contemporary scholars from the literature, no distinction between safety climate and safety culture is made in this dissertation study.

Safety Culture and Accident Prevention

According to Schein (1990), organizational culture produces a specific way the organization perceives, thinks, feels, and behaves about safety. According to Heinrich (1941), unsafe behavior is the antecedent to accidents. It follows then that a good safety culture that promotes safe behaviors will result in fewer accidents. Research has demonstrated that organizational safety culture has a significant positive relationship with accident involvement across a range of industrial settings, such as chemical and nuclear (Hofmann & Stetzer, 1998; Lee, 1998, Lee & Harrison, 2000), manufacturing (Brown & Holmes, 1986; Zohar 2000, 2002a, 2002b), construction (Gillen, Baltz, Gassel, Kirsch, & Vaccaro, 2002), the health care industry (McFadden, Henagan & Gowen, 2009), and the service industry (Barling, Loughlin, & Kelloway, 2002). Most recently, Bottani, Monica, and Vignali (2009) showed a clear difference in accident prevention results between adopters and non-adopters of safety management efforts. Clarke (2006) summed up this research in a meta-analytic review of 35 published studies. He found support for the contention that improving safety climate/culture will have a significant effect in the enhancement of employee safety performance, accident prevention, and a reduction in occupational accidents and injuries.

The Factor Structure of Safety Culture

The concept of safety culture, or the idea that social and organizational factors influence safe behaviors, was first posited by Heinrich (1941) with his "domino" model

of accident causation. In his study of social and organizational factors that contribute to safety performance, Cohen (1977) found seven elements: management commitment, management-worker interaction, workforce stability, industrial relations, housekeeping, training, and conventional safety practices. Zohar (1980) tested a similar model and found eight key factors to relate safety performance: management attitudes, training, effects of safe conduct on promotion, effects of safe conduct on social status, level of risk, work pace, status of safety officer, and status of safety committee. However, Brown and Holmes (1986) questioned the psychometric validity and generalizability of Zohar's (1980) results because the research had not undergone the recommended replication and because it had been confined to an Israeli sample. After expanding the sample context and accounting for post-traumatic (accident involved) and pre-traumatic (no accident involvement), Brown and Holmes (1986) used confirmatory factor analyses to find support for only three of the eight dimensions in Zohar's (1980) model.

Dedobbeleer and Beland (1991) attempted to repeat the work of Brown and Holmes (1986) using a sample of construction workers, but found support for only two of the three dimensions found by Brown and Holmes (1986). They attribute the difference mainly to methodological issues, i.e., use of weighted least squares versus maximum likelihood. Dedobbeleer and Beland (1991) made no discussion of differences that might be attributable to sample contexts. Diaz and Cabrera (1997) used Zohar's (1980) approach with a study group of Spanish airport workers and found six factors versus Zohar's (1980) eight. Diaz and Cabrera (1997) further noted that the significance of the six factors varied depending on the specific job at the airports (e.g., fuel handlers versus ramp workers). They noted that attitudes toward safety procedure compliance differed

with job situational factors (e.g., work hours, age, and risk). Mearns, Flin, Fleming, and Gordon (1998) studied the safety culture factor structure of workers on off-shore oil platforms and found nine factors of significance. However, they found a wide variety of factors across specific job contexts and suggested that different jobs may be responsible for varying "safety subcultures." Certain jobs supported only four significant factors while others supported all nine. Examples of differences in job context included parent employer, supervisory status, length of service, type of work (caterer versus deck-hand) to name a few. Hayes, Perander, Smecko, and Trask (1998) argued that the reason for these variations of factor structure was that only a limited component of the work safety domain was sampled. Researchers later employed wider ranges of context and still reported a large variance in factor structures (Fang, Chen, & Wong, 2006; Fernandez-Muniz, Montes-Peon, & Vazquez-Ordas, 2007; Silva, Lima, & Baptista, 2004; Wahlstrom, 2001).

These examples of researchers reporting a wide variation in the factor structure of the safety culture led Clarke (2000) and Cooper (2000) to conclude no general consensus exists about the factor structure of safety culture. They did, however, observe some difficulties with the methodology that contribute to the lack of consensus. Specifically, Cooper (2000) noted that the continued use of quantitative survey instruments that are nearly alike may be a key contributor to the consensus problem. Cooper (2000) discusses the concept of reciprocal determinism for Social Learning Theory and posits that learned behaviors get modified over time as each employee increases self-efficacy. Hence, the learned safety behaviors (the organizational practices aimed at safety) get modified over time and especially on an individual basis. Therefore, researchers making exclusive use

of surveys might only be testing their a priori assumptions about safety behaviors on a sample that is still modifying those behaviors. Contributing to the same line of reasoning, Cox and Flin (1998) noted that the survey instruments being used by most quantitative research on safety culture are based on Zohar's (1980) original safety climate survey with only modifications for specific contexts. Thus, not only has the use of a quantitative survey instrument biased the respondents toward the a priori knowledge of the researcher, the a priori knowledge may have been fixed in time by continually building the instrument upon the Zohar (1980) questionnaire. The result is that prior researchers' a priori assumptions built into the survey instruments for factor structure may contain a series of gaps in the substantive knowledge about the antecedents of safety culture. Clarke (1999) implied this gap issue when she reported that "intergroup biases" caused by differing perceptions of the safety values under different working conditions within the same firm were responsible for the variation among different research studies. Clarke (2000) later suggested that qualitative methods, rather than survey methodology, might have been useful for resolving intergroup bias, but because of the time and cost involved, the methodology was ignored.

In this dissertation, the Delphi mixed-methodology is used with an initial qualitative inquiry as recommended by Clarke (2000), followed by a series of quantitative inquires. The initial qualitative inquiry is exploratory in nature and is intended to discover the wider breadth of the social and organizational factors that influence a positive safety culture. It is followed by more quantitative inquiries aimed at concentrating the initial discoveries toward a consensus of most important. The exploratory approach, i.e., open-endedness of the first inquiry, is intended to gain the

maximum understanding of the range of possible factors and minimize biases induced by assumptions of this researcher (Ray & Sahu, 1990). Linstone and Turoff (2002) describe the Delphi methodology as a useful technique for "re-definition of problem attributes or solution opportunities" which directly applies to the problem under study by this dissertation.

In contrast to random sampling, the Delphi also requires purposeful sampling, i.e., the study respondents are selected for their demonstrated expertise. Delbecq, Van de Ven, & Gustafson (1975) describes these expert participants as those with "a deep understanding in the problem and experience to share" and Duffield (1993) as "representative of their profession or professional organization." For this dissertation, the selected respondents' knowledge, skills, and experience with occupational safety bring a much wider discovery of potential factors that relate to safety culture. In short, the exploratory front-end and the purposeful sampling associated with the Delphi methodology has provided significant potential to compensate for the shortcomings experienced by previous research

As discussed, Clarke (2000) recommended a qualitative approach as an alternative to the overused survey questionnaires. However, she did not specifically recommend a Delphi methodology. Five other traditions of qualitative inquiry (Creswell, 1998) have been examined as potential alternatives: (a) biography, (b) phenomenology, (c) grounded theory, (d) ethnography, and (e) case study. All are exploratory in nature. However, because of the small sample focus, all but the phenomenology would have limited generalizability. Polkinghorne (1989) gives example of phenomenological studies with the number of informants ranging from five to 25 which might appear to be

adequate for this study. Creswell (1998) notes, however, that it is essential that the selected informants have experienced the phenomena being studied. In this case, safety culture would be the phenomena, and ensuring informant experience may present some difficulty. Additionally, the phenomenology taken in its purest form is not usually intended for exploring relationships (e.g., organizational practices to safety culture), but rather studies the concept of how people experience the phenomena (Creswell, 1998). In short, it appears the Delphi methodology offers the most promise.

The Delphi Method

As part of the cold war defense research in the 1950's, the US Air Force contracted the Rand Corporation to conduct a study using expert opinion to determine the optimal US industrial system target from a Soviet strategic planning view that required the fewest A-bomb munitions. This study, including the methodology used, was called "Project Delphi," hence the origin of the method's name (Dalkey & Helmer, 1963). Alternative approaches to handling this problem at that time would have required data collection from multiple intelligence channels, most of which individually were considered to be sufficiently biased to dominate the simulation model.

Because of the classified nature of the originating study, it took until the late 1960's for Delphi to gain the attention of researchers outside the defense community. Because of the rapid pace of aerospace and electronics development at that time, Delphi became the methodology of choice for technological forecasting and justification of large expenditures, especially in the aerospace and defense industries. Traditional researchers unfamiliar with Delphi applications might have an image that Delphi is limited to forecasting. However, during the last quarter-century, thousands of research studies

using Delphi methodologies have been conducted in diverse disciplines such as operations, management science, environment, transportation, health, and other social sciences (Linstone & Turoff, 2002). Objectives have grown beyond forecasting to studying problems that do not lend themselves to precise analytical techniques or to problems that are readily susceptible to sample biases (Linstone & Turoff, 2002). Some of the more prominent examples of non-forecasting research using Delphi are included in the following discussion.

Jung-Erceg, Pandza, Armbruster, and Dreher (2007) conducted a study to determine the absorptive capacity of manufacturing firms in Europe. Absorptive capacity is a firm's capability to assimilate external knowledge for the purpose of increasing the firm's innovativeness. Absorptive capacity was thought to be a function of the firm's existing stock of knowledge and the firm's diversity of expertise, experience, and culture. Because these variables are highly dynamic, contextually based, and difficult to operationalize, analysis by traditional quantitative methods would not be practical. In particular, Jung-Erceg et al. (2007) noted that it was unlikely that a simple random sample would adequately include all the contexts, diversity, and dynamics of the variables, and just as unlikely to facilitate convergence of the results. Jung-Erceg et al. (2007) concluded that an initial exploratory approach was necessary and turned to a Delphi methodology with its purposeful sampling and iterative inquiry. They assembled a panel of experts that deliberately cut across gender, age, occupation, knowledge, skills, and other essential characteristics to ensure completeness for informing the research. The initial inquiry of the panel produced a large number (101) of wide ranging responses, and by the iterative Delphi procedure, narrowed it down to eight as the most important. Thus,

Jung-Erceg et al. (2007) successfully used a Delphi methodology to research a problem with a somewhat fuzzy set of independent variables. It is for reasons very similar to the Jung-Erceg et al. (2007) research study that Delphi methodology has been used for this dissertation study. For this study, the lack of general consensus regarding the factor structure of safety culture in the existing research indicates a need for an initial exploratory approach by a panel of experts that will span the different paradigms through which safety culture is observed.

Another example is Dressel, Consoli, Kim, and Atkinson (2007) study to identify the successful and unsuccessful practices used by university counseling center supervisors for multicultural supervision. Multicultural supervision was defined as a supervisory situation where the individuals in the supervisory-subordinate dyad differed in their ethnicity. Because no set of best practices for multicultural contexts existed, and because the range of cultures was considerably diverse, Dressel et al. (2007) recognized the need for exploratory research coupled with a purposefully selected sample that covered the diverse range of cultures. They successfully employed a Delphi methodology to initially discover 141 practices which later converged into 35 most important practices by the final round. Again a parallel can be drawn between the Dressel et al. (2007) research and this study. In this dissertation, the lack of a consensus group of practices related to safety culture is similar to the absences of a set of best practices for the Dressel et al. (2007) research.

Croom (2000) used a Delphi approach to identify the web-based procurement practices that led to successful maintenance, repair, and operating supply management. The rapidly evolving technology of web-based procurement had not facilitated the

development of a reliable set of practices from which a survey instrument could be constructed. The exploratory nature of Delphi facilitated Croom's (2000) first-ever identification of a set of practices and the purposeful sampling, in contrast to random sampling, ensured the full spectrum of end users was included. The parallel that is drawn between the works of Dressel et al. (2007), Croom (2000), and this dissertation research is that no consistent set of antecedent factors exist.

Boynton (2006) conducted a study to identify those professional values that were key to ethical decision-making by public relations practitioners. Boynton (2006) challenged the ethics code of the Public Relations Society of America (PRSA), which at the time had been in its eighth iteration and was thought to be out-of-date and biased by its self-primacy. For these reasons, Boynton (2006) selected the Delphi methodology because of an exploratory front-end not available with traditional survey instruments. For the initial Delphi round a single open-ended question was used: "What values do you deem most important for public relations practitioners to employ in their jobs?" (p. 326). After three rounds the results of the study affirmed the existing six core values found in the PRSA code and added two more. For this dissertation study of safety culture, the same bias stemming from self-primacy as found in Boynton's (2006) research problem is thought to be one of the reasons for the lack of general consensus of the factor structure of safety culture.

In their study of the effect of quality management (QM) on corporate performance, Saizarbitoria, Landin, and Fa (2006) found that most of the traditionally used quantitative surveys were specifically aimed at managers assigned to the quality control function and introduced a bias by ignoring the diversity of the management team.

To avoid this distortion, Saizarbitoria et al (2006) used a Delphi methodology with its exploratory inquiry and purposeful sampling to inform the research with opinions of a wide range of experts having a variety of functions in the implementation of the QM models. In this dissertation research, participants were purposefully selected from four diverse groups (upper-level managers, safety professionals, consultants, and auditor/inspectors) to avoid the distortional bias that Saizarbitoria et al (2006) encountered with traditional survey methodologies.

The aforementioned examples of research illustrate how the purposeful sampling aspect (panel of expert participants) of the Delphi methodology was used to compensate for unique biases introduced by context and self-primacy. Both of the same types of biases have confounded the previous safety culture research, which is the subject of this dissertation study. The examples also illustrate how the exploratory nature of the first round of inquiry of a Delphi methodology is useful for studies which have complex or poorly defined dependent variables. In the case of this safety culture research, the lack of general consensus on factor structure is indicative of complexity and/or poor definition of the input variables. The author of this dissertation concludes that choice of the Delphi methodological design for researching the organizational practices related to safety culture is well-supported by the literature.

Chapter II Conclusion

The review of the literature presented in this dissertation study revealed that culture of an organization can be modeled with shared values at the core that are manifested through observable organizational practices surrounding the core and reinforcing specific individual behaviors. Safety culture, a subset or subculture of

organizational culture, can be expected to be manifested through a set of safety-specific practices that ultimately lead to safe behavior by the individuals and ultimately accident reduction. To manage safety culture effectively requires an understanding of the factor structure or antecedents and, although the literature contains a plethora of studies with this purpose, a lack of consensus exists regarding the factor structure. By this literature review, numerous researchers have been identified who found that consensual weakness may be the result of methodological issues stemming from respondent bias (relating the party line), bias introduced by replicate survey instruments, or contextual variances. Also identified and discussed are several studies from the literature that have applied Delphi methodologies to address the same weaknesses. Therefore, the author concludes that the literature supports the application of Delphi as the methodology, and Hofstede's (2001) onion model as the theoretical foundation, to identify the practices that relate to a positive safety culture. Chapter III presents a discussion of a procedure for applying Delphi to the problem of identifying the organizational practices leading to a positive safety culture.

CHAPTER III

METHODOLOGY

Introduction to the Chapter

The review of the literature discussed in the previous chapter shows evidence that researchers of safety culture have not been able to report a general consensus regarding the factor structure of that culture, i.e. the antecedents of safety culture. Therefore, the purpose of this dissertation study is to determine those organizational practices that lead to the establishment or maintenance of a positive safety culture. In doing so, I have utilized a Delphi methodology in contrast to purely traditional quantitative studies that have typically been used by previous researchers.

This chapter begins with a brief overview of the Delphi method, followed by more detailed discussion of the methodological requirements of Delphi and the procedural steps to be followed. For each appropriate step, I discuss important attributes reported in the literature, how that information led to the structure of the actions in this study, and the objective of conducting that procedural step. I conclude the chapter with a discussion of validity and reliability expectations for the Delphi methodology.

Overview of the Delphi Methodology

The Delphi methodology is a mixed-method using an exploratory research approach coupled with explanatory approach, which when combined gains consensus about a problem solution. A key feature of Delphi is the use of a purposefully selected group of participants who possess specialized knowledge in the problem discipline,

instead of the random sample traditionally used to inform research (Bonnemaizon, Cova, & Louyot, 2007; MacCarthy & Atthirawong, 2003; Ray & Sahu, 1990; Reid, 1988; Rowe & Wright, 1999; Saizarbitoria, Landin, & Fa, 2006). The group of participants is frequently referred to as the "panel of experts." Delphi is an appropriate methodology for researching problems for which there is scarce or uncertain knowledge or which do not lend themselves to precise analytical techniques (Jairath & Weinstein, 1994; Williams & Webb, 1994). Anonymity of the participants' identity with respect to each other is maintained to eliminate interpersonal and inter-organizational bias. Multiple iterative rounds of inquiries are used to gain consensus which is the Delphi equivalent to determining the statistical central tendency. Leedy and Ormrod (2005) describe this approach as the "data analysis spiral" in which repetitive collection and analyses of the data spirals into a consensus final result. The exploratory nature of Delphi stems from its mixed-method methodology. It begins with a qualitative inquiry and ends with a more traditional quantitative method to reach consensus. Open-ended questions are used for the first round inquiry to the participants to maximize inclusion of a full spectrum of variables (Linstone & Turoff, 2002). Subsequent rounds of inquiry are aimed at reducing the spectrum of variables down to a smaller number, for which the panel of participants reaches consensus about inclusion and importance. Each round of inquiry is prefaced with a summary of the results of the previous round, such that participants see the entire panel's input, and can be expected to adjust their responses based upon the aggregate panel response (Scheibe, Skutsch, & Schofer, 2002). The rounds of inquiry continue until consensus is confirmed, at which time the study is concluded.

