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# Causes and Prevention of Electric Power Industry Accidents: A Delphi Study

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This is to certify that the doctoral dissertation by

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Abstract

The electric power industry is very complex, dangerous, and challenging. The number of workplace accidents declined over the last decade, but worker injuries and fatalities continue to occur. The purpose of this Delphi study was to gain consensus regarding the most feasible and desirable methods to prevent accidents and deaths. The research question focused on gaining consensus from a panel of experts regarding the most desirable and feasible solutions to fatal and serious workplace accidents in the United States. The Bolman and Deal 4-frame model proved useful for understanding challenges within the electric industry and how workers and leaders can work together to best prevent accidents. Twenty-seven managers, trainers, supervisors, and workers, each with more than 10 years of experience in the United States electric power industry, responded to 30 items in the first round. The responses from the first round, where 70% or more of participants agreed, were analyzed using the NVivo 12 Plus software. Consensus occurred after each round: In the first round through the solutions participants provided. In the second round and later rounds, consensus occurred through acceptance of items with scores of 3 or higher on a 5-point Likert-type scale endorsed by 70% or more respondents. Participants decided if the solutions were desirable and feasible in the second round, and important and credible in rounds third and fourth. Participants concurred that organizational leadership, managers, supervisors, and workers were in different ways responsible for accident prevention. Supervisors and managers who communicated organizational priorities, and demanded strict compliance with policies, rules, and procedures, promote social change in a highly specialized industry.

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# Dedication

My mother would be smiling in heaven, and she will never stop.

Safe working is a necessity and not a benefit. To all my colleagues and friends in the electric power industry always remember that in the work safe message, there is a me who is you.

## Acknowledgments

Success is nothing more than the completion of a journey that was not possible without assistance. At Walden University, I owe my success to Dr. E. Thompson and Dr. N. Swain.

My life has been a journey to places and experiences that I just never imagined. I am here because of Vivian and Lakshmi (Tara). You inspired me to continue and to reach where I wanted you to go. Leader of the family Siddiqa, my daughter in law, I looked out for your calls each night as I pressed on to this point. Varna, your support is most appreciated too. Anne Marie and Miss Elsie; your quiet and calm reassurance is significant and worth so much more.

I would not be here without my wife, Caroline Wendy. You are my soul mate and true friend, and this is our success as, without your constant encouragement and challenges, this outcome would be so very different. We have another Ph.D. success to celebrate, and I look forward to that.

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# Chapter 1: Introduction to the Study

In 2017, five electricity industry employees, including a manager, died in a single workplace accident in Florida (Bedi, Capriel, Dawson, & McGrory, 2017). That same year, a lineman in Minnesota was seriously injured when the boom arm of his bucket truck fell off when it became detached from the vehicle (Staff, 2017), and in Fairmont, North Carolina, a lineman died while moving a fallen power line from across a roadway (Sinclair, 2017). Although infrequent, accidents have a high impact and were dangerous in the electric power industry. In this study, I focused on determining how to mitigate accidents in the electric power industry and the prevention of severe injuries and death to workers. This workplace experience was necessary to research since the electricity industry is one where sophisticated safety workplace arrangements are employed, yet accidents still occur. Manuele (2014) highlighted the increased emphasis on workplace safety while indicating that the worst accidents continued to happen. These were the ones where workers became severely injured or killed. Chapter 1 contains the background for this research, a problem statement, a purpose statement, the research question, the conceptual framework chosen for this exercise, and a section on the nature of the study. Sections on the assumptions I made, the scope and delimitations, limitations, and significance of the study also form part of this chapter.

## Background of the Study

White et al. (2016) considered worker beliefs about the effectiveness of workplace safety arrangements that Australian electrical workers experienced. That study was similar, in ways, to this current research to determine ways to prevent accidents which were happening in the U.S. electric power industry. The prevailing impression was that electric power industry workers were proficient at recognizing hazards, capable of evaluating the risks, and of mitigating them. Aboagye-Nimo, Raiden, King, and Tietze (2015) studied on-site workplace training and accident prevention at construction worksites in the United Kingdom and considered how tacit knowledge resulted in improved safety performance. Aboagye-Nimo et al. reported that knowledge is essential to successful business organizations. Active learning, team building, interpersonal communications, self-learning, and critical thinking were all bolstered by tacit knowledge (Aboagye-Nimo et al., 2015). Fordyce et al posited that with an understanding the learning techniques, trainers could better prepare workers to appreciate the dangers of electrical work and how to mitigate hazards. These hazards were either unrecognized or misunderstood by trained and untrained workers in electric utilities (Fordyce et al., 2016). Worker knowledge about the dangers of working on electrical systems grew from working arrangements and situations, and social reality and exposure. Explicit knowledge come from organizational procedures, equipment manuals, manufacturers instructions, classroom exercises, and books. Tacit knowledge is a mixing of explicit knowledge and on-site experience gained from actual work exposure; the individual's skill, expertise, and personal trait. Aboagye-Nimo et al. found that construction workers relied more on tacit knowledge than explicit knowledge as they were trained on-site more often than in classroom settings. This experience led to better appreciation, understanding, attitudes, and behavior and improved workplace safety performance (Aboagye-Nimo et al., 2015). Laberge, MacEachen, and Calvet (2014) studied how young workers and inexperienced persons were frequently injured at work and found that ineffective safety programs were linked to workplace accidents. Safety training was more focused on teaching strategies and objectives and not concentrated on learning activities and plans.

Laberge et al. (2014) found that learning strategies allowed participants to strengthen their abilities and competence. They also found that dangerous situations and inconsistent application of workplace rules occurred when there was an absence of learning initiatives. These included inconsistent use of safety rules and in some cases absolute disregard to getting work done (Laberge et al., 2014). Nye, Brummel, and Drasgow (2010) posited that employees found organizational change, when built on a platform of validity and reasonableness, was tolerable and doable. The instances where workers recognized organizational change as valid and acceptable, however, were unlike other cases where the change was introduced by top-management without worker involvement, even if these were superior (Nye et al., 2010). Aboagye-Nimo et al. (2015), Laberge et al. (2014), as well as Bordia, Restubog, Jimmieson, and Irmer (2011) supported this finding.

Volberg et al. (2017) estimated that there were over 200 investor-owned electric power industry companies in the United States. Recorded instances of electric industry workplace deaths in the United States declined over the 10 years prior to the Volberg et al. (2017) study. Despite a decline in worker fatalities, accidents still occurred as there were 63 fatalities including 21 line workers from 1995 to 2013 in 18 power companies that contributed to the database used by Volberg et al. (2017). Individuals working around energized power systems were particularly vulnerable since they were exposed to other dangerous and hazardous conditions which ranged from working at heights, working in confined spaces, to working in remote locations (Fordyce et al., 2016). Volberg et al. indicated that the risk of falling was highest in winter when working conditions deteriorated.

Research studies into workplace accidents were focused mainly on the identification of causal factors that primarily addressed human errors and worker performance (Dekker, 2006; Manuele, 2014). None of these have explained how accidents occurred and how to prevent them. The researchers assumed that better worker performance, supported by workplace training, promoted a safer working arrangement and a reduction of accidents. With on-the-job and workplace training, workers were better informed and more likely to assess workplace situations and to remain safe (Drupsteen, Groeneweg, & Zwetsloot, 2013).

Griffin and Curcuruto (2016) suggested that workers were motivated by managers, at both the individual and the group levels, to work safely and to adopt attitudes that synergized with prescribed safe work arrangements. The top management of an organization was therefore mainly responsible for existing safety arrangements and performance (Tucker, Ogunfowora, & Ehr, 2016). Manuele (2014) found that accident investigations focused more on identifying individuals as accountable for breaches than on the deeply embedded issues that required in-depth problem-solving knowledge. Incident investigators looked for causes that were consistent with their own beliefs about how the accident happened (Dekker, 2006; Manuele, 2014). That focus was akin to investigators applying accident modeling consistent with their understanding and analysis of failure. That perspective often resulted in confusion and other negatives which prevented correction of the real cause of the accident (Dekker, 2006; Manuele, 2014). Failure to identify all of the pertinent and relevant factors that contributed to an accident may explain why accidents continued to happen.