In their "how-to" description, Linestone and Turoff (2002) specify five key requirements necessary for success of the Delphi method: (a) a purposefully selected panel of participants (experts) to inform the research, (b) anonymity of the panel participants, (c) multiple reiterative rounds of questioning, (d) controlled feedback between rounds, and (e) convergence to consensus. The remainder of this chapter addresses this dissertation author's application of the five key requirements of the Delphi methodology.

Participants (the Panel of Experts)

One of the defining features of the Delphi methodology, and an essential element for its success, (Pasukeviciute & Roe, 2001) is purposeful sampling to inform the research instead of the random sampling desired for traditional quantitative research methods. Sampling is done randomly when the goal is representation of a larger population (Babbie, 2004). Purposeful sampling means "the researcher establishes in advance a set of criteria or attributes...then searches for exemplars that match the specified array of characteristics" (LeCompte, Preissle, & Tesch, 1993, p. 69). Creswell (2003) states the reason for purposeful sampling is to "ensure a selection of participants that will best help the researcher understand the problem and answer the research question" (p.185). Delbecq et al. (1975) call this sample a panel of experts. Delbecq et al. (1975), Keeney, Hasson, and McKenna (2001), and Powell (2003) define experts as individuals accomplished in their field and respected as such by their peers. Pasukeviciute and Roe (2001) note that crucial for success is that the panel participants "must have a deep interest in the problem and experience to share" (p. 390) and they should be "representative of their profession or professional organization" (p. 390).

Delbecq, et al. (1975) note that besides expertise, panel members must be highly motivated to work on the problem and be willing to remain engaged for the duration of the study.

For this dissertation study, I have pursued participants that meet the definition of expert from four different career disciplines: (a) safety professionals, (b) managers, (c) safety consultants, and (d) safety oversight officers. All four of these types of people routinely observe, participate in, or recommend organizational practices that relate to accident and injury avoidance. However, because their job functions are different, they view the practices through different lenses, which some researchers have found advantageous. For example, Delbecq, et al. (1975), Powell (2003); and Rowe and Wright (2001) report those Delphi panel participants with widely varying personalities and substantially different perspectives produce higher quality and more acceptable solutions.

Safety professionals are those employees whose primary job function is internal consulting and enforcement of both corporate and regulatory occupational safety requirements. These employees are typically certified by an industry trade group and frequently are accountable to the highest level managers in the organization. They are usually positioned outside the line organization so they are not accountable for product quotas or schedules. However, they are frequently the promoters of the safety practices they observe. Utilization of these experts on the Delphi panel in this study avoids bias that might be induced by organizational norms or peer and supervisory influence, yet still provides an "insider" viewpoint.

Managers are those employees who direct the activities of others and are accountable for accomplishment of the organization's goals. They are typically CEO's,

COO's, plant managers, or work group managers. Utilization of these experts brings to the panel the input of those people who position the value of safety within the strategy of the corporate or functional unit. They also hold the positions within the firm that are held most accountable for accidents and incidents resulting from unsafe actions.

Safety consultants are safety professionals hired from outside the firm. Like safety professionals previously described, they are independent of the line organizations, with less of a day-to-day exposure to employees. They tend to bring a broader swath of experience to the Delphi panel, having seen more than one firm and more than one set of safety practices.

Safety oversight officers are those people who perform shop-floor audits and inspections and report to a regulatory agency, a standards committee, or an industry trade group. They are independent of the line organization and the firm and, as auditors, do not usually perform field consulting while they observe. Thus they are less likely to be biased by the business or social needs of the workers they are observing. They bring to the panel an expertise viewed through a more wide-angled critical lens.

I have utilized the South Carolina chapter of the National Safety Council (SCNSC) to provide intermediary assistance with recruiting panel participants. McKenna (1994) found that using an intermediary to facilitate contact with the potential participant, in contrast to a "cold call," increases the willingness to participate and maintain involvement for the duration of the Delphi rounds. The SCNSC is the state level chapter of the National Safety Council (NSC), operating at the national level, but with offices and resources located conveniently to this researcher's primary location. The SCNSC routinely provides training for managers and safety professionals at the majority of its

600 member firms. The SCNSC is closely networked with the Occupational Safety and Health Administration (OSHA), provides consulting services to its member firms nationwide, and routinely conducts occupational safety inspections, audits, and accident investigations. As a result of those activities, the SCNSC has developed a nationwide sphere of influence which I have utilized to connect with potential candidates for the panel of participants for this dissertation study.

Powell (2003) reports that participant panel size is an attribute that is equally as important as the panel's level of expertise. Connsiderable discussion by researchers is found in the literature regarding the most appropriate size for a Delphi panel. In a comparison of healthcare studies conducted over a 10 year period using Delphi methodologies, Reid (1988) found panel sizes to be as few as ten to as many as 1,685. Linstone and Turoff (2002) specify anywhere from 10 to 50 members. Reid (1988) notes that replicability and generalizability of the results increases with panel size, but so does the dropout rate increase and concludes that 20 is near optimum size. Bonnemaison, Cova, and Louyot (2007) found that eight to ten members was sufficient, with five to seven being the minimum threshold. They noted that beyond 12, the marginal contributions were minimal. Delbecq et al. (1975) notes when choosing the panel size, a tradeoff occurs between richness of data and attrition resulting from respondent fatigue. For this dissertation research, I set a goal of at least 24 participants to be remaining at the end of the study, which compares favorably to the recommendations of Linstone and Turoff (2002), Reid (1988), and Bonnemaison et al. (2007). To accomplish that goal, 60 were targeted for initial recruitment, which accommodates a potential exclusion rate of 20 percent and a potential attrition rate of 50 percent (60 x (1.0- 0.20) x (1.0-.50) = 24).

Panel participants are recruited by using a combination of purposive and snowball sampling (du Plessis & Human, 2007; Marsden, Dolan, & Holt, 2003). For purposive sampling, some a priori knowledge exists regarding the candidate's credentials to warrant a direct contact by the researcher or the intermediary. This direct contact confirms the candidate meets inclusion criteria (discussed later), is willing to participate, and has potential to remain engaged for the duration of the study. Purposive sampling adds some assurance that knowledgeable participants will be on the panel (du Plessis & Human, 2007). For snowball sampling, I asked those participants recruited by purposive sampling to identify other potential candidates for the Delphi panel. Compliance with the inclusion criteria for the snowball recruits was ensured by my evaluation of the demographics data submitted with the first round inquiry (see Appendix C). Recruitment of the panel was formalized by my letter contained in Appendix B. To minimize attrition, Hasson et al. (2000) found it essential to inform participants at the onset, in writing, about the expectations of them for the study and I have delineated those obligations in the recruitment letter (Appendix B).

The following inclusion criteria were used for participants from the four separate career disciplines. Managers must have at least one year experience directing the work of their subordinates and will have five or more subordinates reporting to them either directly or indirectly. Safety professionals must hold entry-level or higher certification by an industry trade group or equivalent experience as defined by the job description. Safety consultants must have participated in providing counsel to at least three clients or hold entry-level or higher certification by an industry trade group. Safety oversight officers must have participated in the conduct of at least three audits or inspections and

the reporting of findings, or hold entry-level or higher certification by an industry trade group for at least one year. The industry trade group certification (BCSP, 2012) requirements were reviewed and deemed to contain appropriate subject matter expertise for inclusion criteria. Participant compliance with the exclusion criteria was confirmed by personal contact in the case of purposive sampling and by examining the responses in the demographic section of the Round 1 Delphi Inquiry (see Appendix C).

It is noteworthy to conclude this subsection on "Participants" by describing more fully the recruitment letter in Appendix B. Hasson et al. (2000) noted the importance of informing the panel with as much information as early as possible in the study. It is through this letter that many of the important points just previously described will be accomplished, including: (a) explain the research and its purpose, (b) explain the intent of anonymity and the measures taken to ensure anonymity, (c) describe the expectations of the participants, (d) affirm the voluntary nature of this study, (e) obtain implied consent, and (f) provide contact information to the participant.

Anonymity

The problem solving capability of the Delphi methodology relies on a structured group communication process which allows the individual participants to function as a whole when solving complex problems (Linstone & Turoff, 2002). It relies on the proverb that "two heads are better than one" (Rowe, Wright, & Bolger, 1991). However, group dynamics can introduce a number of biases when the participants interact face-to-face, or are able to identify each other's contributions (Goodman, 1987; Mead & Moseley, 2001). Most threatening is the domineering personality or outspoken individual that takes over the process and inhibits other opinions (Couper, 1984). Other sources of

bias include: unwillingness by some participants to take a position until all facts are presented, participants inhibited by higher authority positions, unwillingness to abandon a position once publicly taken, and participants who are concerned about how that their ideas may be received (appearance of idiocy) by others (de Viliers, de Villiers, & Kent, 2005; Mead & Moseley, 2001, Weinstein, 1994). To minimize such biases and maximize consensus, Inaki, Landin and Fa (2006), Keeney et al. (2001), MacCarthy and Atthirawong (2003), and Ray and Sahu (1990) strongly recommend that participants must not know the identity of the other members of the group, especially when opinions are being expressed. Several steps were taken to ensure anonymity of the participants. Recruitment of the participants was accomplished by individualized letters that did not identify any other participants. For snowball recruiting, the nodal participants were not informed if their recommended participants were included. Finally, the specialized features of SurveyMonkey™, the web-based software for collecting data, were used to de-identify the data being collected while still preserving the mailing addresses of the participants.

Where instances of identifiable communications occurred, such as casual inquiries from participants, special precautions, such as external storage media, were taken to maintain confidentiality. To ensure any gaps of anonymity did not lead to researcher bias, I 'bracketed" potential pre-conceptions of the study as Creswell (1998) recommends for any typical qualitative analysis.

Consensus

Consensus is vital to success for the Delphi methodology. It is appropriate at this point to discuss the methods used in this research for measuring consensus especially

since these same methods form the bases for reducing the data between rounds. Brooks (1979) defines consensus as "a gathering of individual evaluations around median responses with minimal divergence" (p. 378). Powell (2003) defines it in terms such as "most participants agreed" (p. 379). Katcher, et al. (2006) reported consensus was reached when all participants selected the same scale rating i.e., 100% agreement. The variety of definitions led Crisp, Pelletier, Duffield, Adams, & Nagy (1997) to correctly conclude that the issue of consensus is one of the most contentious components of the Delphi methodology. Nonetheless, a number of substantive approaches are reported in the literature for measuring consensus and which lead to defensible conclusions for this dissertation.

The movement toward consensus was measured as soon as quantitative data was collected, i.e., beginning with the Round two inquiry. The approaches for determining consensus reported by researchers in the literature span a wide range of sophistication. The lesser sophisticated are characterized by a "majority rules" approach, with the definition of majority ranging from 51% up to 100% (de Villiers et al., 2005; du Plessis & Human, 2007; Keeney et al., 2006; Katcher et al., 2006; Murry & Hammons, 1995; Williams & Webb, 1994), with the most dominant in the 70% to 80% range. The risk of using simple majority is that bipolarity may exist and a significant minority opinion could get overlooked. The simple majority approach can be improved by quantifying the "minimal divergence" in Brooks (1979) definition of consensus. Williams and Webb (1994) used the standard deviation of the mean as a measure of divergence, using one standard deviation as the threshold. If all practices fell within one standard deviation (68%) of the mean, consensus would be declared. Dajani, Sincoff, and Talley (1979)

measured the coefficient of variation (standard deviation divided by the mean), V, and declared consensus when V was less than or equal to 0.5. An alternative approach by Duffield (1993) declared consensus when no more than 10% of the scores changed (either direction) between rounds.

To cope with potential bi-polarities in Delphi methodologies, Brightman and Schneider (1994), Linstone and Turoff (2002), and Saizarbitoria et al. (2006) recommend using the median instead of the mean to measure central tendency, and interquartile ranges (IQR) instead of standard deviations to measure divergence. They note that median and IQR (value of the 75^{th} percentile minus the 25^{th} percentile) will allow detection of bipolar tendencies and at the same time effectively reduce the impact of statistical outliers. Rather than "declaring" consensus, Saizarbitoria et al. (2006) reported the "degree of consensus" reached by comparing the change of the IQR from one round to the next. Crisp et al. (1997) agrees that there is no black and white numerical decision point for consensus and that a judgment of stability is a preferable indication of consensus.

My review of the literature uncovered four statistical measures of stability: (a) the two-sample z-test for the difference between two means (Hartnett & Murphy, 1985), (b) the Wilcoxon rank sum test statistic (Z) (Brightman & Schneider, 1994; Dovich, 1988), (c) the Kendall coefficient of concordance (W) (Jairath & Weinstein, 1994; Legendre, 2005; Neter, Kutner, Nachtsheim, & Wasserman, 1996), and (d) the Kruskal-Wallis test statistic (H) (Brightman & Schneider, 1994). The two-sample z-test relies on either the t-distribution or the standard z-distribution to assess the equality of the means for two Delphi rounds of inquiry. Kendall's W is a non-parametric statistic that assesses the

agreement among raters. The raters, or participants, in a Delphi study rank the list of practices from most important to least important from which Kendall's W is calculated. If W equals one, then agreement among the participants is unanimous; if zero, there is no agreement; and values in between indicate a greater or lesser degree of agreement. The Wilcoxon Z is also a non-parametric statistic that assesses two different sets of data for the degree of difference in the dispersion around the two medians. For a Delphi study, the Wilcoxon Z can be used to determine the change in divergence (dispersion about the median) from one round of inquiry to the next. Minimal change in the divergence would indicate stability. The Kruskal-Wallis H is a non-parametric statistic that measures the degree of agreement between the medians of two sets of data or, in the case of a Delphi study, the medians of two successive rounds of inquiry.

In this dissertation, I used a combination of the consensus approaches discussed above. For the early rounds of inquiry, where the method is just transitioning from qualitative to quantitative, I used majorities, medians, and IQR's for decisions regarding attrition of practices collected in the initial exploratory round. With the second and subsequent rounds, I relied primarily upon two-sample z-tests of means equality and the non-parametric Wilcoxon Z test to evaluate the degree of consensus. Application of these tests are presented in detail in Chapter IV.

Multiple Iterative Rounds of Inquiry

The classic Delphi methodology is essentially an iterative series of questionnaires posed to the panel of participants. In the Delbecq et al. (1975) model, the first questionnaire is a broad-based question. Each subsequent questionnaire is built upon the responses of the preceding questionnaire. The process stops when the responses attrite

down to a final set for which consensus can be confirmed. The following discussion describes the procedure, objective and justification for the each successive round.

Round 1 inquiry. The objective of the Round 1 inquiry is to obtain a broad list of organizational practices the panel participants conclude are related to a positive safety culture. The inquiry is deliberately non-specific to engage the respondents in "brainstorming" to elicit a wide-ranging list of practices. In Chapter II,

I argued that the exploratory research contribution resulting from Delphi contrasts this study with previous safety culture research by not biasing the participant responses with a predetermined list of outcomes. To that end, the recommendations of Delbecq et al. (1975) have been followed and the inquiries began with an open-ended question that allows free responses from the participants. The impact of this open-ended, Round 1 inquiry is best described by the converse analogy made by Linstone and Turoff (2002) to a multiple choice examination, which by its nature biases the respondent with insights of the instructor's mode of thought as well as the substance of the question. The use of an open-ended inquiry may necessitate additional rounds of inquiry. However, the tradeoff is in favor of reduced bias imposed by the investigator.

The open-ended approach has some drawbacks in that it can generate large, unmanageable amounts of data. Therefore, Schmidt (1997) and Hasson et al. (2000) recommend limiting the number of items in the response for the first open-ended inquiry. In this dissertation, I set a limit of seven items for the first round of inquiry based upon the following examples in the literature: Schmidt (1997) recommends a limit of six items; Ray and Sahu (1990) used a limit of five; and Schmidt, Lyytinen, Keil, and Cule (2001) used a limit of six. Dressel, Consoli, Kim, and Atkinson (2007) did not define a

limit and received an average of seven items from the participants on the first round of inquiry. Therefore, the limit of seven chosen for this study approximates response levels reported in the literature.

Appendix C contains the Round 1 open-ended inquiry. This particular inquiry format was selected to facilitate the analysis (discussed later) between Rounds 1and 2. I pilot tested the Round 1 inquiry questionnaire with potential panel participants to test readability and the delivery and collection channels. In this Round 1, the participants are asked to provide up to seven practices as single words or short phrases (entered in the left-hand column) with attendant detailed explanations, including examples, in the right hand column. The single word or short phrase descriptors for the practices (left-hand column) allows for more simplified removal of duplication. The details and examples from the right-hand column provide more in-depth understanding of the practice descriptors, allowing additional collapsing of the list, or identifying the need for further reconciliation. The Round 1 inquiry also collected demographic information about the potential participants (see Appendix C) which was used for judgment against the pre-established inclusion/exclusion criteria.

Following approval of the Internal Review Board, the Round 1 inquiry was transmitted to the potential participants as a web hyperlink in the recruitment letter. The transmittal included guidance for completion of Round 1 and guidance for future data collection via the SurveyMonkey™ website.

The Round 1 inquiry actually consisted of two separate surveys, 1a and 1b, daisy-chained within the SurveyMonkey™ website. The intent of the separation is to permit de-identification of the participants' responses while still maintaining an e-mail address

list of the panel participants. The 1a survey collected the actual subjective research data while the 1b survey collected demographic information and e-mail addresses. The "done" button at the end of 1a survey actually transferred the respondent into the 1b survey (the daisy-chain). By this method research data and demographic/ID data were collected in two disconnected databases, thus producing de-identification of the participants. The ID data consisted of a simple e-mail address list used for transmitting Rounds 2, 3, and 4 inquiries to the participants.

Round 1 data analysis. Two major objectives were the focus of the Round 1 analysis: (a) to complete the inclusion-exclusion test for each potential panel participant, and (b) collapse the data into a single initial list of practices that are related to a positive safety culture. Data collected by the SurveyMonkey™ website was down-loaded in a Microsoft Excel™ format which served the purpose of analysis and archive requirements.

Demographic data. I compared the demographic data for each participant against the inclusion criteria previously discussed. Those meeting the inclusion criteria were e-mailed by the author to thank them for their input and to confirm their e-mail addresses for inclusion in the SurveyMonkey™ collector. At this point I also confirmed that the goals of recruiting at least 60 participants before exclusion tests, and at least 48 after exclusion tests were met. The expected outcome of this part of the analysis was a starting count of the panel participants. If less than 48, recruiting would continue until 48 participants were obtained before continuing the analysis.

Practices and descriptions. The practices and attendant detailed descriptions were also collected in Microsoft Excel™ format. The first step was to review the list and remove undisputable duplicates, and miscellaneous off-normal responses. Delbecq et al.

(1975) notes that whenever an open-ended question is offered in confidence, human nature can produce some strange responses. A frequency count of duplication was maintained for feedback in the next round of inquiry

I applied software-assisted content-analyses to the practice descriptors and the detailed explanations and examples (right-hand and left hand columns of survey questionnaire in Appendix C) to discover commonalities that might justify thematic clustering and further collapse of the list (Babbie, 2004: Creswell 1998). As necessary, a thesaurus was used to review synonyms and words for likeness and combination. Where two or more practice descriptors appeared identical and collapsible, but the detailed explanations were even slightly different, both detailed explanations were retained and combined to capture the full breadth of the response. Hasson et al. (2000) reports that a basic tenet of Delphi is that participants should ultimately be the judges, not the researcher. Therefore, where doubt existed about identicalness, I reiterated the original data back into the following round of inquiry (du Plessis & Human, 2007).

I then applied software-assisted content- analyses to each of the thematic clusters to discover commonalities that might further collapse into specific practices with aggregated definitions. I tracked the number of times a practice or definitional phrase was mentioned so that it could be translated into a frequency for feedback in the next round of inquiry. The outcome of this Round 1 analysis was an initial list of practices, the frequency each occurred, and a detailed definition associated with each practice. This outcome was peer debriefed prior to proceeding to the Round 2 inquiry.

Round 1 peer debriefing. du Plessis and Human (2007) recommend peer debriefing as a way to increase the validity of the Delphi process. Lincoln and Guba

(1985) describe it as exposing the study's process, interim results, and investigator to a disinterested peer to explore aspects of the study that might otherwise remain implicit in the researcher's mind. They specify four responsibilities of the peer: (a) act as devil's advocate, (b) test working conclusions that may be emerging in the researcher's mind, (c) test the next steps in the emerging methodology, and (d) provide the researcher an opportunity for catharsis. I peer debriefed at this point with a non-business university faculty member possessing substantive knowledge of occupational safety and qualitative research methods.

Feedback: Round 1 to Round 2. For the Delphi methodology, the results of the Round 1 analysis form the basis for the feedback included in the Round 2 inquiry. Goodman (1987) reports that the strength of the Delphi process lies in the feedback to guide the panel of participants toward a consensual conclusion. Keeney et al. (2001) describes the feedback as "the process that facilitates the systematic emergence of a judgment" (p. 197). Crisp et al. (1997) and Powell (2003) observe that feedback is the primary channel of communication between members of the panel and its quality and quantity is essential to obtaining a group decision. Rowe et al. (1991) note that it is crucial that the feedback contain both the majority opinions (central tendency) and the minority opinions (the outliers) to ensure that improvement of the participants' positions are maximized. Based on this guidance from the literature, I used the Round 2 inquiry to feed back to the participants the complete information from the Round 1 analysis including: the collapsed list of practice descriptors, the attendant descriptions, and the frequencies of occurrence.

Round 2 inquiry. A mixed-method version of the Delphi methodology uses both qualitative and quantitative methods and the transition begins with this Round 2 inquiry. The objectives of the Round 2 inquiry are to: (a) provide the participants with sufficient feedback from the first round to allow them to comprehend the positions of the other participants; (b) obtain each participants quantifiable agreement, or disagreement, with practices that should remain on the list; and (c) obtain quantifiable decisions from each participant about how important each of the practices is for establishing or maintaining a positive safety culture. Keeney et al. (2001) recommend that all post Round 1 inquiries be structured questionnaires that incorporate feedback from the previous rounds. Delbecq et al. (1975) recommend that the response method be simple to understand. I used the complete list of practices produced by the Round 1 analysis in combination with 5-point Likert-type scales to obtain the participants' judgment on agreement and importance ranking of the practices (See Appendix E). The inquiry is a three-part questionnaire: Section A queries the participants for their judgment that the practice belongs on the list; Section B queries the participant for importance ranking of the practice; and Section C queries the participant for missing or emergent data. The frequency, i.e., the number of respondents who mentioned the practice or some portion of the description of the practice, is included in the first sentence of Section A that introduces the practice.

At the bottom of the scale, section is included for the respondents to explain entries at the extremities of the scale. Rowe et al. (1991) reported that it was important to capture and communicate the outliers, and this part of the inquiry is intended to accomplish that purpose.

Section C is included for the purpose of capturing practices that were missed by the participants in the Round 1 inquiry, or practices that were lost during collapsing in the Round 1 analysis. Section C further serves to close the loop on the "member checking" that is intended to support the validity of this study (Lincoln & Guba, 1985).

I used the SurveyMonkey™ website to transmit the Round 2 inquiry and receive the responses from the participants. Round 2 was pilot-tested like Round 1 and adjusted as necessary.

Round 2 data analysis. The objectives of the Round 2 analysis are to detect early indications of consensus by the panel of participants about which practices might be related to a positive safety culture, and to use the early indication to decide which practices should be carried forward to the Round 3 inquiry. Some practices will stay on the list, while others will be deleted from any further analysis. I converted responses to quantitative data by assigning numerical scores to the scale responses: "5" for strongly agree and very important; "1" for strongly disagree and very unimportant; and others portioned equally between. With quantitative measures, I used traditional statistical measures to interpret convergence to consensus. Per the previous discussion regarding consensus, I used the 70% to 80% range as the first test for decisions to drop or carry forward practices to the Round 3 inquiry. The following rules were applied for making the first decisions:

> Practices for which 80% of the participants selected "strongly agree, agree, very important, or important" will be carried to Round 3.
>
> Practices for which 80% of the participants selected "strongly disagree, disagree, unimportant, or very unimportant" will not be carried to Round 3.

Because the first test rules above are examining the extremes of the spectrum, I expected some number of practices, specifically those between the extremes, to require further examination to determine carryover. I examined these remaining practices on a case-by-case basis using medians and interquartile ranges (IQR) (Brightman & Schneider, 1994; Linstone & Turoff, 2002; Milkovich, Annoni, & Mahoney, 1972; Saizarbitoria et al. 2006) to judge dispersion of the responses. Wide dispersion indicates that the participant panel is still too divergent on consensus, and further inquiry is warranted; however, a narrower dispersion indicates early convergence and the practice may be a candidate for dropping . I used this dispersion measure and the position of the median to make a judgment whether to drop or carry over those practices falling between the consensus rules previously discussed. The expected outcome of this part of the second round analysis is a shortened list of practices.

The Round 2 inquiry also asks the participants to list any "new" or "missing" practices after the scale ratings. If any practices retrieved from this section of the inquiry exactly matched those that were dropped, they also would be dropped. All remaining new or missing practices would be added to the shortened list and carried forward to Round 3 for evaluation by the participants.

Feedback: Round 2 to Round 3. As done in the previous round, feedback to the participants included information from the Round 2 analysis: the further-collapsed list of practice descriptors, the attendant descriptions, and the individual scoring information for each practice.

Round 3 inquiry. The objectives of the Round 3 inquiry were to: (a) provide the participants with sufficient feedback from the first round to allow them to comprehend

the positions of the other participants; (b) obtain each participant's quantifiable agreement, or disagreement, with practices that should remain on the list; and (c) obtain quantifiable decisions from each participant about how important each of the practices is for establishing or maintaining a positive safety culture. The format of this inquiry is almost identical to the previous round with the exception being the additional votes received in the previous inquiry for each item on the scales (see Appendix F). As with the previous rounds of inquiry, I pilot-tested test this inquiry for readability and function, and made adjustments as necessary

Round 3 analysis. The primary objective of this analysis was to determine the degree of consensus regarding the practices that lead to a positive safety culture. I used the two-sample z-test for means equality and the non-parametric Wilcoxon Z test to determine consensus.

Round 4 Inquiry. The objectives of this final inquiry were to confirm consensus and obtain final member checking. I also used this inquiry to thank participants, solicit feedback, and provide an opportunity to request a summary of results.

Validity and Reliability

Researchers have vigorously debated whether the Delphi technique can be considered valid and reliable by traditional definition (Crisp, Pelletier, Duffield, Adams, & Nagy, 1997; Goodman, 1987; Keeney, Hasson, & McKenna, 2001; McKenna, 1993; Powell, 2003; Rowe, Wright, & Bolger, 1991; Williams & Webb, 1994). Procedural issues are frequently the bases for criticisms, particularly the lack of a singular experimental design. Some researchers have suggested that because Delphi aligns more with qualitative research methods, the concepts of validity and reliability should be

replaced by discussion of credibility (LeCompte, Preissle, & Tesch, 1993) or trustworthiness (Creswell, 1998; Lincoln & Guba, 1985;). For this dissertation study, I used a classical Delphi technique which is a mixed-method utilizing both qualitative and quantitative inquiries. Therefore, in the following discussion, I address the subject of quality in traditional terms of validity and reliability. As the Delphi technique became more pervasive in last two decades, common suggestions for improvement of the quality have begun to emerge (Crisp, Pelletier, Duffield, Adams, & Nagy, 1997; Hasson, Keeney, & McKenna, 2000; Rowe, Wright, & Bolger, 1991; Williams & Webb, 1994). I describe the study rigor intended to maximize validity and reliability.

Internal Validity. Lincoln and Guba (1985) define internal validity as "the extent to which variations in an outcome (dependent) variable can be attributed to controlled variation in an independent variable. A causal connection between dependent and independent variables is usually assumed" (p. 290). This definition suggests a research design that would test outcome variance against the error variance. Research designs using Delphi methodology, including this dissertation research design, are exploratory or explanatory in nature and the researchers do not typically seek out causal relationships. Thus, on the surface, the concept of internal validity does not appear to have strong relevancy for this dissertation study. However, Leedy and Ormrod (2005) note that internal validity is important in any research project because the research must have confidence that the conclusions drawn are warranted from the data collected. Lincoln and Guba (1985) address eight procedural threats to the validity of study findings regardless of causality. Because of the non-experimental nature of Delphi used in this dissertation study, four of those threats have some applicability: (a) history, (b)

maturation, (c) sampling, and (d) panel attrition. History refers to unforeseen external events that might occur between rounds of inquiry and confound the measurements. Because such events are unforeseen, they cannot be controlled. Nevertheless, their likelihood will be minimized by keeping the turnaround time between inquiries as short as possible. I maintained strict confidentiality of panel member identities to prevent unforeseen emergence of the biases induced by group dynamics that were previously discussed. Maturation effects occur when the passage of time between inquiries is long enough to allow the thought processes of the respondent to change. Again the potential effects of maturation were mitigated as much as possible by minimizing the turnaround time between inquiries.

Sampling in Delphi research is not randomized, but rather a purposeful selection of panel participants who have representative knowledge, interest in the topic, and willingness to engage in the iterative process of Delphi. In this dissertation, I rely on the inclusion and exclusion criteria previously discussed to staff the panel. Panel attrition is the most significant threat to the validity of the Delphi methodology, and in this dissertation it was minimized by limitations on the panel size. Larger panels might produce richer data, but the iterative participant response required might also cause respondent fatigue resulting in disengagement, poor response rates, and ultimately attrition. Some tradeoffs are inevitable. In this dissertation, I minimized attrition by controlling feedback information to reduce overload, and used reminder mailings. Baker, Lovell, and Harris (2006), Hasson, Keeney, and McKenna (2000), and Williams and Webb (1994), report that both purposeful selection of the Delphi panel and the actions

taken to minimize their attrition are also actions that increase content, face, and concurrent validity of the study.

Finally, Silverman (2005) notes that both qualitative and quantitative researchers have no "golden key" to internal validity. To maximize internal validity in this dissertation, I have rigorously executed all of the above discussed strategies and have used "member checks" to raise the confidence that the conclusions drawn are warranted (Leedy & Ormrod, 2005). I have deliberately structured the participant feedback from one round of inquiry to the subsequent round to accomplish, in part, the member checking. Besides completeness of the feedback, I requested "missed" information in the subsequent rounds of inquiry to the participants. The missed information request affords the participants an opportunity to adjust the author's analyses.

External Validity. Lincoln and Guba (1985) and Leedy and Ormrod (2005) define external validity as the extent to which the conclusions drawn are generalizable. Lincoln and Guba (1985) identify four threats to the external validity: (a) history, (b) selection effects, (c) setting effects, and (d) construct effects. The history threat for external validity is the same as internal validity and the mitigating strategy has already been addressed. The selection effect threat occurs when the sample is not representative of the population. The setting effect threat occurs when the context of the study is too limited or the limits are not known. The construct effects threat refers to the possibility that the construct under study is applicable only to a sample or a different population.

Leedy and Ormrod (2005) provide three strategies for minimizing the threats and maximizing external validity: (a) real life setting, (b) representative sample, and (c) replication. These three strategies do not necessarily correspond respectively to the

aforementioned threats. It is the combination of the strategies that mitigate the combined effects of the threats. The purposeful selection of the Delphi panel of experts, as previously described, is how I have deployed the strategies of real life setting and representative sample. Regarding the third strategy, replication, I do not plan to replicate this dissertation study under another context, but rather rely upon demonstrations of replication by prior researchers and strict adherence to the protocol and procedures of the Delphi methodology is rigorously followed.

Reliability. Lincoln and Guba (1985) consider reliability to be synonymous with consistency and accuracy, and testable by replication. They report the threats to reliability will most likely come from careless acts in the measurement or assessment process. I have used peer debriefing (Creswell, 2003; Lincoln & Guba, 1985; Williams & Webb, 1994) with at least one outside reader to review the data management including collapsing, combining, and interpreting of data, where potential exists for bias or distortion. This approach, when combined with member checks, ensures transparency of the study and improves the reliability of the outcomes.

Chapter III Conclusion

Two important notions were described in the literature review in Chapter II: First, the link between practices and safety culture; and second, the lack of general consensus of the factor structure of safety culture attributable to the methodologies that have thus far been used to explore that factor structure. In this Chapter III, an alternative research method, the Delphi methodology, has been presented in detail as a means for defining antecedents of safety culture while eliminating the biases that may have contributed to lack of consensus in previous research.

Chapter IV presents data collection results and their analysis. With the Delphi methodology there are multiple inquiries and data captures, including separate analyses between data collections. Data are presented in sufficient detail to explain the collapsing of results. Where appropriate, discussions include explanation of decision-making for carryover into subsequent rounds including the supporting statistics. The final Chapter V summarizes the results, conclusions, implications for practitioners, and extensions for further research.

CHAPTER IV

RESULTS AND ANALYSIS

Introduction to the Chapter

The goal of this research study was to determine the organizational practices that lead to the establishment or maintenance of a positive safety culture. I have exhaustively discussed the lack of a general consensus in the literature regarding the factor structure of safety culture. I have also argued that a Delphi research methodology, which includes an exploratory research component, is appropriate for addressing the gaps in the existing research that may be contributing to the lack of consensus on factor structure. This chapter presents the results and the concurrent analyses of having executed the Delphi approach described in Chapter III.

Data Collection

All data were collected using the SurveyMonkey™ website. Special restrictive settings had to be selected for the SurveyMonkey™ operation to ensure anonymity and confidentiality. Using Delphi presents somewhat of a challenge. Delphi requires multiple queries of the same set of participants; therefore, it was necessary to know the contact information (e-mail addresses) of the participants for subsequent queries. I separated the Round 1 inquiry into two surveys within SurveyMonkey™ so the e-mail addresses collected would be stored separately from all other data. This approach successfully de-identified the data, however, the drawbacks are discussed in Chapter V.

The Participants (Panel of Experts)

The South Carolina National Safety Council provided a consultant who acted as an intermediary for recruiting most of the panel participants. The intermediary had some personal and professional knowledge of the candidates which provided better assurance that the goals of the panel makeup would be readily attained. Appendix A is the authorization to make the necessary contacts for this research. Approximately one half of the initial panel membership was recruited by direct contact and the other half by snowballing. The snowballing was accomplished primarily through the intermediary's blog site.