Mathieu, Neumann, Hare, and Babiak (2014) posited that workplace job satisfaction influences performance outcomes. Hayek, Thomas, Milorad, Novicevic, and Montalvo (2016) explained that worker job satisfaction and work commitment linked to how leadership impacted organizational culture and social norms. Volberg et al. (2017) found that workplace training enhanced worker commitment, job satisfaction, and safe work. White et al. (2016) suggested that worker beliefs were advantageous in bolstering individual and group–level safety. White et al. also indicated that these beliefs were tested when customer outages and outage durations increased; directly due to workplace safety measures, taken to minimize errors and accidents.. Wong and Laschinger (2013) and Volberg et al. (2017) suggested that organizational leadership should focus on addressing fundamental problems and encourage meaningful worker involvement, change in organizational resilience, preventative measures, and monitoring arrangements that could be employed to prevent accidents. Volberg et al. (2017) and Fordyce, Kelsh, Lu, Sahl, and Yager (2007) conducted similar studies on electric industry worker injuries and concluded that insufficient data was available to effectively analyze accidents in the electric power industry across the United States. Understanding the lessons from previous workplace accidents and existing workplace conditions, and ensuring the placement of useful measures to prevent employee-injuries are critically dependent on proactive management (Dekker, 2006; Manuele, 2014). I conducted this study to determine how to prevent workplace accidents, serious, and fatal employee injuries in the North American electric power industry.

## Problem Statement

No More Must Die. Let him be the last was the first line of a newspaper article that highlighted the death of an electric utility lineman; this heart rendering plea seemingly a never-ending note (Patterson, 2012, para 1). The general problem that I addressed in this study was an increase in electric power industry related fatalities across the United States. In 2015 there were

800 fall victims and 22 electric utility related fatalities in 4,836 fatal work injuries across the United States (OSHA, 2017).

The specific problem was that although management in the electric power industry in the United States has placed heavy emphasis on workplace safety, fatal and serious accidents continue to happen and there are no clear solutions to prevent these accidents (Fordyce et al., 2016; Schwarz & Drudi, 2018). Manuele (2014) believed that workplace accidents are symptoms of significant safety management system problems and that accident investigations presented opportunities for the identification of system deficiencies that could be corrected to prevent future accidents. Fox (2014) reported on two linemen being killed in a lift truck accident on an electric power line roadway in Bourne, Massachusetts, USA. I conducted this research to identify and understand issues that may guide on how to prevent future accidents.

## Purpose of the Study

The purpose of this normative Delphi research was to prevent workplace accidents resulting in serious and fatal worker injuries by gaining consensus on the reasons why these occur and desirable and feasible solutions from a select group of experienced U.S. electric power industry experts including trainers, employees, supervisors, and managers. Participants I selected for this study possessed technical knowledge and electric power industry work experience. The results from this study may help guide actions to prevent future accidents. The focus of this study was two-fold. First, I sought to determine what trainers, employees, supervisors, and managers experienced with electric power industry accidents, attributed as the real causes of workplace accidents, worker fatalities, and serious injuries. Second, with an understanding of the real causes, my focus was on identifying ways to prevent future accidents, worker fatalities, and serious injuries.

## Research Question

What is the consensus of opinion of a panel of experts in the electrical power industry regarding desirable and feasible solutions to fatal and serious workplace accidents occurring in the United States?

## Conceptual Framework

Manuele (2014) suggested that workplace accidents usually are due to a combination of different work factors. Griffin and Curcuruto (2016) reported that managers and supervisors influence actual work procedures and arrangements. The belief was that an understanding of the structural functions, authority, and planning arrangements in any organization revealed how workplace accidents occurred (Manuele, 2014). Bolman and Deal (2013) described a framework to look at social interactions, cultural dynamics, ethical consideration, and organizational resilience from four different lenses; Structural, Human Resource, Political, and Symbolic. Bolman and Deal's four frameworks were used to facilitate a holistic method for examining organizations from the perspectives of knowledgeable participants with electric power industry experience, and to view how the organization was and what the organization could become (Bolman & Deal, 2013). The Bolman and Deal model provided a better understanding of the underlying deep-seated reasons for fatal and serious electric power industry accidents in the United States.

The four-frame model allowed me to better understand work challenges and how workers mitigate and prevent errors and accidents. Each of the frames provided me with opportunities to view problems through lenses that promoted particular visions and voices from that perspective. Bolman and Deal (2013) indicated that no single frame was superior to the other, but they were complementary and allowed for an individual to gain knowledge and to understand how to best address complex organizational problems.

It is common for leaders and managers to worry about flagging organizational performance, which may increase worker insecurity and fears about job stability and tenure (Dekker, 2003; Probst, 2015). Managers had first to know that a gap existed between the expected performance-level and the actual outcome: A better realization covered the closing of that gap. Discipline was a crucially relevant factor if the gap closure were to happen. This discipline extended into data identification and analysis and a linking of the results of the data examination to the desired outcomes, especially in regards to details of what was to be done, by whom, and how that could happen (Albert & Hallowell, 2013). In this situation, data was a representation of micro aspects of the activities, and systems that needed to be improved or even entirely revamped if performance outcomes were to develop. Trust was a necessary ingredient in this process as individuals had to be confident that other individuals who work together towards targeted results were able to synchronize on the belief that they all contributed with the same enthusiasm (Tucker, Ogunfowora, & Ehr, 2016). Gladwell (2007) indicated that speed must augment trust. In a high-trust environment, communication errors never deliberately became misinterpreted (Bolman & Deal, 2013; Moffatt-Bruce et al., 2017). The opposite is true as well. In a low-trust environment, even good communication is, at times, interpreted as weak and untrustworthy (Bolman & Deal, 2013).

Trust among individuals in a work environment promotes influence. Influence grows into power. Any individual who influences others in the workplace by encouraging and supporting trust eventually develops a powerful impact on the other individuals in that environment (White et al., 2016). This influence can then elevate into the organization at different levels. The broader influence carries symbolic significance akin to the Symbolic Frame purported by Bolman and Deal (2013). When the influence brings authority, either formal or through respect, that signified individual political strength within the organization; akin to the Political Frame suggested by Bolman and Deal (2013). The formal authority that an individual exercised at work come from the Structural Frame, as positional strength gives the office holder organizational jurisdiction for directing functions sanctioned by the organization (Bolman & Deal, 2013).

The structural frame provided me with opportunities to understand teams and individuals within organizations from the depiction of individual and group roles, working arrangements, formal manager-supervisor-worker relationships, and work coordination. From these manager-supervisor-worker relationships, the work rules, procedures, regulatory systems, were managed through the representation of influence from the Structural Frame. Working problems were very often due to structural issues that went unaddressed: It was important that organizational structures remained current and relevant to the demands made, for superior organizational outcomes. Organization charts were set to cover the working environment, systems, and technology. When problems occurred, it usually surrounded a mismatch of the organization structure with the existing circumstances (Bolman & Deal, 2013).

The Bolman and Deal (2013) human resources frame is rooted in the relationships that exist among individuals who work together. These relationships become almost family-type, especially when individuals work together for long periods and develop lasting trust and togetherness. Researchers can develop a better understanding of individual feelings, issues of trust, skills development, prejudices, and other human type challenges by considering this perspective. In effect, the human resources frame provides insight into how people conduct work, their feelings about the work itself, and all of the influences that impact the activity (Uehli et al., 2014). A natural form of interpersonal contest exists even if it remained silent and almost invisible. Different departments, judged on their outputs and efficiencies, compete with other teams for supreme recognition as the best outfit in the organization. Individuals in the same group often attempt to climb to the top to become recognized as the leader of the pack (Bolman & Deal, 2013). Individuals in these circumstances employ many different techniques as they negotiate, coerce, convince, and even outsmart others in organizational politics (Scott, Fleming, & Kelloway, 2014). Conflicts and other negatives reflect the real downside of the political frame. The Symbolic Frame deals with organization culture, the spirit of success, and social stories about the organization as caring, ethical, and supportive. Problems from this perspective arise when there is a disconnection between social reality and the picture of a caring organization.