The recruitment letter (see Appendix B) contained a web hyperlink which led the participant to enter the survey website. Potential participants could opt-out by simply not clicking on the hyperlink.

Initial recruitment was 68 participants versus my goal of 60. This goal was based upon worst-case attrition rates mentioned in the literature from which I forecasted an end-of-study panel size of 24. Actual attrition rates were less than half of those rates in the literature and panel participant sizes are reflected in Table 7.

Recruitment was part of the Round 1 inquiry. The demographic data (see Appendix C) was used to test for the exclusion-inclusion against the criteria previously discussed. Three respondents were excluded: One respondent (safety professional) failed to meet the industry certification criteria; a second respondent (manager) chose not to provide the span-of-control data necessary for evaluation and was therefore excluded; and a third respondent provided frivolous responses suggestive of an unreliable informant. The profile of the panel initially recruited is shown in Table 1. Having met

the profile goals of six participants from each category, I proceeded with the remaining analysis of Round 1 data.

Table 1

Delphi Panel Participants by Occupation

Participant Category	Initially Recruited	Excluded*	Final Number of participants
Safety Professional	48	2	46
Auditor or Regulator	7	0	7
Consultant	7	0	7
Manager	9	1	8
Total			68

*One Safety Professional was excluded for failure to meet professional certification criteria; a second Safety Professional was excluded for responding frivolously; and one manager was excluded for failure to provide span-of-control information.

Round 1 Inquiry

The primary focus of the Round 1 inquiry was the collection of up to seven "practices" and definitions from each panel participant. The question format was open-ended (see Appendix C) to facilitate the exploratory research component of this dissertation study. In total, 275 practices were tallied prior to analysis. Submission rates averaged 4.1 practices per panel participant and ranged from one to seven per participant. Thirty-one practices were submitted without an attendant definition. All other practice responses contained definitions. A few definitions were in excess of 100 words each.

All information was obtained within 10 days following issuance of the recruitment letter. The collector for Round 1 was left open for 30 days; however, the latter 20 days of the period were silent. All data were downloaded into an Excel™ spread sheet for further analysis.

I used Creswell's (1998) phenomenology model for textual analysis. A computer-assisted word-and-phrase-search software routine was used for the first-pass textual analysis. My objective was to sort the data into more manageable chunks (Miles & Huberman, 1998) according to broad subject categories. I identified 13 broad categories as shown in Table 2. All raw data was match-fitted into one of these 13 broad categories and then each category was separately analyzed.

I analyzed the individual broad categories by selecting sentences and phrases that had similar themes. The broad categories, including the raw data, were laid out on a Table top map and phrases were color coded to match themes. These tabletop color-coded maps proved useful in conducting the peer debriefings. Similar color-coded phrases were extracted from the raw data and recomposed into a single practice descriptor and detailed definition. During the de-composition and re-composition process, care was taken to record the number of times the theme was cited by different panel participants. The re-compositions, including the citation frequencies, would be returned to the Delphi panel for the next round of inquiry. Appendix D is a detailed example of the previously described thematic analysis for the broad category of "management." I disaggregated the raw data in this category and recomposed them into four candidate practices and definitions for a return to the Round 2 inquiry. I have used differentiating fonts in Appendix D as a proxy for the color-coded maps.

Table 2

Practices Collected By Round One Inquiry

Broad Category	Practice	n	Definition
Management	1. Management involvement and participation	11	Walk the talk. Managers at all levels are involved in all EHS activities such as safety meetings, safety program & goals development, evaluating performance metrics, audits, inspections, pre-startup safety reviews, job cycle checks, incident investigations, and wearing the appropriate personal protective equipment just like front line workers.
	2. Safety leadership	4	Managers set safety goals and objectives for accident frequencies and employee participation in safety activities, including measurement criteria for performance against those goals, and communicates the goals and performance frequently to the entire organization.
	3. Management systems	3	A system of corporate governance exists that defines and owns safety as a corporate value, states a vision and belief about the value of safety, and defines the roles and expectations of all members for safety.

Broad Category	Practice	n	Definition
	4. Management commitment	3	Management makes accident reduction an integral part of the business plan by allocating sufficient budget and manpower resources to support attainment of the safety goals and objectives.
Communication	5. Posters, signs, banners, and E-mails	8	Use of signs, posters, banners and other visual materials to either warn people of hazards or to promote safe practices. Use memos or e-mails where signs are not appropriate.
	6. Atmosphere of openness	10	Conduct open communication regarding safety problems and concerns. Reinforce that retaliation will never result from reporting a safety concern or counter opinion.
	7. Share experiences	10	Use videos, written reports, presentations, and personal discussions to communicate lessons learned from safety successes and accident analyses. Communicate to everyone including customers.
	8. Communications accuracy	6	Ensure job communications are frequent and accurate by using phonetics and repeat-backs.

Broad Category	Practice	n	Definition
Near miss	9. Near miss review	6	A formalized system for reporting, analyzing, and acting upon near-miss accidents. No-fault self-reporting is encouraged. Analysis is for root cause. Remedial actions are determined, deployed, and communicated.
Hazard assessment	10. Hazard assessment	6	Hazards analyses are conducted for specific jobs and facilities on a recurring schedule to identify potential hazards and the adequacy of their mitigation. Procedures and work instructions are included for compliance, with specific focus on changed conditions. Corrective actions are documented.
Oversight	11. Audits	8	Formalized audits of worker safety and the safety programs are conducted according to a written plan and schedule. Findings are recorded, reported and tracked through disposition.
	12. Inspections and walkthroughs	8	Less formal than an audit. Conducted in the work place by all levels of management and peers. Findings are corrected as they are found. Interaction is encouraged. Reporting, if any, is more general.

Broad Category	Practice	n	Definition
	13. Observations	9	Usually conducted by peers as part of a behavior-based program. Findings are corrected on the spot. Reporting is de-identified.
Safety first	14. Putting safety first	3	Commonly called toolbox talks, pre-job briefs, or meeting preambles. Start all evolutions with a discussion about safety.
Training	15. Orientation training	11	Newly assigned employees are trained in foundational S&H topics.
	16. Monthly safety meetings	17	Monthly meetings are venues for essential ongoing S&H training. They consist of timely S&H topics, lessons learned, shared experiences, and program changes. They are typically interactive and rely on participant involvement.
	17. Conferences	3	Safety professionals attend national conferences to gain cutting edge knowledge of the latest advances in safety.
	18. Annual training and testing	4	Every employee annually receives S&H refresher training and must satisfactorily pass a test.

Broad Category	Practice	n	Definition
	19. Job specific training	5	Employees are trained to be skilled at their specific task, use the correct tools, follow the work plans (procedures), and recognize abnormal conditions.
	20. Training quality	3	All training is conducted by qualified instructors, is objective based, contains real (versus hypothetical) situations, and is assessed periodically.
Employee involvement	21. Employee involvement	26	Employees at all levels of the organization participate in training, observation, inspection, problem solving, committee participation, policy and procedure development, and accountability for safety performance.
Stop work authority & Time Out	22. Time Out	26	All employees have the responsibility and authority to stop work or declare a stand down when an evolution in progress does not appear to be proceeding safely. All employees are encouraged to maintain a healthy uneasiness with a questioning attitude and call for a stop-work when the situation doesn't "feel" right.
Accountability	23. Performance evaluations include safety	8	Personal safety performance is included as part of the annual performance review.

Broad Category	Practice	n	Definition
	24. Disciplinary actions	8	Appropriate sanctions are administered against employees who fail to perform safely.
	25. Enforcement	3	Organizations that fail to comply with S&H policies, rules, and regulations are penalized (e.g., compensation), including suppliers and customers.
Trust	26. Building trust	11	Coach instead of being a police officer, avoid placing blame, follow through on commitments, correct problems rather than just reporting them, and constantly use good interpersonal skills.
Documented policies	27. Policies and procedures	15	Written guidance and instructions exist for safely conducting evolutions at all levels in the organization. Content is in compliance with statutory regulations, corporate values, and industry best practices. Content is user-friendly.
	28. Periodic review of policies and procedures	10	Policies and procedures are reviewed periodically and revised promptly to comply with changed conditions.

Broad Category	Practice	n	Definition
Incentives	29. Pay for performance	11	Financial incentives (pay bonuses), clearly tied to positive S&H performance, are provided to all employees who contribute toward achieving goals and objectives.
	30. Celebration	11	Recognition events are held to reward S&H accomplishments. Commemorative tokens are provided to mark the occasion. All employees are provided the time to celebrate.

Note. n = the number of respondents who cited the particular practice.

The remaining 12 broad categories were analyzed according to the same process described in Appendix D. Initially, 28 recomposed practices were identified. However, as the result of peer debriefing, I elected to subdivide two of the practices resulting in a total of 30 practices for the Round 2 inquiry. I conducted the peer debriefing with a Nova Southeastern University faculty member who was familiar with the Delphi methodology, but not a member of the business school. She provided excellent devil's advocacy. Table 2 contains the results of my complete analysis of the data from the Round 1 inquiry, including the first cut broad categories, the re-composed practice descriptors and detailed definitions, and n, the frequency of citation.

Round 2 Inquiry

The objectives of the Round 2 inquiry were to (a) transition from qualitative to quantitative inquiry, (b) provide the participants with sufficient feedback from the first

round analysis to allow them to comprehend the positions of the other participants; (c) obtain each participant's quantifiable agreement, or disagreement, with the recomposed practices and descriptions; (d) obtain quantifiable decisions from each participant regarding the importance of each practice for establishing or maintaining a positive safety culture; and (e) provide an opportunity to challenge the results of my judgments made during the Round 1 analysis.

Appendix E is an example of the Round 2 inquiry provided to the participants via SurveyMonkey™. The Appendix shows the complete detail for the first practice "Management Involvement and Participation." It begins with a statement of the practice, frequency of citation by the panel, and the composed definition of the practice. Section A queries the participants' agreement, using a 5-point scale, with the practice as it has been composed; Section B queries the participants' view of the importance, using a 5-point scale, the practice has for achieving a positive safety culture. This same line of inquiry was repeated for all remaining 29 practices. The repetition of each practice was excluded from Appendix E to save space. Section C queried for an open-ended response to provide the participants an opportunity to revise the list of 30 practices and offer any non-specific comments. The Round 2 inquiry was e-mailed to all the addresses provided by the Round 1 inquiry except for the 3 exclusions. No delivery failures occurred.

Fifty-two of the original 68 panel participants responded to the Round 2 inquiry. Because of the data de-identification requirement, non-responders could not be specifically pursued. I elected to wait no longer and closed the data collector at 52 because it compared favorably with my forecast of 40 after attrition. Not all 52 participants responded to all of the inquiry questions. The responses per question ranged

from a low of 49 to a high of 52. Actual response rates are given by "N" in Table 3. The 5-point scale responses were assigned scores for computational analysis. For the agreement inquiry, strongly agree was assigned 5 points, and strongly disagree was assigned 1 point with intermediates evenly spaced. For the importance inquiry, very important was assigned 5 points, and very unimportant was assigned 1 point with intermediates evenly spaced. The data were analyzed with SPSS™ and the descriptive statistics are presented in Table 3.

Table 3

Practices Evaluated by Round 2 inquiry

	Practice	N	Mean Score	Median Score	σ	IQR	5+4 %	Action
1	Management involvement and participation							
	Agreement	52	4.87	5	0.341	0	100	Retain
	Importance	52	4.94	5	0.233	0	100	
2	Safety leadership							
	Agreement	52	4.54	5	0.603	1	94	Retain
	Importance	51	4.63	5	0.656	1	90	
3	Management systems							
	Agreement	52	4.37	4.5	0.735	1	88	Retain
	Importance	51	4.41	5	0.746	1	88	
4	Management commitment							
	Agreement	50	4.74	5	0.522	0	96	Retain
	Importance	50	4.80	5	0.400	0	100	
5	Posters, signs, banners, and E-mails							
	Agreement	52	3.69	4	1.048	1	69	Drop
	Importance	52	3.60	4	1.079	1	58	
6	Atmosphere of openness							
	Agreement	52	4.65	5	0.676	1	92	Retain
	Importance	52	4.71	5	0.660	0	96	
7	Share experiences							
	Agreement	52	4.31	4	0.666	1	88	Retain
	Importance	52	4.13	4	0.785	2	75	
8	Communications accuracy							
	Agreement	52	3.85	4	0.907	2	62	Drop

	Practice	N	Mean Score	Median Score	σ	IQR	5+4 %	Action
	Importance	51	3.84	4	0.872	2	61	
9	Near miss review							
	Agreement	51	4.33	5	0.784	1	80	Retain
	Importance	51	4.35	5	0.836	1	80	
10	Hazard assessment							
	Agreement	51	4.57	5	0.602	1	94	Retain
	Importance	51	4.63	5	0.593	1	94	
11	Audits							
	Agreement	51	4.25	4	0.737	1	86	Retain
	Importance	51	4.24	4	0.730	1	86	
12	Inspections and walkthroughs							
	Agreement	51	4.57	5	0.533	1	98	Retain
	Importance	51	4.61	5	0.527	1	98	
13	Observations							
	Agreement	51	4.00	4	0.840	2	69	Drop
	Importance	51	3.94	4	0.872	2	63	
14	Putting safety first							
	Agreement	51	4.16	4	0.849	1	80	Drop
	Importance	51	4.12	4	0.878	1	76	
15	Orientation training							
	Agreement	51	4.63	5	0.483	1	100	Retain
	Importance	51	4.55	5	0.695	1	98	
16	Monthly safety meetings							
	Agreement	51	4.27	4	0.794	1	82	Retain
	Importance	51	4.22	4	0.800	1	76	
17	Conferences							
	Agreement	51	3.78	4	0.976	2	57	Drop
	Importance	51	3.65	4	1.026	2	53	
18	Annual training and testing							
	Agreement	51	3.82	4	0.964	1	71	Drop
	Importance	51	3.63	4	1.102	1	61	
19	Job specific training							
	Agreement	51	4.57	5	0.634	1	96	Retain
	Importance	51	4.57	5	0.693	1	92	
20	Training quality							
	Agreement	51	4.24	4	0.703	1	88	Retain
	Importance	51	4.24	4	0.782	1	82	
21	Employee involvement							
	Agreement	50	4.62	5	0.690	1	92	Retain
	Importance	50	4.58	5	0.751	1	88	
22	Stop work authority							

	Practice	N	Mean Score	Median Score	σ	IQR	5+4 %	Action
	Agreement	50	4.64	5	0.592	1	94	Retain
	Importance	50	4.60	5	0.632	1	92	
23	Performance evaluations							
	Agreement	50	4.32	4	0.811	1	90	Retain
	Importance	50	4.24	4.5	0.950	1	82	
24	Disciplinary actions							
	Agreement	50	3.98	4	0.948	1	78	Drop
	Importance	50	3.98	4	0.927	2	76	
25	Enforcement							
	Agreement	50	3.72	4	1.114	2	64	Drop
	Importance	49	3.78	4	1.055	2	67	
26	Building trust							
	Agreement	50	4.74	5	0.482	0	98	Retain
	Importance	50	4.72	5	0.449	1	1.00	
27	Policies and procedures							
	Agreement	50	4.12	4	0.791	1	0.78	Drop
	Importance	50	4.08	4	0.821	1	0.78	
28	Periodic review of policies and procedures							
	Agreement	50	3.92	4	0.956	2	0.66	Drop
	Importance	50	3.92	4	0.913	2	0.70	
29	Pay for performance							
	Agreement	49	3.08	3	1.175	2	0.33	Drop
	Importance	49	3.06	3	1.202	2	0.35	
30	Celebration							
	Agreement	50	4.06	4	0.835	1	0.76	Drop
	Importance	50	3.94	4	0.835	2	0.66	

Notes. N = the number of panel participants responding for the specific question. σ is the standard deviation of the mean score. IQR is the inter-quartile range about the median score. "5+4 %" is the percent of respondents that selected either strongly agree, agree, or very important, important.

Because the ultimate objective of Delphi is to determine consensus, these particular descriptive statistics are intended to indicate the panel's central tendency and the dispersion of the opinion among the panel participants. The mean and median are measures of central tendency, while the standard deviation and the inter-quartile range

(IQR) are measures of dispersion around those central tendencies respectively. Brightman and Schneider (1994) suggest the median is preferable when the number of outliers is sufficient to warrant evaluation of bi-modal tendencies. Initial inspection of the data revealed no evidence suggesting a bi-modal behavior; however, the median and IQR are presented for completeness.

The column labeled "5+4 %" in Table 2 contains statistical information used to decide which practices would be carried over into the Round 3 inquiry. In Chapter III, I defined the decision rule for carry over as those practices for which at least 80% of the participants gave scores of 4 or 5 would move to Round 3. The "5+4 %" column lists the percentage of participants that selected 4 or 5 for the survey questions. Upon applying the decision rule to these data, the following 12 practices were dropped from continued evaluation by the Delphi methodology:

- 5. Posters, signs, banners & e-mails
- 8. Communications accuracy
- 13. Observations
- 14. Putting safety first
- 17. Conferences
- 18. Annual training and testing
- 24. Disciplinary actions
- 25. Enforcement
- 27. Policies and procedures
- 28. Periodic review of policies and procedures
- 29. Pay for performance

- 30. Celebration

Two additional practices, number 7, “share experiences,” and number 16, “monthly safety meetings,” were on the borderline and could have been dropped by strict adherence to the decision rule. However, after closer examination on an individual basis, I decided to retain them into Round 3. Number 7, scored only 88 and 75, and number 16, scored only 82 and 76, but both practices had a relatively narrow dispersion as indicated by the low standard deviation, thereby indicating close agreement by panel participants.

The combination of borderline score and narrow dispersion suggested another round of evaluation by the full panel was in order. The peer debriefer concurred with this decision and no changes were made as a result of that quality review. The comments provided in Section C of the inquiry were few and inconsequential. No new practices were added as a result of the comments, nor was any syntax of existing practices changed.

Round 3 Inquiry

The objectives of the Round 3 inquiry are not too dissimilar to the previous round which were to: (a) provide the participants with sufficient feedback from the previous round to allow them to comprehend the analysis and the positions of the other participants; (b) obtain each participant’s quantifiable agreement, or disagreement, with practices that remain on the list; and (c) obtain quantifiable decisions from each participant about how important each of the practices is for establishing or maintaining a positive safety culture. The significant difference between Round 3 and the previous Round 2 inquiry is the feedback provided to the participants. In Round 3, the participants

were informed that the number of practices has decreased from 30 to 18 as a result of their input, and the prior voting results of the group are included on each survey question. Appendix F is an example of the Round 3 inquiry provided to the participants via SurveyMonkey™. Again, the Appendix shows the complete detail for only the first practice, "Management Involvement and Participation." It begins with a statement and detailed definition of the practice followed by a query of the participants' rating of agreement and importance using a 5-point scale. The number of votes received in the prior round of inquiry is listed beside each scale descriptor so the participant can readily see how the panel vote was divided in the prior round. This same line of inquiry was repeated for the remaining 18 practices. The repetition is excluded from Appendix F to save space. A final open-ended question is provided to give the participants an opportunity to suggest modifications. The Round 3 inquiry was e-mailed to all the same addresses used for the previous inquiry. No delivery failures occurred.

Fifty-six panel participants responded to the Round 3 inquiry after 5 days. This was four more than responded in Round 2 indicating that at least 4 participants thought to be lost to attrition rejoined that panel. I elected to wait no longer and closed the data collector at 56 because again it compared favorably with my attrition forecast. As before, not all participants responded to all of the inquiry questions. Four of the practices received responses from only 54 participants. Actual response rates are given by "N" in Table 4. The 5-point scale responses were again assigned the same numerical scores for computational analysis. SPSS™ was used to calculate the mean, standard deviation, median, IQR, and 5+4% for the Round 3 response data as done for the previous Round 2. In order to preserve the identity of the practices from round to round, I retained the same

practice numbering even though 12 practices were dropped from the set. For that reason, the practice numbers in Table 4 are not continuous. The gaps are caused by the dropped practices. The Round 3 analysis, however, provided the first opportunity to quantitatively test for consensus, the desired outcome of the Delphi methodology.

Consensus Testing: Round 3

Two sample z test. Consensus occurs when the central tendency of the participant panel's response, and the dispersion of the responses about that central tendency, both stabilize, that is, they do not significantly change from one round of inquiry to the next. I tested for the first part of consensus definition (stability of central tendency) by comparing the means of each practice for equality. The hypotheses for this test are:

H_0: $\bar{u}_{nr2} - \bar{u}_{nr3} = 0$

Ha: $\bar{u}_{nr2} - \bar{u}_{nr3} \neq 0$

where $\bar{u}_{nr2}$ is the mean for practice n from Round 2 and $\bar{u}_{nr3}$ is the mean for practice n from Round 3.

The two-sample z test statistic for testing $\bar{u}_{nr2} - \bar{u}_{nr3}$ is:

$$z = (\bar{u}_{nr2} - \bar{u}_{nr3}) / [(\sigma_{nr2}^2 / N_{nr2}) + (\sigma_{nr3}^2 / N_{nr3})]^{½}$$

For a two-tailed test at $\alpha = 0.05$, if the calculated z value exceeds the critical $z = 1.96$ then the null hypothesis must be rejected. For this study, rejection of the null hypothesis indicates that consensus was not achieved. The calculated z test statistic for each of the practices, and its corresponding p-values are listed in the rightmost two columns in Table 4. The null hypothesis was rejected for two practices, number 2, safety leadership, ($z = 2.08$, $p = 0.0376$) and number 19, job specific training, ($z = 1.97$, $p = 0.0488$)

Table 4

Results of Round 3 Inquiry and Comparison with Round 2

	Practice	N	Mean	Med	σ	IQR	5+4, %	Comparison of Means Rounds 2 & 3 z scores	Comparison of Means Rounds 2 & 3 p values
1.	Management Involvement & Participation								
	Agreement	56	4.964	5	0.186	0	100	1.85	0.0644
	Importance	56	4.964	5	0.186	0	100	0.54	0.5892
2.	Safety Leadership								
	Agreement	56	4.25	5	0.829	1	82	2.08	0.0376
	Importance	56	4.357	5	0.854	1	82	1.85	0.0644
3.	Management Systems								
	Agreement	54	4.241	4	0.607	1	94	0.95	0.3422
	Importance	54	4.333	4	0.720	1	93	0.55	0.5824
4.	Management Commitment								
	Agreement	54	4.778	5	0.497	0	96	0.38	0.704
	Importance	54	4.926	5	0.262	0	100	1.88	0.0602
6.	Atmosphere of Openness								
	Agreement	56	4.857	5	0.350	0	100	1.94	0.0524
	Importance	56	4.821	5	0.383	0	100	1.05	0.2938
7.	Share Experiences								
	Agreement	56	4.107	4	0.795	1	86	1.42	0.1556
	Importance	56	4.179	4	0.710	1	82	0.30	0.7642
8.	Near Miss Reviews								
	Agreement	54	4.556	5	0.685	1	89	1.54	0.1236
	Importance	54	4.481	5	0.739	1	85	0.83	0.4066
9.	Hazard Assessment								
	Agreement	56	4.643	5	0.549	1	96	0.66	0.5092
	Importance	56	4.607	5	0.618	1	93	0.17	0.865
11.	Audits								
	Agreement	56	4.161	4	0.701	1	86	0.68	0.4966
	Importance	56	4.161	4	0.701	1	86	0.54	0.5892
12.	Inspections and Walkthroughs								
	Agreement	56	4.607	5	0.557	1	96	0.37	0.7114
	Importance	56	4.679	5	0.538	1	96	0.69	0.4902

	Practice	N	Mean	Med	σ	IQR	5+4, %	Z scores	p values
15.	Orientation Training								
	Agreement	54	4.704	5	0.457	1	100	0.83	0.4066
	Importance	54	4.704	5	0.457	1	100	1.34	0.1802
16.	Monthly Safety Meetings								
	Agreement	56	4.304	4	0.679	1	91	0.20	0.8414
	Importance	56	4.107	4	0.880	1	79	0.67	0.5028
19.	Job Specific Training								
	Agreement	56	4.786	5	0.490	1	96	1.97	0.0488
	Importance	56	4.786	5	0.490	1	96	1.85	0.0644
20.	Training Quality								
	Agreement	56	4.018	4	0.855	1	80	1.44	0.1498
	Importance	56	4.125	4	0.803	1	86	0.72	0.4716
21.	Employee Involvement								
	Agreement	56	4.75	5	0.509	0	96	1.09	0.2758
	Importance	56	4.75	5	0.509	0	96	1.35	0.177
22.	Time Out								
	Agreement	56	4.607	5	0.618	1	93	0.28	0.7794
	Importance	56	4.643	5	0.666	1	89	0.34	0.7338
23.	Performance Evaluations Include Safety								
	Agreement	56	4.357	4	0.854	1	82	0.23	0.818
	Importance	56	4.429	4	0.863	1	82	1.07	0.2846
26.	Building Trust								
	Agreement	56	4.786	5	0.490	0	96	0.48	0.6312
	Importance	56	4.857	5	0.350	0	100	1.74	0.0818

Note. N is the number of respondents; σ is the standard deviation of the mean; IQR is the interquartile range; 5+4 % is the percent of respondents that selected strongly agree, agree, very important, or important; Z is the resultant statistic for test of equality of the means for Rounds 2 and 3; p is the value for the corresponding statistical test.

indicating that consensus did not exist among the panel participants for inclusion of these practices, based upon inequality of the mean between Rounds 2 and 3.

Wilcoxon non-parametric rank test. The second part of testing for consensus, the stability of the dispersion around the median, is determined by the Wilcoxon non-parametric rank test. Appendix H is a detailed example of how this test is conducted.

The hypotheses for the test are:

H_0: The two populations have equal dispersions

H_a: The two populations have unequal dispersions

The calculated z values for the agreement rankings and the importance rankings were 0.348 and 0.6011 respectively. For a two-tailed test at $\alpha = 0.05$, if the calculated z value exceeds the critical z = 1.96 then the null hypothesis must be rejected. In this case the null hypothesis was accepted for both agreement and importance. Thus I can safely conclude that, based upon dispersion about the median, consensus was achieved between Rounds 2 and 3. The corresponding p values for this test are listed in Table 7.

At this point, I had mixed results about consensus: based on the means equality test, 2 of the 18 practices failed consensus; based on dispersion about the median, consensus was strong. For the two practices that failed consensus, the p-values (see Table 4) were 0.0488 and 0.0376, both of which I considered close enough to the threshold of 0.05 to warrant further examination. I elected to begin this examination by conducting a Round 4 inquiry with the same 18 practices carried in Round 3.

Round 4 Inquiry

The objectives of the Round 4 inquiry were identical to those for Round 3, (a) provide the participants with sufficient feedback from the previous round to allow them to comprehend the analysis and the positions of the other participants; (b) obtain each participant's quantifiable agreement, or disagreement, with practices that remain on the list; and (c) obtain quantifiable decisions from each participant about how important each of the practices is for establishing or maintaining a positive safety culture. Appendix G is an example of the Round 4 inquiry provided to the participants via SurveyMonkey™.

Again, the Appendix shows the complete detail for only the first practice "Management Involvement and Participation." This same line of inquiry was repeated for the remaining 18 practices. The repetition is excluded from Appendix G to again save space. A final open-ended question was provided to give the participants an opportunity to suggest modifications. The Round 4 inquiry was e-mailed to all the same addresses used for the previous inquiry. No delivery failures occurred.

Sixty panel participants responded to the Round 3 inquiry after 5 days. This was four more than responded in Round 3 indicating that at least 4 participants rejoined that panel. Again, not all participants responded to all of the inquiry questions. Four of the practices received responses from only 52 participants. Table 5 illustrates the variance in panel membership over the duration of all four rounds of inquiry.

Table 5

Participant Panel Populations

		Responses per Question	
Round of Inquiry	Participants in the Round	Least	Most
1	68	NA	NA
2	52	49	52
3	56	54	56
4	60	54	60

The results of this analysis of data collected from the Round 4 inquiry are provided in Table 6. The format of Table 6 is identical to previous rounds for comparative purposes.

Consensus Testing: Round 4

Two sample z test. The calculated z test statistic for each of the practices, and its corresponding p-values, are listed in the rightmost two columns in Table 6. All calculated values of z were less that the critical value of 1.96 for a two-tailed test at $\alpha = 0.05$. Thus, I can conclude that consensus has been achieved based upon the equality of all means.

Wilcoxon non-parametric rank test. The calculated z values for the agreement rankings and the importance rankings were 0.9082 and 0.7881 respectively; both less than the critical $z = 1.96$ for a two-tailed test at $\alpha = 0.05$. Thus, I can conclude that, based upon dispersion about the median, consensus was achieved between Rounds 3 and 4. The corresponding p values for this test are listed in Table 7.

A visual comparison of the z and p values in Tables 4 and 5 provide some clues as to why consensus was reached after Round 4. The majority of the z scores significantly decreased and the majority of the p values significantly increased from Round 3 to Round 4, which is indicative of a convergence of the opinion of the panel participants. Round 3 and Round 4 contained the same number (18) of practices which likely accounts for the convergence. In contrast, Round 2 to Round 3 had a decrease (30 to 18) in the number of practices causing a dilution of the votes in the former round. It is also possible that the effects of participants re-joining the panel between rounds may have had just enough impact on the consensus tests to change the borderline values. With consensus reached after Round 4, I terminated data inquiries for this study.

Ranking of the Practices

Besides a consensus list of practices that lead to a positive safety culture, the research data provide the opportunity to rank the practices in priority of importance. Some combination of both the agreement rating and the importance rating is more

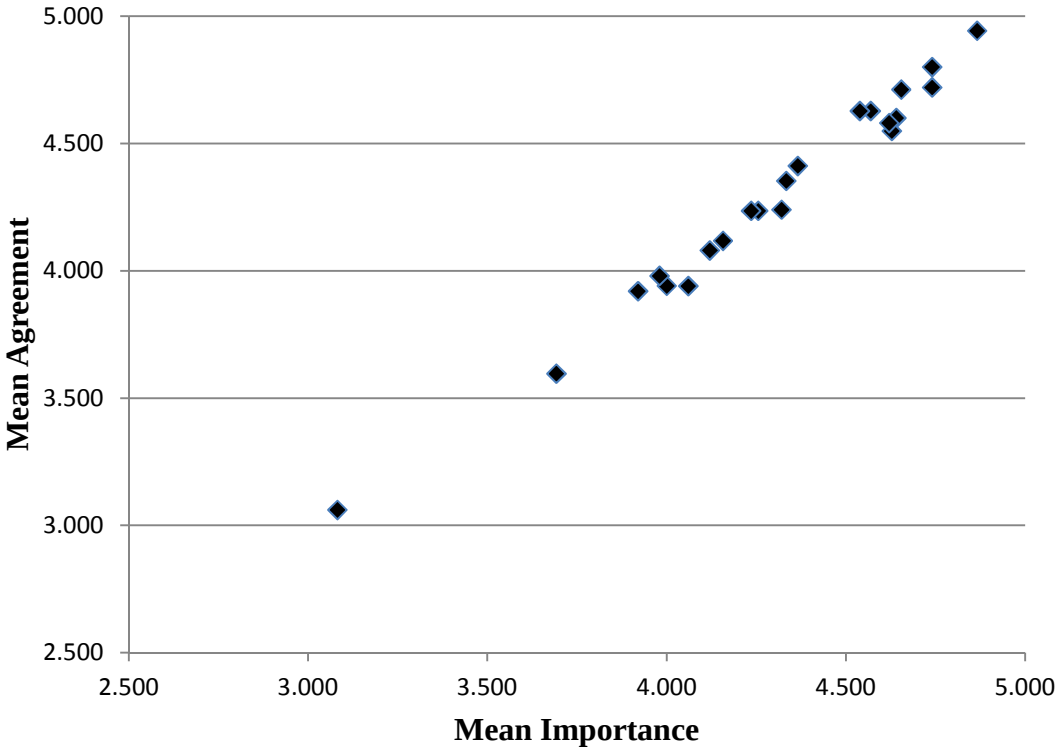

Figure 2. The Round 4 mean agreement rating versus the mean importance rating for each practice.

appropriate for a practitioner than either one alone. Figure 2 is a plot of the mean agreement rating versus the mean importance rating. The near-linear relationship suggests little difference between the two parameters with respect to ranking. As a result, I have ranked the practices according to the average of the agreement and importance ratings. The final rankings are shown in Table 8. I changed the practice numbers to letters to distinguish its position in the rank with its former identity carried in the data analysis.

Figure 3 shows a plot of the averaged practice mean ratings including the 95% statistical confidence interval. This plot shows that some overlap of rank exists between adjacent practices or groups of adjacent practices; however, there is a clear distinction of rank from top to bottom.