## Nature of the Study

The Delphi technique originated in the 1950s at RAND Corporation (Dalkey & Helmer, 1963; Linstone & Turoff, 1975). Research conducted with the Delphi technique is any qualitative, quantitative, or mixed approach formulated on group interaction where the participants are not known to each other and communications are limited to each of the participant and I. The Delphi technique is a useful research design when there is participant disagreement on the research subject or when there is a lack of knowledge regarding the research subject or problem. Dalkey and Helmer (1963) contended that research success depends on participant ability, opinion, experience, and speculation. A distinct and significant benefit of the Delphi technique was the anonymous nature of the exercises which removed the need for face-to-face meetings. The Delphi design, as in this study, also promotes the inclusion of individuals whose participation in traditional research is, at best, remote and limited. The electric power industry participants in this study were an example group of individuals not usually selected in studies and analyses of this kind. The Delphi technique enabled me to study research participants in a wide-geographic space, and allowed for removal or filtering of issues usually associated with face-to-face human influence and interaction (Brady, 2015; Cegielski, Bourrie, & Hazen, 2013; Habibi, Sarafrazi, & Izadyar, 2014; Kerr, Schultz, & Lings, 2015; Lai, Flower, Moore, & Lewith, 2015; Merlin et al., 2016).

Linstone and Turoff (1975) indicated that there was no single *best* or *unique* basis to examine any scientific procedure or theory. Researchers can, therefore, draw from many different research methodologies to conduct a study. A phenomenological approach was possible, but that was not suitable for this research because my focus was on reasons for accidents that happened and potential solutions rather than lived experiences of people who experienced a workplace accident. A case study was also possible, but my focus was not on a specific phenomenon bounded by time and space (Yin, 2017). A quantitative study was also possible. However, the data for this study was not quantitative because my focus was on expert opinions rather than on numeric data. Hsu and Sandford (2007) indicated that the Delphi technique is suitable for research participants who are knowledgeable in their expert domain. The normative Delphi technique and approach allowed for possible consensus on why fatal and serious accidents were happening in the electric industry from a group of industry experts selected from experienced and knowledgeable electric power industry trainers, employees, supervisors, and managers and who had experience with workplace accidents in the United States. Using the Delphi technique, I systematically honed the expert input by use of a series of questionnaires with controlled participant feedback (see Linstone & Turoff, 2011). Novakowski and Wellar (2008) and Yousuf (2007) described a normative Delphi as a consensus Delphi that focused on establishing desirable goals and priorities and not on what was probable. The normative Delphi technique and approach aligned with the specific problem that workplace accidents continued to occur in spite of management's heavy emphasis on safety. The Delphi technique allowed for the generation of consensus about situations which were not entirely understood (see Heitner, Kahn, & Sherman, 2013; Linstone & Turoff, 1975).

Linstone and Turoff (1975) indicated that three rounds could prove sufficient for result stability and consensus from participant responses. Linstone and Turoff further suggested that additional rounds would likely not be beneficial and might only serve to delay completion of the study with no measurable change when compared to stopping the process at the end of three rounds. Hsu and Sandford (2007) espoused a different view by indicating that a fourth round was at times necessary for consensus. Delbecq, Van de Ven, and Gustafson (1975) concurred with Hsu and Sandford and even suggested a fifth-round if that became necessary to achieve consensus. Without consensus, they contended that the entire study effort could become wasted. I aimed to reach consensus in four rounds.

For the first round, I forwarded a list of reasons why accidents happen and invited the research participants to add to the list and to provide solutions to those reasons. The participants each had two weeks to respond. This information and feedback from the research participants, were summarized into themes, coded, and used to generate questionnaires for the second and subsequent rounds in the research exercise. Items that were mentioned by the respondents moved to Round 2. These items, incorporated into 5-point Likert-type statements, formed the basis for Round 2. In Round 2, participants responded to two different and distinct 5-point Likert-type scales; one for responses that they considered as desirable and another they considered as feasible. Where 70% or more of the participant responses selected a score of 3 or more on both Likert-type scale for the same item, that item remained for inclusion in the Round 3 questionnaire. I used these responses to determine the degree to which the respondent agreed or disagreed with a particular item (see Novakowski & Wellar, 2008). Responses from Round 3 where 70% or more of the participant responses selected a score of 3 or more on the 5-point Likert-type scale were treated as important and extracted for Round 4. In Round 4, participants rated their confidence in the overall findings of consensus-based solutions emergent from Round 3. Information provided by knowledgeable individuals, about how to prevent accidents followed. My goal in this study was to explain how to prevent accidents that happen in spite of safety precautions employed in the electric power industry in the United States.

## Definitions

*Approved practice:* Work procedures employed when no isolation of energy sources occur before performing skilled work.  This practice is to provide safe work measures for individuals completing the task (ISHA, 2014; OSHA, 2017).

*Authorized worker:* A person formally recognized, sanctioned, and competent to perform work listed on the company recognized list (OSHA, 2017).

*Competent person:* (a) An individual trained, possessing knowledge, and experienced in arranging and performing work; (b) an individual who was aware of and knowledgeable on the safety regulations, rules, and procedures regarding work; and (c) an individual capable of recognizing and mitigating hazards and dangers in the work environment (ISHA, 2014; OSHA, 2017).

*Competent worker:* A skilled individual who performed specific work and satisfied the conditions listed for a competent person.  The company determines the particular task which is known to the skilled worker (ISHA, 2014; OSHA, 2017).

*Delphi expert/panelist:* A knowledgeable and experienced individual who is familiar with the study topic and willingly participates in the exercise (Skulmoski, Hartman, & Krahn, 2007).

*Expert panelist:* An individual who satisfied three criteria: (a) was a manager, supervisor, trainer, or worker in the electric power industry; (b) had more than 10 years of industry practice and experience; and (c) had knowledge about accidents in the electric power industry in the United States.

*Hazard:* A condition where a potential for uncontrolled interaction with energy sources could cause injury or death to individuals (Capelli-Schellpfeffer, Floyd, Eastwood, & Liggett, 1999).

*Incident:* An event, situation, or condition, which has the potential to cause an injury or illness (OSHA, 2017).

*Isolated:* Device or equipment that is separated or removed from energy sources (ISHA, 2014; OSHA, 2017).

*Job plan:* A work arrangement that is known to and agreed by all individuals at the worksite.  It identified hazards that are known and mechanisms to abate hazards or control them when elimination is not possible.  The responsibilities of each workgroup member are itemized and individually identified (ISHA, 2014).

*Personal protective equipment:* Approved safety equipment used by individuals for reducing the risk of becoming injured while performing work (ISHA, 2014; Mitropoulos, Howell, & Abdelhamid, 2005).

*Proximity:* The limits of approach to an apparatus that is not safe to touch. It does not apply to in-service equipment that is intrinsically safe for human touch (ISHA, 2014; OSHA, 2017).

*Safe work area:* A specifically identified and designated area for work where all known hazards or danger are removed or controlled (ISHA, 2014; OSHA, 2017).

*Safety interlock.* A device or system which is designed to operate in a particular manner and where the non-designed sequence of operations is prohibited (ISHA, 2014; OSHA, 2017).

*Sociotechnical system*: A grouping of interacting social and technical processes and subsystems that impact one-another and evolve into a complex overarching system (Kroes, 2015).