Table 6

Results of Round 4 Inquiry and Comparison with Round 3

								Comparison of Means, Rounds 3 & 4	
	Practices	N	Mean	Med	**σ**	IQR	**5+4, %**	Z score	p value
1	Management Involvement & Participation								
	Agreement	60	4.867	5	0.499	0	0.97	1.41	0.159
	Importance	58	4.948	5	0.221	0	1.00	0.42	0.674
2	Safety Leadership								
	Agreement	55	4.218	4	0.928	1	0.82	0.19	0.849
	Importance	56	4.429	5	0.776	1	0.86	0.46	0.646
3	Management Systems								
	Agreement	54	4.278	4	0.524	1	0.96	0.34	0.734
	Importance	54	4.333	4	0.720	1	0.93	0.00	1.000
4	Management Commitment								
	Agreement	53	4.755	5	0.580	0	0.96	0.22	0.826
	Importance	53	4.868	5	0.584	0	0.98	0.66	0.509
6	Atmosphere of Openness								
	Agreement	58	4.759	5	0.702	0	0.97	0.95	0.342
	Importance	57	4.789	5	0.449	0	0.98	0.41	0.682
7	Share Experiences								
	Agreement	58	4.103	4	0.824	1	0.86	0.02	0.984
	Importance	55	4.218	4	0.706	1	0.84	0.29	0.772
9	Near Miss Reviews								
	Agreement	56	4.482	5	0.779	1	0.86	0.53	0.596
	Importance	52	4.519	5	0.720	1	0.87	0.27	0.787
10	Hazard Assessment								
	Agreement	56	4.625	5	0.696	1	0.96	0.15	0.881
	Importance	58	4.483	5	0.856	1	0.88	0.89	0.373
11	Audits								
	Agreement	58	4.103	4	0.759	1	0.83	0.42	0.674
	Importance	56	4.179	4	0.758	1	0.88	0.13	0.897
12	Inspections and Walkthroughs								
	Agreement	57	4.596	5	0.617	1	0.96	0.10	0.920
	Importance	56	4.661	5	0.576	1	0.95	0.17	0.865

	Practices	N	Mean	Med	σ	IQR	5+4, %	Z score	p value
15	Orientation Training								
	Agreement	52	4.712	5	0.453	1	1.00	0.09	0.928
	Importance	56	4.607	5	0.618	1	0.96	0.93	0.352
16	Monthly Safety Meetings								
	Agreement	55	4.291	4	0.730	1	0.91	0.09	0.928
	Importance	56	4.089	4	0.969	1	0.79	0.10	0.920
19	Job Specific Training								
	Agreement	56	4.75	5	0.605	0	0.95	0.34	0.734
	Importance	56	4.768	5	0.500	1	0.96	0.19	0.849
20	Training Quality								
	Agreement	57	3.947	4	0.887	1	0.77	0.43	0.667
	Importance	54	4.204	4	0.620	1	0.89	0.58	0.562
21	Employee Involvement								
	Agreement	58	4.603	5	0.808	1	0.91	1.16	0.246
	Importance	58	4.724	5	0.581	0	0.97	0.25	0.803
22	Time Out								
	Agreement	55	4.6	5	0.677	1	0.93	0.06	0.952
	Importance	58	4.517	5	0.895	1	0.84	0.85	0.395
	Performance Evaluations								
23	Include Safety								
	Agreement	54	4.407	5	0.782	1	0.85	0.32	0.749
	Importance	57	4.386	5	0.874	1	0.81	0.26	0.795
26	Building Trust								
	Agreement	58	4.707	5	0.643	0	0.93	0.70	0.484
	Importance	57	4.789	5	0.521	0	0.98	0.74	0.459

Note. N is the number of respondents; σ is the standard deviation of the mean; IQR is the interquartile range; 5+4 % is the percent of respondents that selected strongly agree, agree, very important, or important; Z is the resultant statistic for test of equality of the means for Rounds 3 and 4; p is the value for the corresponding statistical test.

Table 7

Wilcoxon Results: Tests for Consensus

Comparison	Z score	p value
Round 2 to Round 3		
Agreement	0.348	0.9082
Importance	0.6011	0.7881
Round 3 to Round 4		
Agreement	0.6327	0.7673
Importance	0.1424	0.9099

Note. For p values greater than 0.05, reject the alternative hypothesis and accept the null hypothesis.

Chapter IV Conclusion

Both research questions set for this dissertation study were successfully answered. A Delphi participant panel was successfully recruited to inform this research and panel membership was retained at levels above what was forecasted through termination of the study. Attrition was minimal. The data was collected electronically via SurveyMonkey™ while de-identification requirements were maintained. A set of practices that lead to a positive safety culture were obtained and consensus regarding the practice set was achieved after four rounds of inquiry. The consensus set is provided in rank order of importance and agreement in Table 8.

Table 8

Final Consensus Practices in Rank Order

	Practice	AVE Mean
A.	Management Involvement & Participation	4.91
B.	Management Commitment	4.81
C.	Atmosphere of Openness	4.77
D.	Job Specific Training	4.76
E.	Building Trust	4.75
F.	Employee Involvement	4.66
G.	Orientation Training	4.66
H.	Inspections and Walkthroughs	4.63
I.	Time Out	4.56
J.	Hazard Assessment	4.55
K.	Near Miss Reviews	4.50
L.	Performance Evaluations Include Safety	4.40
M.	Safety Leadership	4.32
N.	Management Systems	4.31
O.	Monthly Safety Meetings	4.19
P.	Share Experiences	4.16
Q.	Audits	4.14
R.	Training Quality	4.08

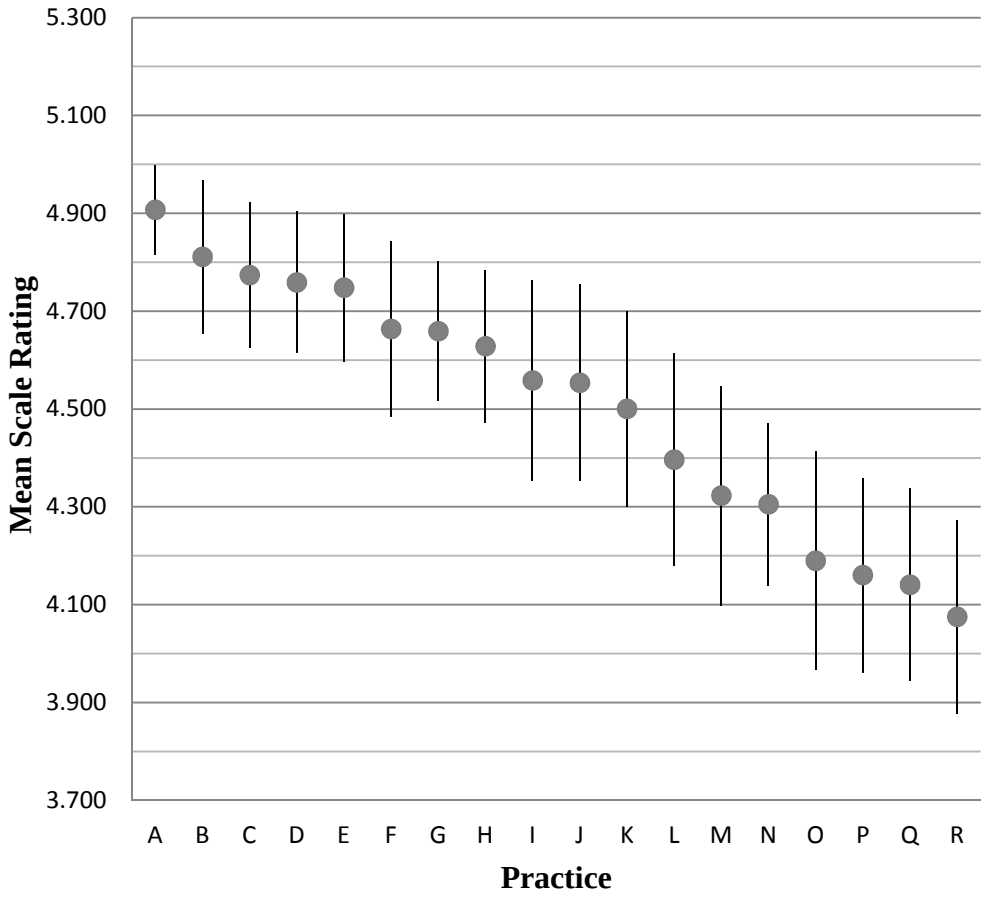

Figure 3. The final average of Agreement and Importance mean ratings for each practice including the 95% confidence interval. Refer to Table 8 for the practice corresponding to the letters on the abscissa.

CHAPTER V

DISCUSSION AND CONCLUSION

Introduction to the Chapter

A positive safety culture within an organization is related to a reduction in the rate of occupational accidents and injuries. However, researchers to date have been unable to reach a general consensus on the factor structure or the antecedents that lead to a positive safety culture. Schein (1990) defines culture as the shared set of attitudes, beliefs, and values. Hofstede's (2001) onion model of organizational culture submits that values are at the core of organizational culture and that "practices" are the manifestation of those values. The aim of this dissertation study was to identify the set of practices that are related to positive safety culture.

The literature review showed the lack of a general consensus regarding the factor structure of safety culture resulted from weaknesses in methodology and research context. The exploratory front-end of the Delphi methodology was used in this dissertation research to overcome those weaknesses.

In this chapter, I will discuss the findings in the context of emerging conclusions from the study. The chapter begins with the outcomes related to the specific purpose of the study, followed by a discussion of the Delphi process and its unique contributions to the outcomes. The chapter concludes with a discussion of the implications for both practitioners and researchers, the limitations of the study, and potential extensions for further research.

Discussion of Outcomes Related to Purpose

The purpose of this research was to answer the following research questions:

Question #1: What practices are used by the members of organizations to establish or maintain a positive safety culture within those organizations?

Beginning with 275 practices offered by the 68 panel participants in the initial round, the list reduced to 30 candidate practices through content analysis of the raw data.

Question #2: Does consensus exist among a panel of safety experts for the set, or subset, of the practices discovered by the first research question?

Through the implementation of the Delphi technique and the perspective of the 68 panel participants, consensus was reached for the inclusion of 18 practices. After four rounds of Delphi inquiries and analyses, the panel participants also reached consensus regarding the importance of these 18 practices. The consensus practices are listed in Table 8.

The differences between the individual practices within the ranking of the 18 practices were small for adjacently ranked practices. In fact, as many as five practices had statistical means that fell within the confidence intervals with each other. However, over the spectrum of all 18, there is a clear hierarchy of importance.

Consensus Practices Related to Safety Culture

Of the 30 practices set forth by the Round 1 inquiry, consensus was reached on both agreement and importance for 18 of them and final member-checking confirmed the 18. Panel members also indicated potential existed for merger of a few of the practices. However, there was no consensus as to which ones. The following discusses the consensus practices.

Management involvement and participation. This practice ranked highest on the importance and agreement scale and had the narrowest dispersion of the 18 practices indicating very strong consensus for its inclusion. Participants most frequently characterized the practice by the cliché, "walk the talk," meaning that safety culture would be established and maintained when managers at all levels personally act out all attributes of the established ESH activities. Such activities include: safety meetings, safety program and goals development, evaluating performance metrics, audits, inspections, pre-startup safety reviews, job cycle checks, incident investigations, and wearing the appropriate personal protective equipment just like front line workers. One panel participant noted "when senior management [is] involved in audits, inspections, and the like …there seems to be improved safety culture, as all employees see that it is something valued by senior leadership." The repeated demonstration of safety as a value is at the core of the Hofstede (2001) onion model that I used as the theoretical foundation for this study

Management commitment. Placing second in the ranking, this practice notes that two unique management functions, business planning and resource allocation, must equally include occupational safety as an element of the business for successful establishment of a safety culture. The practice recognizes that safety goals and objectives cannot be realized without a success-oriented plan and the appropriate resources (monetary and manpower) to execute that plan. More importantly, the inclusion of safety in the resource planning demonstrates to members of the organization, that safety is on the same level as production, service, etc. One panel participant related "my management understands that preventing accidents saves money…and supporting

[safety] initiatives publicly makes a huge difference in whether employees pay attention…and takes us seriously." The most frequently stated portion of the definition of this practice was the willingness of the firm to monetarily fund the safety improvement initiatives.

Atmosphere of openness, and building trust. While these two practices were defined and evaluated separately by all four rounds of inquiry, their definitions are intertwined and with their ranking scores nearly equal, merit discussion together. The definition of "atmosphere of openness" relates to promoting and conducting open communications throughout the organization regarding safety problems without fear of retaliation even for counter opinions. Correction of problems requires a clear understanding of the details, the discussion of which must be free of any chilling effects. One panel participant noted, "allow[ing] concerns to be brought forward and addressed by all levels results in buy-in by the majority of the employees, which leads to a positive safety culture."

The practice of "building trust" refers to blame avoidance, coaching versus policing, action versus promises, and good interpersonal skills, all of which are antecedents to building an atmosphere of openness. Prior research by Clarke (1998), Cox and Cox (1991), Lee (1998), Mearns et al. (1998), Silva et al. (2004), and Rundmo (2000) also found that the equivalent of both practices were present in the factor structure when either one appeared. Thus, these two practices are interconnected and, from a practitioner's view, may be considered as a single practice.

Employee involvement. The objective of this safety practice is the same as any generic employee involvement practice. Involving employees in all safety related

activities produces more buy-in, better solutions, empowerment and self-reliance. One participant related, “involving employees in audits, inspections, training, what-if analyses, problem solving, discussions on job scope hazards, and on special committees has been very successful at developing a safety mindset within their work groups.”

Time Out. Implementation of the “time out” practice was considered by many panel participants as the ultimate employee involvement. The practice requires that all employees have the responsibility and authority to stop work or declare a stand down when a job in progress is perceived to be proceeding unsafely. The panel participants unanimously noted that it is an ultimate measure of safety culture because a work stoppage usually incurs a cost penalty and the existence of this practice demonstrates the corporate value of safety over production.

Job specific training, orientation training, and training quality. All three of these practices include the common activity of training, albeit different viewpoints. The first two, “job specific training” and “orientation training”, ranked in the upper one-third of the set of practices for several important reasons. First, employees must possess the appropriate job specific knowledge and skills to perform job functions safely. Secondly, their competence level is expected to be high enough, as one participant noted, "to ask the questions such as what could go wrong here” so hazards can be identified and mitigated before they cause accidents. Emphasis on “job specific training” is regarded as the means to attaining the intended high levels of competence.

“Orientation training” is the pre-requisite to the job specific training and is aimed at “creating value for safety for all coming into the plant” as noted by one panel

participant. Orientation training is viewed as the first task for every new employee to complete so they are prepared for learning safety skills in the job specific training.

Finally, "training quality" was last in the rank order of importance and the participants' comments addressed typical quality issues such as objective-based training, periodic assessments, and real versus hypothetical cases, with emphasis on the latter by several participants. One participant's statement, "safety training must be authentic and truly represent what the employee observes in their workplace. Hypothetical situations do little to transfer safety information" succinctly describes the training quality practice.

While the differences in importance ranking of these three training-related practices appear significant, the definitions, comments, and examples provided by the participants suggest they are tightly linked. "Job specific training" is the principal antecedent of safety culture. However, its success requires the orientation training as a prerequisite and both training programs require high training quality. Thus, for the practitioner, these three might well be combined into a single practice.

Management systems, safety leadership, and performance evaluations that include safety. The ranking scores for these three practices were nearly identical (4.31. 4.32 and 4.40 respectively) and examination of the participants' comments suggests they are perhaps three parts of the same practice. The "management systems" practice was defined as establishing a system of corporate governance that holds safety as a corporate value, states a vision and belief about it, and defines the roles and expectations of all members of the organization regarding safety. As one participant commented, "too often the safety department of a company is viewed as responsible for safety performance

versus the line organization. It's easy for the lines of responsibility to get blurred so senior management must address this constantly."

The "safety leadership" practice was defined as managers setting safety goals, monitoring performance against goals, and providing appropriate feedback. One participant described it as, "[managers] set up goals for the safety performance of their departments, regions, divisions, etc. Measurement criteria are established (lost work days, emergency responses, workers compensation costs, etc.) and managers are accountable for improvement in their areas." Another participant noted, "the plant manager has a monthly meeting…devoted to safety to track progress of safety-related projects, check status of leading safety indicators, and take action for not hitting targets." Thus, it appears that safety leadership is merely a subpart (a role and responsibility) of the management systems practice. Again, from practitioner's view, potential exists for combining these into a single practice.

The practice of "performance evaluations that include safety" is the final element of accountability for the previous two practices. It is defined as adding the topic of safety performance relative to goals in the annual (or periodic) performance reviews for each employee. A participant commented, "performance evaluations should have a defined component devoted to safety performance and evaluations should impact salary, bonus and promotion decisions."

Audits, hazard assessments, inspections and walkthroughs, and near miss reviews. These four practices are interconnected by their common purpose which is to uncover and ubiquitously correct unsafe conditions or unsafe acts that could lead to

accidents. Based on the participants' comments, the differences are primarily in the setting, the degree of formality, and the actors involved.

"Audits" are the most formal, comprehensive, and are conducted by trained auditors. They were best defined by a participant's comment: "A fully implemented auditing and incident investigation procedure which focuses on reporting of incidents (including near misses), root cause analysis, correction of hazards, and follow-up to ensure that hazards remain corrected, is a necessary attribute of any positive safety culture." Formality is achieved by conducting the audits according to a procedure and schedule. The outcome is generally documented in a written report and subsequent audits examine the compliance with recommendation in that written report. Over a pre-planned, designated time span, all parts of the organization are subjected to audits. The auditors are specially qualified (often evidenced by certification) to conduct audits and may be part of a regulatory agency.

"Near miss reviews" include a formalized mechanism for reporting, analyzing, and acting upon events for which a serious accident was just nearly missed. Voluntary, no-fault, self-reporting is the initiator for a near miss review which differentiates it from the other three practices. Otherwise, the rigor of the analysis and reporting is similar to the audit practice. One participant wrote, "the goal is to learn from mistakes and avoid repeat incidents" which clarifies the purpose of near miss reviews.

"Hazard assessments" are less formal than audits and less comprehensive. They include periodic evaluation of facilities, equipment, processes or people to determine if changes over time have introduced new hazards. Results are documented and changes in policies and procedures are implemented as necessary. A participant's comment, "if you

don't know it's a hazard, it cannot be corrected before an accident happens" succinctly describes the purpose of the practice. Hazard assessments are usually conducted by the people, or their peers, who normally work on the object or process being assessed.

"Inspection and walkthroughs" are even less formal. They are conducted by managers as well as peers. Time is allotted to just "walk around" and observe people working. Deficiencies are corrected immediately, interaction is encouraged, and typically there is no formal reporting. One respondent wrote, "verbal feedback is encouraged between fellow employees during these short review and observation periods so that a feeling of caring, mutual respect, and safety dependency is obtained. The individuals' [identities] are confidential and not shared with management."

It is worth noting that while these four practices are related by common purpose, they are not dependent on one another as were the training practices. The practitioner might implement any one effectively. However, this study concludes that all four are related to a positive safety culture.

Monthly safety meetings. This practice requires that all employees devote some amount of work time (typically 1 hour) every month (or some other appropriate time period) to assemble and engage in a dialogue about safety. Topics vary and might include refresher training, review of new safety practices, review of accident investigations, celebration of successes, etc. Several participants found it important not to structure these meetings but rather address the contemporary issues.

Share experiences. The objective of this practice is to encourage ongoing communications in all directions about personal safety experiences. Participants gave examples ranging from employees making somewhat formal testimonial presentations at

one end of the spectrum to impromptu humorous e-mails about safety from the CEO at the other end.

Comparison to Prior Research

The underlying justification for this dissertation research was the fact that prior research could not reach a consensus on the factor structure of safety culture. While not in consensus, those researchers did identify sets of practices for particular domains of their respective studies. The following discussion compares my conclusions with those of other researchers.

I selected 21 studies from the literature to compare with the results of this study. These studies are some of the more frequently cited in the safety culture research stream and were included by Cooper (2000) and Clarke (2000) in their work to define the state-of-the-art in safety culture research. The results of my comparison are illustrated in Table 9. The letters in the header of Table 9 correspond to the letter designation of my final results in Table 8. Denoted by "X" are those prior research studies that have found a factor similar or identical to a practice found in this study.

Table 9

Comparison to Selected Prior Studies

Study	Practice*																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Brown and Holmes (1986)	X	X																
Cheyne, et al. (1998)		X	X			X		X	X				X					
Clarke (1998)	X		X		X	X		X	X				X					

Study	Practice*																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Cooper and Phillips (1994)		X					X							X				X
Cox and Cox (1991)			X		X	X			X				X	X				
Cox, et al. (1998)						X	X						X	X				X
Coyle, et al. (1995)						X	X						X	X				X
DeJoy, et al. (2004)		X												X				
Diaz and Cabrera (1997)		X			X				X					X				
Fang, et al. (2006)		X			X	X	X	X					X	X				X
Farington-Darby (2005)	X	X	X			X	X		X				X					X
Glendon and Litherland (2001)	X		X			X			X	X			X	X				
Lee (1998)	X	X	X		X	X	X		X				X	X				X
Mearns, et al. (1998)		X	X		X	X			X				X	X				
Mohamed (2002)	X	X	X			X			X				X	X				
Niskanen (1994)	X				X			X	X									

Study	Practice*																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Fernandez-Muniz, et al. (2007)		X			X	X		X					X	X				
O'Toole (2002)	X	X				X	X						X					X
Silva, et al. (2004)		X	X		X	X	X		X				X	X				X
Rundmo (2000)		X	X		X				X					X				
Zohar (1980)		X			X		X		X					X				X

Note. * A = management involvement & participation; B = management commitment; C = atmosphere of openness; D = job specific training; E = building trust; F = employee involvement; G =orientation training; H = inspections and walkthroughs; I = time out; J = hazard assessment; K = near miss reviews; L = performance evaluations include safety; M = safety leadership; N = management systems; O = monthly safety meetings; P = share experiences; Q = audits; R = training quality

Overlap between this dissertation study and the selected 21 studies occurred for 12 of the 18 practices identified in this study. The six practices not clearly coincident with prior research include: job specific training, near miss reviews, performance evaluations include safety, monthly safety meetings, sharing experiences, and audits. One additional practice, hazard assessments, appeared in only one of the 21 studies. The reason for the six non-coincident practices is not readily apparent and is a subject for further research. The 12 practices that did overlap appeared with varying frequency from as much as 15 times for two of the practices identified in this study.

Usage of the Delphi Methodology

A critical factor of this research was the use of the Delphi methodology. It provided the "exploratory" research component necessary to compensate for shortcomings in previous research on safety culture. These shortcomings mainly included biases introduced by a priori knowledge of the researcher, use of replicated survey instruments, and the need for approaching the subject from a broader perspective. The experiences using the Delphi method merit discussion.

The Participant Panel

Delbecq et al. (1975), Keeney, Hasson, and McKenna (2001), Pasukeviciute and Roe (2001), and Powell (2003) note that panel member selection is critical for the adequate validity and reliability of the Delphi methodology. Most important is the level of expertise and willingness to commit to the lengthy process. I engaged the assistance of a national trade association, the National Safety Council, for pursing panel members. Their large database of members with experience and zeal, combined with their brand attached to the introduction, facilitated swift assembly of a model panel. Attrition rates were only ~15% from start-to-finish compared with 60% typically. Turnaround times were 10 days for Round 1, and 5 days each for Rounds 2, 3, and 4, compared to typically 30 days and 15 days respectively.

SurveyMonkey™

Data collection was accomplished almost exclusively by using SurveyMonkey™ a web-based electronic data collection system. It proved to be accurate, time-saving, and

effective for maintaining confidentiality of the participant responses. However, some tradeoffs arise when using SurveyMonkey™, specifically for Delphi methodologies. On the positive side, "survey fatigue" is the most prominent cause of attrition in Delphi and the web-based nature of the system makes it more responder-friendly. Prolonged analysis between rounds of inquiry, another cause of increased attrition, is effectively minimized with the formats of the data collectors in SurveyMonkey™. On the negative side, it is normally more cost effective than postal mailings; however, the required de-identification of responses combined with the need to maintain e-mail addresses of the participants for multiple rounds of inquiry necessitated higher cost subscription levels. On the whole, the tradeoffs are still in favor of using SurveyMonkey™.

De-identified Data

Research for dissertations is typically conducted with the data de-identified so as to hasten and streamline the Internal Review Board (IRB) approval processes. De-identification means that there is no reasonable way to correlate the sample participants' identities with their responses. This presents a unique challenge for the Delphi methodology because multiple rounds of inquiry necessitates that the principal investigator know the identities of the panel members. Without that knowledge it is not possible to query the same participants each time. SurveyMonkey™ accommodates de-identification rather neatly by partitioning research data separately from e-mail addresses which allows consistent sampling. However, de-identification in general, whatever way it is accomplished, limits the research options with Delphi. For example, tardy panel participants cannot be individually reminded of the need to hasten responses. Also with

de-identification, the demographic profiles become blurred after the first round of inquiry because attrition will change the panel makeup. Therefore, demographic dependencies cannot be measured. In addition, follow-ups for clarification of the open-ended questions are not possible. As a result, my recommendation is to conduct Delphi-based research with identities known by the investigator even though it requires the more rigorous path through the IRB.

Peer Debriefing and Member Checking

Peer debriefing was conducted between rounds and provided valuable insights into the conduct of the research. Between Rounds 1 and 2, the peer debrief led me to reconfigure the initial list of practices from 28 to 30 by further sub-dividing two practices. One of these practices ultimately was included in the final list of 18 consensus practices.

Member checking was accomplished by feedback embedded in the round of inquiry and solicitation of open-ended commentary in each and every round. Response to the open-ended comment opportunities was extremely minimal. It is difficult to determine if the lack of comment abundance was the result of pervasive agreement with my analysis, apathy, or survey fatigue. Future users of Delphi should consider making the member checking a higher priority.

Limitations of this Study

As previously discussed, de-identification of the data limits the ability for the researcher to fine-tune the input. Intuitively, it appears to have had little material impact

on the outcome of this research. However, it is worth minimizing the potential risk in future research by maintaining confidential identities and obtaining permission from the participants to do so.

The pool of candidates for recruitment of the participants was mainly focused in the southeastern United States. A broader geographical sample would provide more widely generalizable results.

Implications for Practitioners

I concluded this study with a set of 18 organizational practices that lead to a positive safety culture. This set of practices was arrived at by consensus of a panel of occupational safety experts. Knowledge of these organizational practices can provide the tools for a firm's leadership to manage its exposure to the risk of occupational accidents and injuries without constant command and control. As workers become more singular and remote (e.g., telecommuting, at-home workers, on-the-road workers, etc.), command and control tactics used to influence behavior become less viable, making it necessary to rely more upon instilled cultures.

Implications for Researchers

This study provides a demonstration of the Delphi methodology used to reduce bias resulting from researchers' a priori knowledge. Such bias is typically influential when random sample surveys are used. Researchers may want to consider using Delphi when faced with bias possibilities. In the case of the subject of this research, such biases

may have contributed to the lack of a general consensus regarding the factor structure of safety culture.

Potential Extensions of this Research

Replicating the results of this study using a different panel of participants would increase the external validity and generalizability of the results. Replications should be conducted without de-identification to measure variance resulting from the panel profile.

This study may be one of the earliest studies to use a Delphi methodology for examining the safety culture. Delphi methodologies should be considered when exploring organizational sub-cultures beyond safety, e.g., innovation, ethics, quality, green, etc.

Hofstede (2001) demonstrated that significant cultural variances occur when crossing international borders. Intuition suggests those same differences would apply to the practices that produce a positive safety culture. Therefore, it would be valuable to conduct this same research with participant panels from different countries or regions. The results may be valuable for firms making forays offshore.

APPENDIX A

COOPERATIVE AGREEMENT FOR PARTICIPANT RECRUITMENT

Appendix A

Cooperative Agreement for Participant Recruitment

Authorization

Saturday, January 19, 2013 02:34 PM
Colleen Eubanks [colleen@palmettoehs.com]

To: Andrew Cwalina

Andy,

For the purpose of conducting the described safety culture research, you are authorized to recruit survey respondents from the e-mail addressees provided directly and from posting of the link on my firm's website, blog page, and Facebook page.

Colleen K. Eubanks, CIH, CSP
Palmetto EHS, LLC
803.462.4404 (Phone)
803.462.4408 (Fax)
803.260.3202 (Mobile)
www.PalmettoEHS.com

APPENDIX B

INTRODUCTION AND RECRUITMENT LETTER

Appendix B

Introduction and Recruitment Letter

Dear Participant,

Thank you for considering participation in this research study. This study is being undertaken as partial fulfillment of the dissertation requirements for the degree of Doctor of Business Administration through Nova Southeastern University, Fort Lauderdale, Florida.

The purpose of this research study is two-fold: first to determine the practices used by organizations to establish or maintain a positive safety culture, and second, to determine if there is a consensus regarding those practices that are essential to a positive safety culture. Organizational "practices" are those things that may be done, or said, or written, or communicated, or displayed, or affirmed, and which have a positive influence on safety within the organization.

This study will be conducted using the Delphi method, a multiple-part survey technique for determining consensus around a particular topic. You will receive at least 2 additional surveys after this one over the next two months. Your participation is expected to require no more than 25 minutes total for all parts over the next 2 months. Your responses to this survey will be de-identified by the survey software such that your opinions will remain anonymous throughout the study. The anonymous nature of this Delphi process allows all participants to have an equal voice without individual or group pressure.

Your participation in this study is totally voluntary and anonymous. There is no compensation for participating. A summary of the results will be provided to you upon your request after project completion. You may find the results have some practical value for your workplace.

If you are willing to participate in this study as a Delphi panel member, please complete the remainder of this survey by clicking HERE. By entering this survey, your consent to participate is implied and you will receive subsequent surveys as described above. Again, this is totally voluntary and you may exit the study at any time. If you have any questions regarding this survey, or the research study in general, please do not hesitate to contact me, or my research committee chairperson.

My thanks in advance for your participation

Andy Cwalina
Principal Investigator, Nova Southeastern University
803-649-7064 or cwalina@nova.edu

Dr. Regina Greenwood, chairperson
800-672-7223

APPENDIX C

ROUND 1 INQUIRY

Appendix C

Round 1 Inquiry

Please provide up to seven (7) practices that you either use, or you have observed being used, to establish or maintain a positive safety culture.

PRACTICES are those things that are done, said, written, communicated, displayed, or affirmed and which have a positive influence on the safety of the organization.

Name the practices with a single word or short phrase in the boxes on the left. Then, as necessary, please provide a more detailed description of that practice, including examples, in the corresponding boxes on the right.

Click the "done" button at the end when you have completed your contribution.

Practice	Description, including examples of the practice
1.	
2.	
3.	
4.	
5.	
6.	
7.	

Demographic Information

2. Which of the following best describes your current assignment? Check (√) all that apply.

___ Safety Professional
___Auditor or Regulator
___Consultant
___Manager
___Other, specify_____

3. If a Safety Professional, Auditor, Regulator, or Consultant, do you hold certification?

___Yes
___No

4. If a consultant, how many clients have you counseled?

___less than 3
___more than 3

5. If an auditor or regulator, how many audits, inspections, investigations or other oversight activities have you conducted?

___less than 3
___more than 3

6. If a Manager, how many people report to you, directly and indirectly?

___ Less than 10
___ 11 to 100
___ More than 100

7. How long have you been in this assignment?

___ Less than 1 year
___ 1 to 5 years
___ More than 5 years

___ I would prefer not to answer

8. What is your age (last birthday)?

___ Less than 25 years old
___26 to 35 years old
___36 to 45 years old
___46 to 55 years old
___56 to 65 years old
___over 65 years old
___ I would prefer not to answer

9. What is your gender?

___ Male
___ Female
___ I would prefer not to answer

10. Please provide your e-mail address:

_____

APPENDIX D

DATA ANALYSIS EXAMPLE:

Appendix D

Data Analysis Example:

Raw Textual Data from the Open-ended Questions in Round 1 Inquiry Synthesized to Form the First Cut of Organizational Practices for the Broad Category of "Management"

The Round 1 inquiry requested the respondents to provide up to seven practices that lead to a positive safety culture. The inquiry requested a short practice descriptor, i.e. a single word or short phrase along with an attendant detailed description and example. While the number of entries was limited to seven, there was no word-count limit on the detailed description. Table D.1 shows the format of the collected data. The leftmost column is the sequential number assigned by the SurveyMonkey™ collector; the second column is the short practice descriptor; and the rightmost column is the attendant detailed description. Note that this is an example of just one of the broad categories. There was a total of 13 broad categories (see Table 2) so the example illustrated in this Appendix was repeated 12 more times.

Table D.1 is the output of a computer-assisted textual analysis for the broad theme of "management." After removal of duplicates and frivolous responses, 30 items remained for the next phase of analysis. This second phase of analysis consisted of disaggregating the text into stand-alone phrases, sorting the phrases into like subject bins, and then re-aggregating the phrases into a composite sense-making definition. The disaggregation is illustrated in Table D.1 by typographical distinctions: <u>underscoring</u>, *italicizing*, **bolding**, and *scripting*. In the actual analysis, I produced large Table top

chart-maps and used color-coding (not reproducible here) to perform the disaggregation and re-composition

Table D.2 illustrates the re-composition of each distinctive typographical category into a sense-making definition. The practice descriptor was selected based on a visual majority of the times the phraseology was associated with the disaggregated parts. Table D.2 was used as the basis for constructing the Round 2 Inquiry.

Table D.1

Raw Text Data: Thematic Analysis of the "Management" Broad Category

No.	Practice	Detailed description and examples
2	Senior management commitment AND participation	The ranking manager must demonstrate his/her commitment to worker safety & health through active participation in the EHS process. delegating this responsibility will result in a failure of the system as what is important to THE manager is important to everyone else. If the ranking manager does not participate then neither will middle managers and supervisors.
6	Consistent message delivered about safety is first priority.	*Staff members in the plant all have safety objectives around accident frequencies and employee participation in safety. They have communicated to front line supervisors* they are serious about safety and hold the departments accountable.

No.	Practice	Detailed description and examples
8	Management support	*Management support is needed from the highest level in the company and at the individual locations.* This must be spoken and reinforced with examples that demonstrate their support frequently.
9	Management commitment	**Must be more than "we are going to comply with OSHA" my management understands that preventing accidents saves money; as a regulatory agency our management believes we should hold ourselves to the same standard as the regulated community; funds to purchase the best equipment. I make may management look good and they fully support me.**

No.	Practice	Detailed description and examples
20	Management/Company commitment	The common theme I have seen across the various organizations that have a positive safety culture is management commitment to the safety and overall well-being of their employees. Everyone is looking for the magic bullet to make companies safer, the latest program, the latest mantra, the lasest buzzword. Call safety a priority or a value, call your program behavior based or people based, without the commitment of the company and management, the rest is just smoke & mirrors, and the employees always know it. Once your company is TRULY committed, you can use whatever buzzword or program you choose, so long as it fits the organizational and personal culture.