*Supervisor*: A person designated by the employer as the individual who is in charge over a workplace and has authority over a worker (ISHA, 2014).

*Work procedure*: A detailed, step-by-step description of how to perform the task approved by the company (ISHA, 2014).

*Worker:* A person who performs work for monetary compensation (ISHA, 2014).

*Workplace:* Any premises or location upon, in or near which a worker worked (ISHA, 2014).

## Assumptions

In this study, I assumed the participants where knowledgeable of workplace conditions and systems. These participants were U.S. electric power industry managers, supervisors, trainers, and workers: They may not have possessed the training as workplace safety professionals, but their experiences with working arrangements and procedures proved crucially relevant to this study. Manuele (2014) suggested that workplace accidents usually occur when several different workplace factors contributed to breached barriers and safeguards. That information could have been vital and sufficient to prevent injuries and deaths while at the same time, made the workplace safer (Weber & Wasieleski, 2013).

Second, I assumed that research participants, as Delphi panelists, provided honest and truthful answers in the different rounds of questionnaires I distributed. Kim and Kim (2016) indicated that panelist bias sometimes leads them to misrepresent the information that they provide by exaggerating the importance of issues and also understating the effect of the other problems.

Third, I communicated with research participants through consistently formatted questionnaires in language that was unambiguous, not misleading, and simple to understand (see Novakowski & Wellar, 2008). The main aim of a Delphi technique was to gain consensus among the Delphi experts. It would be difficult to achieve this if the expert panelists were unsure about the meaning of questions I asked as the researcher.

## Scope and Delimitations

The research scope of this exercise was delimited to the electric power industry and how to prevent accidents that were occurring in the United States. The primary focus was to understand the contributing factors for situations where electricity industry workers became severely injured or even killed while performing work. The strategy was to employ a four-frame model espoused by Bolman and Deal (2013) to understand the electric power industry and to use this to promote working arrangements where employees were not injured or killed while performing work. It proved a helpful model for further studies in the electric power industry as well as other industrial sectors.

Understanding how accidents occurred was preliminary to the deliberate taking of steps toward the prevention of future electric industry workplace accidents and to keep workers safe and uninjured. For this study, a specific delimitation surrounded the intention to use the Bolman and Deal four-frame model. The different perspectives described in the four-frames allowed for a better review of organizational and people issues and dynamics that contributed to workplace accidents. No previous study of this kind, using this model, was conducted in the electric power industry.  Study-success depended on a heavy reliance was on the research participants from the electric power industry and the detailed data that they provided during the Delphi rounds.  That placed significant researcher responsibility on the strategies used to select the participants (Brady, 2015).  Individuals with little or limited knowledge and experience might have caused the research not to be meaningful, even if there was a consensus.

Another specific delimitation was the decision on the normative Delphi technique, what a Delphi expert was, and how that aligned with the actual selection of participants.  It was possible that overlooking of suitable and relevant experts occurred in spite of best efforts to choose from the best potential candidates.  Participant identification, on the LinkedIn social medium, was be done through experts in the electric power industry in the United States (Brady, 2015).  It was not expected but possible that the selected participants, even over the vast geographical space, may have proven unhelpful because they were personally-linked to the sequence of activities in the electric power industry and which led to accidents.

A delimitation condition surrounded the research question being too pointed and possibly contentious for experts to admit to issues in the electric power industry freely.  That could have resulted in worker participants blaming managers and supervisors.  The reverse may also have happened. Without genuine interaction and contribution from the participants, actions, systems, group politics, structural inadequacies, technologies, and techniques that factored in the accidents occurring in the electric power industry could have remained unidentified.  The period for conducting the study was a delimitation because accidents that likely occurred during this timeframe might have influenced participant responses.  If there were no accidents, participant response might be different from situations where serious and fatal accidents happened. There was no evidence of this, and none of the participants indicated that accidents were occurring during the Delphi rounds.

A delimitation condition involved the geographical area from which research participants came, the scales selected, and the choice of measurements for consensus. The research methodology was another delimitation as this was deemed suitable by me as the researcher. This research methodology provided opportunities for me to delimit the scope of the questions for Round 1 and for the themes and codes that I used as the researcher. The scales and measurements chosen worked well in previous research, and I anticipated a similar result in this study.

## Limitations

The first limitation was that the study results proved useful in the electrical power industry only, because of the uniqueness that existed in this industry. The use of the Bolman and Deal four-frame approach to analyzing data and participant feedback provided for an appreciation and real understanding of the issues that contributed to serious and fatal accidents in the electrical power industry may be advantageous. This advantage might be a limitation as it can prove challenging to extend the lessons beyond the realm where the participants were experts and to extend the findings to other industries and workplaces: that was not an expectation (Moore, 2016).

The second limitation was that the Delphi panelists as research participants could have brought very pointed views prevalent only where the individual worked. Researcher tact and skill to ensure that the research remained on-course was essential because, in the end, the electrical power industry might become much safer than it is (Clibbens, Walters, & Baird, 2012; San Su, Wardell, & Thorkildsen, 2013).

The third limitation could have been that the best candidates declined participation even though the selectees possessed the necessary experience and knowledge to satisfy the research requirements and criteria. This selection included experienced and knowledgeable electric power industry managers, supervisors, trainers, selected from the across the United States and who knew about serious and fatal accidents that occurred in the industry (Volberg et al., 2017). Participants were able to describe work arrangements, procedures, environments, and issues that were pertinent and vitally connected to workplace safety management in the electrical power industry. The participants were willing to share information that contributed to new learning and for an opportunity to understand what went wrong. The participant identification process on public social media provided more significant opportunities for suitable panelists as experienced and respected industry practitioners for this study. That way, each participant were interested as contributors to accident prevention efforts and to make the electric power industry safer than it is (Volberg et al., 2017).

A fourth limitation was the my personal and professional bias, as the researcher, which influenced the strategy used to conduct the literature search, data collection, and analysis in this study. The Delphi technique preference in this study allowed me to include one question in the Round 1 questionnaire to encourage the Delphi panelists to suggest other information they considered as pertinent for this study and which was not covered by the questions set by me. The identification of relevant issues represented a significant effort to improve the research trustworthiness as well as the data derived from the process (Yin, 2013). Inclusion to the Delphi panelists as research participants for confirmation of the information they provided enhanced the likelihood that the data was correct (Patton, 2015).

The fifth involved my management of the Delphi study. The iterative process that the Delphi technique required was a possible disadvantage as research participants could have chosen to drop out before the end of the study. Attrition by participants may have affected the research and highlighted credibility issues in the overall findings (Annear et al., 2015; Willems, Sutton, & Maybery, 2015). Twenty-five (25) participants was felt to be acceptable but only if the attrition rate remained less than 25 % over the entire study; to this end, the intention was to use more than 25 Delphi panelists as research participants (Brody et al., 2014; Sinclair, Oyebode, & Owens, 2016). I remained meticulous and exercised all available opportunities to keep the research exercise free of administrative delays and inefficiencies (De Loë, Melnychuk, Murray, & Plummer, 2016; Patton, 2015).

A sixth limitation involved a possible social desirability bias that could have resulted when Delphi panelists responded in ways that misrepresented their real position because they preferred to behave in ways considered as socially acceptable (Heitner et al., 2013; Kim & Kim, 2016). Removal of bias due to individual social desirability bias, the questions did not require Delphi panelists to reveal or recount their behavior, contribution, or influence on any particular accident or workplace issue directly related to the study. I also ensured the strictest controls on participant anonymity and research confidentiality (Heitner et al., 2013).

## Significance of the Study

The first consideration of individuals at work should be the avoidance of accidents, the prevention of personal injuries, and the safeguarding of life. Workplace safety arrangements were regulated, and organizations included safety as among the highest values, sufficient for its inclusion in the mission, vision, and policy statements. Employers set safety procedures and rules that managers were to implement and monitor for compliance. Workers were expected to follow set work procedures and to do all that could be expected to prevent errors, workplace accidents and injuries to themselves and others at work. OSHA (2017) stipulated specific duties, roles, and responsibilities for employers, employees, and workplace safety committee members. OSHA also had the power to conduct random checks in different workplaces and to instruct employers to initiate mandatory compliance orders when substandard safety conditions existed. Despite these arrangements and safeguards, accidents still occurred, sometimes with fatal consequences.

Individuals went to work each day with the intent of returning home after contributing to organizational outcomes and success. Sadly, that did not happen every day for each person at work. Each year more than 4000 individuals in the United States did not ever return home at the end of the workday (OSHA, 2017). In the electric power industry, where significant emphasis and resources are committed to safety at work, and safety management systems, worker injuries and deaths were occurring (Fordyce et al., 2007; Volberg et al., 2017). This study was about the search for deep underlying causal factors that evaded the safety barriers in the electric power industry and contributed to workplace accidents where workers became severely injured or killed while doing work. The Bolman and Deal (2013) conceptual framework chosen for this study allowed for consideration of organizational issues from leadership, to internal politics and group dynamics which spanned across technical challenges, professional boundaries, and social dimensions (Moffatt-Bruce et al., 2017; Vassiliou & Alberts, 2013).

Electricity was dangerous, but it was not the only danger that electric power workers faced. There were electrical, fall, and other hazards in the working environment. Individuals who worked in these conditions must maintain an awareness of hazards. These workers must understand the dangers and be competent at initiating actions to mitigate the associated risks. Individual and personal safety was only as effective as the protective measures employed to keep the workplace safe. Death or severe injury was a frequent reminder of breached workplace safety barriers. Volberg et al. (2017) indicated that an average human could die with a current flow of less than one (1) ampere. Power lines can carry up to 2000 amperes (Fordyce et al., 2016). In one organization where a fatal accident occurred in which four employees died, the organization approved and set safety rules indicated that safety rules were mandatory and required full compliance at all times (Cameron, 2017). The safety rules covered situations where employees were to involve their supervisors if circumstances existed where the work instruction was not specific or not fully understood: consistent with the leadership view espoused by Tucker et al. (2016). There was another fatal workplace accident in this company despite organizational prevention efforts (Vanmeer, 2019). This study was significant as it represented a real opportunity to determine why electric power industry workers became injured or killed at work and what could be done to prevent future accidents.

**Significance to Practice**

Understanding issues that contributed to workplace accidents might provide opportunities for organizations to revise work procedures, to update working systems, and to adopt more suitable arrangements to mitigate accidents. This understanding might also allow for better monitoring and enforcement of safe work arrangements developed from the lessons learned from previous accidents. The study may be sufficient to extend current knowledge and strategies for optimal work designing, planning, and execution while meaningfully contributing to accident-free electric power operations in the United States.

**Significance to Theory**

Understanding the causes of accidents that occurred in the electric power industry was important because of the dangers and hazards associated with working near or on electric systems and because of how often workers were required to work in dangerous and hazardous conditions. This study was significant as it could contribute towards theory by pinpointing areas of focus and extending current knowledge about risk mitigation efforts on how to curb and to prevent workplace accidents. This study might provide information for a better understanding of the issues that contributed to electrical power industry accidents.

**Significance to Social Change**

Promoting social change from this study might come from the identification of operational, organizational, regulatory, and contributing factors to supplement the already known causal factors of workplace accidents. Understanding the reasons that preventable accidents occurred might result in the implementation of new strategies to overcome these issues, help to prevent injuries to workers, and to help industry practitioners better understand what can be done to remain safe while conducting work. Surviving victims of workplace accidents and other workers who were on-site when accidents occurred undergo prolonged periods of doubt and apprehension (Beus, Dhanani, & McCord, 2015; Manuele, 2014). A possible social benefit from this study could be the sharing of experiences from individuals with knowledge and understanding of previous workplace accidents: This could be used to remind workers, supervisors, and managers that safe work was better for long-term organizational success where workers were not killed or injured.

## Summary and Transition

A Delphi approach was the preferred research methodology, with experienced and knowledgeable electrical power industry managers, supervisors, trainers, and workers as the research participants; this was an opportunity to explore the working arrangements in the focus industry and to get feedback from individuals who knew this business from a first-hand perspective. The conceptual framework choice in this study, based on a Four-Frame model (Bolman & Deal, 2013), allowed for analysis of safety practices in the electrical power industry from a logical strategy that was easy to understand. That way, questions about how accidents occurred and whether the causal influencing factors were isolated and addressed to answer how to prevent future accidents and worker injuries and deaths. The Delphi technique supported the conditions where group consensus could be realized among experts as research participants especially when there was no well-established history of previous studies (Afshari, 2015; Wester & Borders, 2014). The possible research limitations, assumptions, and delimitations were included in Chapter 1 together with a definition section for terms relevant to this study: This was in addition to a section on the purpose of this research and another on the significance of this effort.

In Chapter 2, there is an in-depth exploration and review compilation of the pertinent and current literature on workplace accidents where workers become severely injured and killed at work. These are synthesized and compared for similarities in accidents where the lessons can be applied to provide opportunities to prevent future accidents. Preventing workplace accidents in the electric power industry and pre-empting situations that can result in severe worker injuries and deaths is an attempt to promote social change in a highly specialized and complex industry.

# Chapter 2: Literature Review

The general problem was that there is an increasing problem of electric power industry related fatalities across the United States. The specific problem was that although management in the U.S. electric power industry has placed heavy emphasis on workplace safety, fatal and serious accidents continue to happen and there are no clear solutions to prevent these accidents (Fordyce et al., 2016; Schwarz & Drudi, 2018). Workplace safety challenges range from physical hazards that are always difficult to recognize and to mitigate, interpersonal interactions that complicate hazard abatement, and organizational factors driven by technology aided business horizons and stakeholder demands (Andel, Hutchingson, & Spector, 2015). The electric power industry, in this regard, is no different from many other business realms. The reach and impact of the electric power utility might match and even surpass other critical sectors such as water, communication, and energy. The general arrangements for managing in these industries are aligned in many ways, even if each sector has unique priorities. In these sectors, complex dynamics give rise to surprising results and organizational flexibility (Osborn, 2008). Managing workplace safety is, therefore, a complex responsibility that mirrors other business activities that impact the success of the organizations (Andel et al., 2015).

Chapter 2 contains a description of the literature search strategy, the conceptual framework I adopted for this study, a review of previous studies, a discussion of literature relevant to this research, and a summary and conclusion. The previous studies on the electric power industry were few and not exhaustive. Data were difficult to source, and where available, the information was incomplete (see Fordyce et al., 2016; Volberg et al., 2017).

**Literature Search Strategy**

The strategy I used for this literature review involved exhaustive searches of EBSCOhost, Emerald Management Journals, SAGE Premier, Thoreau Multi-Database, and ProQuest databases that I accessed via Walden University's library.

Table 1

Outline Strategy of Literature Search

| | | | |
|---|---|---|---|
| Vital search terms | leadership, workplace accidents, worker injury and fatality. Safety management, accident investigation, electrical power, electric power line safety, safety training, behavior, attitudes, safety culture, safety climate, safety theory and models, worker performance, supervisor safety, and management safety roles. | | |
| Strategy for Literature search | Walden University databases EBSCOhost, Emerald Management Journals, SAGE Premier, Thoreau Multi-Database, and ProQuest. Google Scholar, relevant industry, regulator, and professional organization websites, peer-reviewed journals, magazines, news media and books. | | |
| Emphasis on literature from 2013 and on crucially relevant papers before that. | | | |
| Source of information | Since 2013 | Before 2012 | Total |
| books | 0 | 2 | 2 |
| Non-peer-reviewed | 1 | 3 | 4 |
| Dissertations | 18 | 0 | 18 |
| Peer-reviewed articles | 275 | 35 | 310 |
| Other Reliable Sources | 4 | 0 | 4 |
| Total | 298 | 40 | 338 |
| %(peer-reviewed/total) | 88 | 12 | 100 |

This strategy extended to Google Scholar, relevant industry, regulator, and professional organization websites, peer-reviewed journals, magazines, and books. My primary intent and focus was on sourcing literature published inside a 6-year window that began in 2013. I also included older articles that included vital information. Key search terms and phrases included: *leadership, workplace accidents, worker injury, and fatality*. Other search words and phrases were *safety management, accident investigation, electrical power, electric power line safety, safety training, behavior, attitudes, safety culture, safety climate, safety theory and models, worker performance, supervisor safety, and management safety roles*. From the selected articles, I developed a comprehensive understanding of different approaches to workplace safety and accidents, the methods of determining how best to find the underlying and direct causal factors, and other compelling and relevant reasons for use as part of this particular study.