No.	Practice	Detailed description and examples
21	Management Leadership	*Signed written safety management plan Publish the plan* Lead safety culture/participate in activities **Show safety as part of overall business success**
31	Management involvement	Management must be involved, to the extent possible, in developing and reinforcing the local safety culture. the best Behavior Based Safety Program was headed by the Production Manager. This demonstrates that it is not just another weird safety professional program.
32	Management Safety Goals	*Employers set up goals for managers for the safety performance of their departments, regions, divisions, etc. Measurement criteria are established (lost work days, EMR, Workers compensation costs), and managers are given responsibility to manage improvement in their areas of responsibility.*

No.	Practice	Detailed description and examples
33	Management shows their commitment	When middle-level management shows a commitment to safety by practicing it themselves and seeking the safety office's input before taking on a project, it really shows in the employee's behavior. E.g. *when our supervisors expect their folks to wear respirators and they do it themselves,* the employees wear their respirators even when no one is watching. **When upper-level management shows a commitment to safety by adequately funding and staffing the safety office, and supporting our initiatives publicly, it makes a huge difference in whether the middle management and employees pay attention to our advice. When we got an increased budget, one-time funding to implement a major program, and an additional employee, all the sudden depts. that used to scoff at us started to take us more seriously.**
34	Manager communication	*This is during a job when a manager communicates with a worker to ensure the job is proceeding as expected.*

No.	Practice	Detailed description and examples
35	Model the Way	Leaders understand that their behavior is scrutinized by the workforce, and ensure that they act safely and demonstrate interest in safety improvements.
36	Include all employees in some safety activity led by management.	Safety activities include meetings, incident investigations, audits, safety program development and execution, pre-startup safety reviews, and job cycle checks, among others. These can not be delegated to low level employees without management leadership. Managers must be seen as leading these activities.
37	management leadership	In regards to safety, management must lead, walk the walk and talk the talk, safety must be a priority not lip service
38	Management commitment to policy through practice	All managers wear safety glasses when required.
39	Management commitment	**Upper site management and corporate management support of the safety process and safety related activities. This is generally demonstrated by budget and time resources allocated for safety, and when management has a visible but meaningful role in the process.**

No.	Practice	Detailed description and examples
40	Managers giving time and effort to safety	
55	Integrated Safety Management System	*A formal process that identifies management as the "owner" of safety and as such presents a beliefs and vision statement around safety as corporate values. The top manager chairs a steering committee that defines the roles and responsibilities .*
95	*Establish a statement of policy on safety by top management and follow it.*	*It is necessary that top management describe in words the policy of the organization with regard to safety and then demonstrate their own commitment to following it.*
172	Management leadership	In regards to safety, management must lead, walk the walk and talk the talk, safety must be a priority not lip service

No.	Practice	Detailed description and examples
175	Inclusion of safety in Corporate values	Corporate Values include: Serve our communities Achieve Communicate openly and honestly Respect diversity and care for each other Excel in customer service and safety Do what is right
176	Senior management involvement	When senior management are involved in audits, inspections, and the like and routinely evaluate metrics around safety, lead by example, etc., there seems to be improved safety culture, as all employees see that it is something valued by senior leadership.
194	*Set expectations*	*If people don't understand what's expected with respect to safety, then how can they participate?*
195	Clearly define who is responsible for safety	to often the safety (ESH) department of a company is viewed as responsible for safety performance versus the line organization. its easy for the lines of responsibility to get blurred so senior management must address this constantly

No.	Practice	Detailed description and examples
197	Safety/Health Policy Statement	Developed Safety/Health Policy Statement which outlines roles/responsibilities of all levels of organization.
198	RZAZ	Roles, responsibilities, authorities and accountabilities are clear, understood, implemented and evaluated to ensure these are conducted at all levels of the organization
200	Management commitment	Leaders need to walk the walk and talk the talk.
204	Line Managers are responsible for safety, not the safety professionals	

No.	Practice	Detailed description and examples
209	*Safety Targets*	*Developed safety targets which are now tracked, measured, and reported in the same manner as production, quality, cost, and delivery.*
217	Leadership setting the example	I've seen the safety culture of an organization go from "world class" to below average in a short 90 day period when the infusion of new leadership and direct repots felt they did not have to follow the rules and procedures that were part of the previous companies culture for achieving safety excellence
219	Safety Steering Committee	*Monthly Vice President Safety Steering Committee Meeting designed to review safety performance with core stakeholders, in a much more working group environment.*

Note. Textual descriptions are assigned to one of four groups (see Table D.2) as designated by underscore, *italicization*, *script font*, or **bold** font. This Table only represents the broad category of management. Twelve additional broad categories were analyzed similarly.

Table D.2 contains the re-composition of the distinguished phrases in Table D.1. The phrases were assembled into four like-content bins and a composite definition was synthesized to capture the essential meaning of the phrases. The practice descriptor (left hand column) was based on a majority association from the raw data. The typological distinctions have been carried into this Table to illustrate the procedure used and flow of information. Peer debriefing was conducted with the color-coded Table-top charts and the content of Table D.2 was carried into Round 2 for evaluation by the Delphi panel.

Similar results were produced for the remaining 12 broad categories and are summarized in Table 2.

Table D.2

Re-composition of "Management" Thematic Category Analysis

Practice	Re-constructed Description
Management Involvement and Participation	Walk the talk. Managers at all levels are involved in all EHS activities such as safety meetings, safety program & goals development, evaluating performance metrics, audits, inspections, pre-startup safety reviews, job cycle checks, incident investigations, and wearing the appropriate personal protective equipment just like front line workers.
Safety Leadership	*Managers set safety goals and objectives for accident frequencies and employee participation in safety activities, including measurement criteria for performance against those goals, and communicates the goals and performance frequently to the entire organization*

Practice	Re-constructed Description
Management Commitment	**Management makes accident reduction an integral part of the business plan by allocating sufficient budget and manpower resources to support attainment of the safety goals and objectives.**
Management Systems	*A system of corporate governance exists that defines and owns safety as a corporate value, states a vision and belief about the value of safety, and defines the roles and expectations of all members for safety.*

Note. Underscoring, Italicization, Bolding, and Scripting correspond to the thematic analysis from Table D.1.

APPENDIX E

ROUND 2 INQUIRY

APPENDIX E

ROUND 2 INQUIRY

Note For this Appendix

This Appendix provides an example of type and format of questions used in the Round 2 inquiry. To conserve space, details are provided for only one of the 30 practices that were actually contained in the Round 2 inquiry. Only the titles of the practices 2 through 30 are shown below; however, the question formats, including the 5-point scales, for each subsequent practice were identical to practice 1. The descriptions and frequencies for practices 2 through 30 were extracted from Table 2.

Introduction Letter for Round 2 Inquiry

Greetings Research Participant,

Thank you for completing the Round 1 survey for the research study to determine the organizational practices that lead to a positive safety culture. As promised, there are multiple parts to this research and the purpose of this e-mail is to launch the Round 2 survey. This survey is all multiple-choice and should require about 15 minutes of your time.

You are one of 68 participants in the study. Nearly 300 practices were submitted, and through combination and clustering, I have collapsed the number down to 30 that are part of this survey. In this Round 2, I will be asking if you agree with the 30 practices, and how important you think they are. The last question in this survey provides space for optional comments if you should have any. Otherwise, all questions are multiple-choice.

Begin the survey by clicking HERE. Feel free to contact me by reply to this e-mail.

Best regards,

Andy

Andy Cwalina, Principal Investigator

Nova Southeastern University

803-649-7064, cwalina@nova.edu

The Survey

Practice: 1. Management Involvement and Participation

Section A. The following organizational practice "Management Involvement and Participation" was referenced by 11 study participants.

Management Involvement and Participation: Walk the talk. Managers at all levels are involved in all S&H activities such as safety meetings, safety program & goals development, evaluating performance metrics, audits, inspections, pre-startup safety reviews, job cycle checks, incident investigations, and wearing the appropriate personal protective equipment just like front line workers.

Do you agree that this practice leads to a positive safety culture? Indicate your position below

___ STRONGLY AGREE
___ AGREE
___ NEITHER AGREE NOR DISAGREE
___ DISAGREE
___ STRONGLY DISAGREE

Please provide a short explanation if you have selected “Strongly Disagree”
_____
_____

Section B. Now please indicate how important the practice of "Management Involvement and Participation" is to a positive safety culture.

___ VERY IMPORTANT
___ IMPORTANT
___NEITHER IMPORTANT NOR UNIMPORTANT
___UNIMPORTANT
___VERY UNIMPORTANT

Please provide a short explanation if you have selected “Very Unimportant”
_____
_____

Practice: 2. Safety leadership

Practice: 3. Management Systems

Practice: 4. Management Commitment

Practice: 5. Posters, Signs, Banners and E-mails

Practice: 6. Atmosphere of Openness

Practice: 7. Share Experiences

Practice: 8. Communications Accuracy

Practice: 9. Near Miss Reviews

Practice: 10. Hazard Assessments

Practice: 11. Audits

Practice: 12. Inspections and Walkthroughs

Practice: 13. Observations

Practice: 14. Putting Safety First

Practice: 15. Orientation Training

Practice: 16. Monthly Safety Meetings

Practice: 17. Conference Attendance

Practice: 18. Annual Training and Testing

Practice: 19. Job Specific Training

Practice: 20. Training Quality

Practice: 21. Employee Involvement

Practice: 22. Time Out

Practice: 23. Performance Evaluations Include Safety

Practice: 24. Disciplinary Actions

Practice: 25. Enforcement

Practice: 26. Building Trust

Practice: 27. Policy and Procedures Available

Practice: 28. Periodic Review of Policies and Procedures

Practice: 29. Pay For Performance

Practice: 30. Celebrations

Section C: Missing Practices. If you feel that an important practice has not been included on the above list, please add it below:

Single word or short phrase:_____

Detailed description including examples:

_____

_____

_____

Additional Comments (optional)

_____

_____

APPENDIX F

ROUND 3 INQUIRY

Appendix F

Round 3 Inquiry

Greetings Research Participant,

Thank you for completing the surveys for Rounds 1 and/or 2 for the research study to determine the organizational practices that lead to a positive safety culture. As you know there are multiple parts to this research and the purpose of this e-mail is to launch the third survey. This survey is similar to the previous, but much shorter and should require only about 5 minutes of your time.

The first "introduction" page of the survey explains how this survey differs from the previous ones. Please read it carefully.

Begin the survey by clicking HERE.

Feel free to contact me by reply to this e-mail

Best regards,

Andy

Andy Cwalina, Principal Investigator
Nova Southeastern University
803-649-7064, cwalina@nova.edu

Round 3 Introduction

Thanks for entering the survey.

This 3rd round of the survey looks very, very similar to the previous round with TWO exceptions:

First, it's shorter, and should take less time. In the previous survey there were 30 practices. You and the other participants found overwhelming support for only 18 of those practices. Therefore, the remaining 12 have been eliminated from the study.

Second, you get to see the opinions of all the other participants, while you're making your selection this time. For each multiple choice question, the previous votes of all participants are shown.

Thanks again, and click the Next button below to get started.

---

1. Management Involvement and Participation

Definition: Walk the talk. Managers at all levels are involved in all S&H activities such as safety meetings, safety program & goals development, evaluating performance metrics, audits, inspections, pre-startup safety reviews, job cycle checks, incident investigations, and wearing the appropriate personal protective equipment just like front line workers.

Do you agree that this practice leads to a positive safety culture? Indicate your position below

___ STRONGLY AGREE (45 votes in previous round)
___ AGREE (7 votes in previous round)
___ NEITHER AGREE NOR DISAGREE (0 votes in previous round)
___ DISAGREE (0 votes in previous round)
___ STRONGLY DISAGREE (0 votes in previous round)

Please provide a short explanation if you have selected “Strongly Disagree”
_____
_____

Now please indicate how important the practice of "Management Involvement and Participation" is to a positive safety culture.

___ VERY IMPORTANT (49 votes in previous round)
___ IMPORTANT (3 votes in previous round)
___NEITHER IMPORTANT NOR UNIMPORTANT (0 votes in previous round)
___UNIMPORTANT (0 votes in previous round)
___VERY UNIMPORTANT (0 votes in previous round)

Please provide a short explanation if you have selected “Very Unimportant”
_____
_____

Practice: 2. Safety leadership

Practice: 3. Management Systems

Practice: 4. Management Commitment

Practice: 5. Atmosphere of Openness

Practice: 6. Share Experiences

Practice: 7. Near Miss Reviews

Practice: 8. Hazard Assessments

Practice: 9. Audits

Practice: 10. Inspections and Walkthroughs

Practice: 11. Orientation Training

Practice: 12. Monthly Safety Meetings

Practice: 13. Job Specific Training

Practice: 14. Training Quality

Practice: 15. Employee Involvement

Practice: 16. Time Out

Practice: 17. Performance Evaluations Include Safety

Practice: 18. Building Trust

Additional Comments (optional)

_____

_____

APPENDIX G

ROUND 4 INQUIRY

Appendix G

Round 4 Inquiry

Greetings Research Participant,

Thank you for completing the surveys for Rounds 1, 2, and 3 for the research study to determine the organizational practices that lead to a positive safety culture. As you know there are multiple parts to this research and the purpose of this e-mail is to launch what will most likely be the last survey. This survey is identical in format to the previous one; only the vote numbers have changed.

Begin the survey by clicking HERE.

Feel free to contact me by reply to this e-mail

Best regards,

Andy

Andy Cwalina, Principal Investigator
Nova Southeastern University
803-649-7064, cwalina@nova.edu

Round 4 Introduction

Thanks for entering the survey.

As in previous rounds, you get to see the opinions of all the other participants, while you're making your selection this time. For each multiple choice question, the previous votes of all participants are shown.

Thanks again, and click the Next button below to get started.

---

2. Management Involvement and Participation

Definition: Walk the talk. Managers at all levels are involved in all S&H activities such as safety meetings, safety program & goals development, evaluating performance metrics, audits, inspections, pre-startup safety reviews, job cycle checks, incident investigations, and wearing the appropriate personal protective equipment just like front line workers.

Do you agree that this practice leads to a positive safety culture? Indicate your position below

___ STRONGLY AGREE (54 votes in previous round)
___ AGREE (2 votes in previous round)
___ NEITHER AGREE NOR DISAGREE (0 votes in previous round)
___ DISAGREE (0 votes in previous round)
___ STRONGLY DISAGREE (0 votes in previous round)

Please provide a short explanation if you have selected “Strongly Disagree”

_____
__
_____
__

Now please indicate how important the practice of "Management Involvement and Participation" is to a positive safety culture.

___ VERY IMPORTANT (54 votes in previous round)
___ IMPORTANT (2 votes in previous round)
___NEITHER IMPORTANT NOR UNIMPORTANT (0 votes in previous round)
___UNIMPORTANT (0 votes in previous round)
___VERY UNIMPORTANT (0 votes in previous round)

Please provide a short explanation if you have selected “Very Unimportant”

_____
__
_____
__

Practice: 2. Safety leadership

Practice: 3. Management Systems

Practice: 4. Management Commitment

Practice: 5. Atmosphere of Openness

Practice: 6. Share Experiences

Practice: 7. Near Miss Reviews

Practice: 8. Hazard Assessments

Practice: 9. Audits

Practice: 10. Inspections and Walkthroughs

Practice: 11. Orientation Training

Practice: 12. Monthly Safety Meetings

Practice: 13. Job Specific Training

Practice: 14. Training Quality

Practice: 15. Employee Involvement

Practice: 16. Time Out

Practice: 17. Performance Evaluations Include Safety

Practice: 18. Building Trust

Additional Comments (optional)

_____

_____

APPENDIX H

EXAMPLE OF WILCOXON RANK SUM TEST FOR DISPERSION EQUALITY OF TWO SAMPLE POPULATIONS

Appendix H

Example of Wilcoxon Rank Sum Test for Dispersion Equality of Two Sample Populations

Description

The Wilcoxon Rank Sum (Dovich, 1988) test is a non-parametric test used to test for variation in dispersion and location of the median between two populations. As the differences in dispersion and means approaches zero, the two populations approach consensus. In contrast to the typical "F" test for equivalence, normality of the population distributions is irrelevant because the Wilcoxon Rank Sum test is non-parametric.

The hypotheses for the test are:

H_0: The two populations have equal dispersions

H_1: The two populations have unequal dispersions

This illustrated example uses the actual data from the 3rd and 4th rounds of inquiry (see Tables 3 and 4). The test is conducted by ranking the response means from both populations from 1 to (n_3+n_4) where n_3 is the number of response means in the Round 3 inquiry, and n_4 is the number of response means in the Round 4 inquiry. The resultant ranking is illustrated in Table H.1. Where two scores are tied for rank, the rank is split between the two ties (example, 5th & 6th rank). W_3 and W_4 are the sum of rank for each Round 3 and 4 respectively.

Table H.1

Ranking of the Means for the Importance Ratings for All Practices in the Third and Fourth Rounds of Inquiry.

Round	Mean	Combined Rank	Round	Mean	Combined Rank
4	4.089	1			
			3	4.107	2
			3	4.125	3
			3	4.161	4
			3	4.179	5.5
4	4.179	5.5			
4	4.204	7			
4	4.218	8			
			3	4.333	9.5
4	4.333	9.5			
			3	4.357	11
4	4.386	12			
			3	4.429	13.5
4	4.429	13.5			
			3	4.481	15
4	4.483	16			
4	4.517	17			
4	4.519	18			
4	4.607	19.5			
			3	4.607	19.5
			3	4.643	21
4	4.661	22			
			3	4.679	23
			3	4.704	24
4	4.724	25			
			3	4.750	26
4	4.768	27.5			

Round	Mean	Combined Rank	Round	Mean	Combined Rank
			3	4.786	27.5
4	4.789	29.5			
4	4.789	29.5			
			3	4.821	31
			3	4.857	32
4	4.868	33			
			3	4.926	34
4	4.948	35			
			3	4.964	36
W_4=Sum of Ranks =		328.5	W_3=Sum of Ranks =		337.5

The Z-score is calculated by:

$$Z = [W - (n_1)(n_1+n_2+1)/2] / [(n_1)(n_{2)}(n_1+n_2+1)/12]^{½}$$

$$= [337.5 - (18)(18+18+1)/2] / [(18)(18)(18+18+1)/12]^{½}$$

$$= -0.142360$$

The test value for $\alpha = 0.05$ using the standard normal probability density distribution (Z values) is +/- 1.96. Since the calculated test value is in this range, the null hypothesis is accepted. It is concluded that the two dispersions are equal and the 3rd and 4th rounds of inquiry are in consensus. The reported p-value would be 0.8051.

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