## Conceptual Framework

Bolman and Deal (2013) indicated that individuals used first hand knowledge to guide them in addressing challenges. They termed this *tribal knowledge*. Workplace success grows on long-lasting traditions referred to as the culture of the organization. Problems are, at times, introduced into the workplace even when individuals focus on making or causing change with positive intent. Bolman and Deal described different well-known cases where leaders and managers introduced change only to see failing results. Described by Bolman and Deal as the curse of cluelessness, it was akin to not seeing the entire picture when handling problems and issues. Cluelessness also aligns with an endemic problem that many individuals experience in situations where they have the right picture but incorrectly chose the solution option.

Sometimes these problems are new, not very well understood, and even require skills that individuals do not possess or have not mastered. As an example, if an individual who is not an expert swimmer is caught in a situation that required them to survive in water, situation would be very challenging, but not impossible. There may be a flotation device that the individual uses until help arrives. In those situations, the individual may survive despite not being able to swim well or not at all.

Table 2

Overview of the Four Frame Model

| | FRAME | | | |
|---|---|---|---|---|
| | STRUCTURAL | HUMAN RESOURCE | POLITICAL | SYMBOLIC |
| Metaphor for organization | Factory or machine | Family | Jungle | Carnival, temple, theater |
| Central concepts | Rules, roles, goals, policies, technology, environment | Needs, skills, relationships | Power, conflict, competition, organizational politics | Culture, meaning, metaphor, ritual, ceremony, stories, heroes |
| Image of leadership | Social architecture | Empowerment | Advocacy and political savvy | Inspiration |
| Basic leadership challenge | Attune structure to task, technology, environment | Align organizational and human needs | Develop agenda and power base | Create faith, beauty, meaning |

*Note*. Adapted from L. G. Bolman, & T. E. Deal (2013), *Reframing organizations: Artistry, choice, and leadership* (5th ed.). San Francisco, CA: Jossey-Bass. Reprinted with permission.

If, on the other hand, the individual attempts swimming to a safe location, that decision could be fatal. Making decisions in such situations is complicated. The individual may be unaccustomed and there would not be a long time for the individual to contemplate their response however careful they believed they were. Even for smart people, cluelessness is a fact of life (Moffatt-Bruce et al., 2017). Bolman and Deal (2013) suggested *reframing* as a concept that individuals and teams employ to understand problems better and to decide on possible ways of addressing the issues or situations that required correction or fixing. Bolman and Deal described four frames for analyzing different conditions: the Structural, Human Resource, Political, and Symbolic frames.

Table 2 offers an overview of the Bolman and Deal four-frame model I used for this study. Bolman and Deal (2013) indicated that managers and leaders must focus on multiple frames to effectively manage in complex working environments. Table 3 shows their key claims about managerial thinking.

Table 3

Expanding Managerial Thinking.

| HOW MANAGERS THINK | HOW MANAGERS MIGHT THINK |
|---|---|
| They often have a limited view of organizations (for example, attributing almost all problems to individuals' flaws and errors). | They need a holistic framework that encourages inquiry into a range of significant issues: people, power, structure, and symbols. |
| Regardless of a problem's source, managers often choose rational and structural solutions: facts, logic, restructuring. | They need a palette that offers an array of options: bargaining as well as training, celebration as well as reorganization. |
| Managers often value certainty, rationality, and control while fearing ambiguity, paradox, and "going with the flow." | They need to develop creativity, risk taking, and playfulness in responses to life's dilemmas and paradoxes, focusing as much on finding the right question as the right answer, on finding meaning and faith amid clutter and confusion. |
| Leaders often rely on the "one right answer" and the "one best way"; they are stunned at the turmoil and resistance they generate. | Leaders need passionate, unwavering commitment to principle, combined with flexibility in understanding and responding to events |

*Note*. Adapted from L. G. Bolman, & T. E. Deal (2013), *Reframing organizations: Artistry, choice, and leadership* (5th ed.). San Francisco, CA: Jossey-Bass. Reprinted with permission.

In successful organizations, leaders use sophisticated systems and technically skilled and competent employees to negotiate these new demands. A pertinent feature of these systems is an increasingly challenging demand for superior outcomes. These demands are usually associated with less time to pre-plan, contemplate alternatives and other possible solutions, and stressful working arrangements and conditions. Operations in some organizations involve 24-hour processes each day with regular schedules—something that was not very common before. Working different shifts, the use of changing technologies, and increased work demands could make interpersonal interactions at work difficult and may contribute to workplace errors (Griffin & Curcuruto, 2016). Bolman and Deal (2013) likened this to smart individuals committing stupid acts and attributed these to sense-making that failed. Such failure is likely to occur in cases where the individuals sometimes do not know or realize that the way they viewed issues may be incorrect (Salguero-Caparros, Suarez-Cebador, & Rubio-Romero, 2015). In these cases, individuals do not fully understand why the results are not what they hoped for (Bolman & Deal, 2013, p.8). That, according to Bolman and Deal is locking onto a single frame and not appreciating the other frames as valid and which could allow for the individual to understand issues from a different perspective. These are mental models used by individuals as maps or labels that allow for cognitive thinking or referencing in such a way that makes sense to the individual.

Gladwell (2007) described decision making as non-conscious, fast, and holistic. That idea extends to a fast-paced sporting decision where the player would scan the environment, calculate the possible moves, and make the selection in time to prevent another player from intervening or blocking the progress. The combination of the different components, non-conscious, fast, and holistic actions, result in skilled judgments even though the individual might at times be incorrect. Bolman and Deal (2013) extended this type of decision making to doctors who were required to diagnose patients--many times without having a full diagnostic understanding of symptoms--only relying on skilled judgments based on training and their practical experience. In these situations, judgment errors may occur. These could be investigated from the different frames to understand what the doctor considered when identifying all possible factors equally relevant and not treated in a particular instance. Bolman and Deal (2013) suggested that mental maps that did not allow individuals to look at problems from more than one perspective were very often the reasons why errors in judgments occurred. An ability to view the same problem from different angles and to make quick and correct decisions afterward is a fluid-expertise that requires sufficient time for its development, exposure by experience, and the continued ability of the individual to learn and apply the teachings (Bolman & Deal, 2013).

Framing involves the development of mental models that allow individuals to consider issues from particular perspectives (Manuele, 2014; Weber & Wasieleski, 2013). Equally important is for that individual to examine different perspectives and to amalgamate the best options from different views and positions that allow for holistic management of a challenge and for the best opportunities to remain error free. Reframing is the ability to move seamlessly from one perspective or frame to the next without losing the ability to keep the best options for problem resolution or results.

Frames and maps are similar as they represent windows to view different perspectives and tools to navigate that territory (Bolman & Deal, 2013). Each frame is distinct from another and provides strengths and limitations to the individuals who use it as a mental model to decipher any issue. Just as the right tool makes any job more straightforward and simple to accomplish, the proper perspective on a topic allows for the best appreciation of the problem and to provide successful solutions. Tools can make completing a job more manageable, but if they are the wrong ones, the task becomes much more difficult (Labib, 2015; Murata, 2017). Individuals using the wrong tools are more likely to make errors. These tools are not only the high precision and well-engineered devices; it includes the different perspectives that individuals use to understand fully and to address challenging problems.

Solving simple problems with a single tool or from only one perspective is common, but more complex issues require the use of different tools for success. Solving problems and handling challenges in the complicated business place is unlike any other experience. The electric power industry is an excellent example of a complicated business where technological systems and devices are managed together with different demands from the various stakeholders requiring maximum returns on their investments (Bedi et al., 2017). It means, therefore, that individuals who work in the electric power industry are ideal candidates for viewing problems and challenges from different perspectives and frames before opting for suitable means of addressing them (Bolman & Deal, 2013; Fordyce et al., 2016). When decisions are incorrect, errors occur (Dekker, 2015). In the electric power industry, if that error occurs on a power line, the result is usually a fatality or serious injuries suffered by the victim.

Managers and other individuals, as experts, usually focus on these expert strengths in a myopic manner without exploring the different ways of addressing problems (Brody et al., 2014; Capelli-Schellpfeffer, Floyd, Eastwood, & Liggett, 1999). The result is that many of these individuals assume that a one-size-fits-all approach always has the best results. However, individuals who critically assess problems from different frames are better equipped to understand, appreciate, and negotiate problems. Using them allows for successful outcomes, individual experience, confidence, and wisdom (Bolman & Deal, 2013).

**Regulating Electric Power in the United States**

The U.S. electric power regulatory set-up is a layered one where there are federal, regional, state, and industry accepted arrangements for operating and managing the electricity grid and all connected constituent systems (Slayton & Clark-Ginsberg, 2018). Volberg et al. (2017) suggests that the electricity system has for its entire history broadly consisted of Generation, Transmission, and Distribution (G, T, & D). Significant changes occurring in the electric power industry that makes for radically different operating modes, players, business arrangements, and competition focused primarily on technical and financial efficiencies and customer satisfaction (White et al., 2016; Zohar, 2014).

At the federal level there are three different regulators; the Federal Energy Regulatory Commission (FERC), North American Electric Reliability Corporation (NERC), and the Occupational Safety and Health Administration (OSHA). FERC, NERC, and OSHA primarily focussing on technical, operational, and safety capabilities of the electric power companies which operates in the G, T, & D aspects of the business (Slayton & Clark-Ginsberg, 2018). State-level regulators set financial operations criteria. FERC, empowered by the Energy Policy Act of 2005, is the regulator for setting NERC arrangements as the reliability regulator of the electric grid. FERC also regulates inter-state bulk power connectivity otherwise called the Transmission System, in the same manner as it does oil and natural gas pipelines in the United

States. FERC is vested with the responsibility for licensing hydropower projects throughout the United States (FERC Overview, 2018, April). NERC is the primary regulator of the North American Electric Power System with direct authority to mandate reliability and system security standards and procedures. Their area of control covers the entire United States, all of Canada, and a section of Baja California (Mexico) for electricity reliability, seasonal and long-term. NERC also provides certified training for operators and industry personnel. NERC is empowered through its Rule of Procedure (ROP) to require Transmission Companies, also called Transmission Operators or Bulk Power Companies, to comply with operating requirements according to the ROP (About NERC, 2018, April). Organizations not complying with these requirements are obligated to provide acceptable reasons or risked being sanctioned and are fined by NERC for the non-compliance. There are instances where the Regional Reliability Organization (RTO) assume responsibility for reliability and security oversight in place of NERC. In this event, NERC citing the RTO for violations of operating compliance not met for their region of control occur. Demeritt, Rothstein, Beaussier, and Howard (2015) posits that regulation is the common most way to enforce governance and policy for risk management in systems that require experts and knowledgeable personnel in particular industries. One example ROP is NERC Blackout and Disturbance Response Procedures which is in effect from July 01, 2014 and where reactive power and electric load are defined to be consistent with two previously existing procedures ( NERC Blackout and Disturbance Response Procedures, 2014, July). NERC provided leadership, technical advice and expertise, and coordination in the US and Canada when major blackout events occurred (Abraham et al., 2004). For the efficient, reliable, and sound operation of the power system, it is critical to establish a clear delineation of roles and other coordination requirements among industry participants and governments. Analysis of investigative findings from significant system blackouts and other major high-impacting system emergencies, just as that which happened in 2003 in the North Eastern United States and Eastern Canada, and following-up on recommendations promoted this (Abraham et al., 2004).

**United States Safety Legislation**

Regulating Safety in the workplace happen in a layered manner from the federal level to regional regulatory agencies, and State managed systems (OSHA, 2017). The Federal Agency that regulated workplace safety throughout the United States was the Occupational Safety and Health Administration (OSHA). State-managed safety and health regulators oversee safety management in 22 different states. Each of these is OSHA approved for similar or superior arrangements than what exist for OSHA. State-managed safety programs for public and private sector workers occur in Michigan, Maryland, Tennessee, and Vermont, for example. In some states like Connecticut, New Jersey, New York, and Illinois, state-managed safety programs only cover public sector workers through OSHA approved state-managed programs. Federal OSHA regulations cover private sector workplaces and workers.

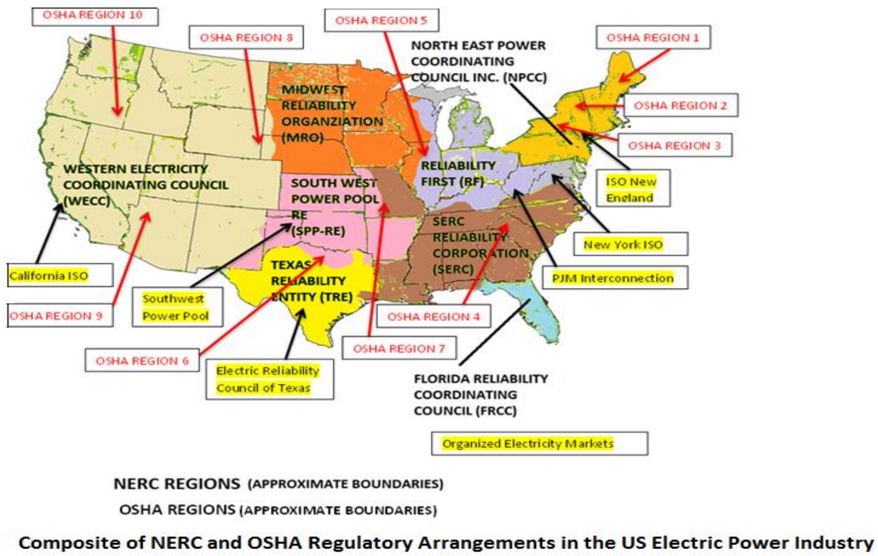


*Figure 1*. Composite of NERC and OSHA regulatory arrangements. Adapted from OSHA (2017), NERC (2017)

OSHA is a legally formed entity originating from the US Occupational Safety and Health Act of 1970 (OSH Act of 1970, 2017, October). The OSH Act 1970 does not cover workers engaged in self-employment or in specific industries which were regulated by other federal institutions or agencies like, for example, the American Coast Guard, the Department of Energy, and the Mine Safety and Health Administration (OSH Act of 1970, 2017, October). The prelude to the OSH Act 1970 was an average of 14000 worker deaths per year (or 38 worker deaths per day) in US workplaces. Since 2003, more than 4500 worker deaths per year (or > 12 worker deaths per day) has been the real workplace experience. From 2003 to 2009, more than 5200 workers died at work each year. In 2016, 5190 fatalities occurred. For each year from 2009 to 2015, more than 4500 workers were victims of fatal workplace accidents (National Census, 2017).

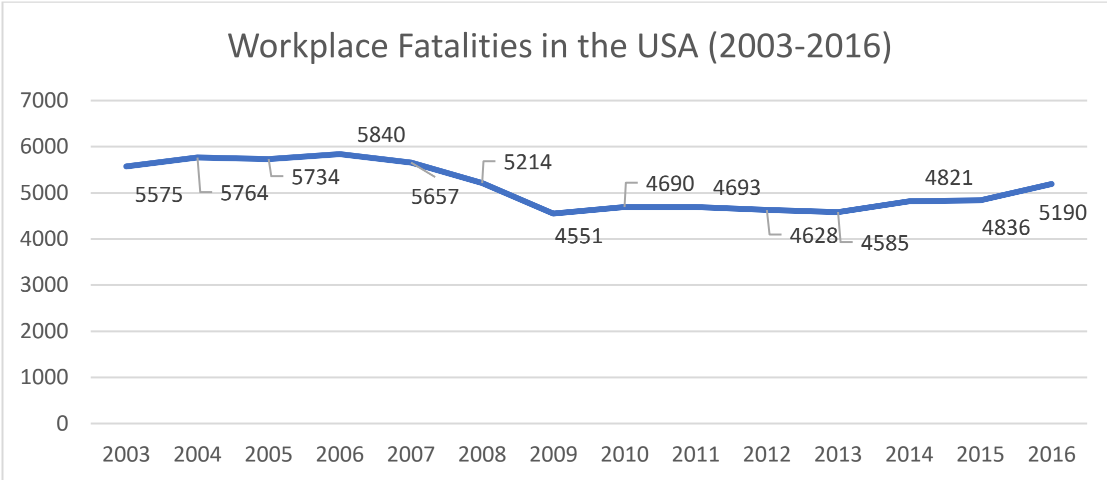


*Figure 2.* U.S. Bureau of Labor Statistics on Workplace Fatalities. Adapted from NATIONAL CENSUS OF FATAL OCCUPATIONAL INJURIES IN 2016 dated December 19, 2017.

The United States Bureau of Labor (BLS) estimated that in 2016, the workforce was double that of 1970 and that severe workplace accidents and illnesses reduced from 11 to 3.6 per 100 000 workers in the same period. Worker accidents in the electric power industry are lumped in a category called Utilities and amounts to 2.8 in 2016. OSHA credited the reduction in workplace accidents and severe injuries to the enforcement of the OSH Act 1970 and the efforts of employers, safety professionals, worker unions, and primarily the workers themselves. These all culminate in a 66% reduction; but not an elimination of workplace mishaps, deaths, and injuries. The BLS estimates that worker compensation for workplace injuries and illnesses in the United States directly amounts to approximately $1 billion per week. Indirect costs are appreciably higher as that cost include lower productivity outputs and outcomes, worker training, replacement costs for damaged equipment, and lost time in delayed start-ups after workplace accidents. OSHA, from the OSH Act 1970, is expected to develop, promulgate, and enforce workplace safety standards for which employers are to comply. Example work standards includes fall protection, machine guarding, and handling of chemicals in the workplace: these and other safety standards are aimed at ensuring that proper safeguards and safe working conditions are sufficient to prevent workers injuries or illnesses. OSHA assists companies, employers and workers' training, and provides information on workplace safety so that workers and employers have an understanding of their workplace safety duties, rights, roles, and responsibilities. The 2015-2016 BLS reported worker deaths in the selected (as examples in this study) states of the United States as captured in Table 4.

Employers are required, by the OSH Act 1970, to comply with OSHA safety standards, to identify and abate workplace hazards, to provide employees with necessary training and information regarding dangers at work, and to notify OSHA of workplace accidents where workers are killed or injured. For safe workplaces, employers are also required to provide workers with necessary personal protective equipment (PPE), to keep workplace safety records, and to desist from retaliatory actions against workers who reports safety infractions to OSHA.

OSHA is vested with the power, through the OSH Act 1970, to conduct workplace inspections, even without advanced notification. These inspections happen when there are risks of worker deaths or severe injuries. Citations for workplace safety violations as well as financial penalties for these violations and failure to curb further violations usually resulted from OSHA inspections and investigations. The OSH Act of 1970 make employers responsible for maintaining safe workplaces so that workers are not injured or even killed. To this end, workers are required to support employers in ensuring the maintenance of workplace safety measures and that individuals do not misuse safety equipment, tools, and systems. Workers aere, therefore, to be trained to understand and to handle dangers that might be present in the workplace. For denial of this right or any other safety provisions permitted by the OSH Act 1970, workers have recourse in whistle-blowing to OSHA.

Table 4

| State | Counts (Fatalities) | | Rates (Fatalities/100 000 Workers | |
|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 |
| Connecticut | 44 | 28 | 2.6 | 1.6 |
| Delaware | 8 | 12 | 1.9 | 2.6 |
| District of Columbia | 8 | 5 | 2.4 | 1.4 |
| Indiana | 115 | 137 | 3.9 | 4.5 |
| Kentucky | 99 | 92 | 5.5 | 5.0 |
| Maine | 15 | 18 | 2.5 | 2.4 |
| Maryland | 69 | 92 | 2.4 | 3.2 |
| Massachusetts | 69 | 109 | 2.1 | 3.3 |
| Michigan | 134 | 162 | 3.1 | 3.5 |
| New Hampshire | 18 | 22 | 2.7 | 3.2 |
| New Jersey | 97 | 101 | 2.3 | 2.4 |
| New York | 236 | 272 | 2.7 | 3.1 |
| Ohio | 202 | 164 | 3.9 | 3.1 |
| Pennsylvania | 173 | 163 | 3.0 | 2.8 |
| Rhode Island | 6 | 9 | 1.2 | 1.8 |
| Vermont | 9 | 10 | 2.9 | 3.2 |
| Virginia | 106 | 153 | 2.8 | 4.0 |
| West Virginia | 35 | 47 | 5.0 | 6.6 |
| Wisconsin | 104 | 105 | 3.6 | 3.6 |

*Note*. Adapted from U.S. Bureau of Labor Statistics Release NATIONAL CENSUS OF FATAL OCCUPATIONAL INJURIES IN 2016 dated December 19, 2017 (p.10).

**Worker Safety Beliefs**

White et al. (2016) considered a framework based on the theory of planned behavior, to explore underlying worker beliefs about workplace safety among electrical workers in Australia. White et al. treats beliefs as advantages, disadvantages, referents, barriers, and facilitators of workplace safety compliance.  Individual and co-worker personal safety are the advantages of safety compliance; disadvantages involve workload and customer inconvenience; referents represents customers, supervisors, and worker-teams; cost and time constitute the barriers and, equipment availability, worker knowledge, and training are the facilitators. White et al. (2016) believe that identified worker beliefs could are an essential catalyst to initiate safer workplaces and better electrical safety decisions.

Albert and Hallowell (2013) describes the working environment that electrical workers negotiated as high risk and where live power systems sometimes lead to serious workplace accidents, worker injuries and even death. White et al. (2016) captures that when electrical worker injuries occurred, the calculated hospitalization rate is 4 cases in every 100 000 individuals cared for in these facilities. That is serious enough to cause a renewal of focus on electrical work and how workers use work systems, procedures, and personal protective equipment to ensure that they remain safe throughout work exercises (White et al., 2016). Comparing workplace electrical data on accidental deaths, White et al. indicates that annually there are approximately 350 electricity-related deaths in the United States and that almost 34% of these victims would be electrical workers. In Australia, electrocution is third on the list of leading causes of workplace deaths. Nearly 50% of electrocutions occur on live power lines or from contact with these lines. Contact with energized transformers, electrical wires or other circuit components by electricians are also a leading cause of electrical worker injuries and deaths.

White et al. (2016) identifies that within Australia, just as in many other countries worldwide, there are regulatory frameworks and policies for managing safety in the workplace. These are intentional and developed so that workplace safety can build upon a framework where worker rights, roles, and responsibilities are in line with the employer's roles and responsibilities. White et al. (2016) are unconvinced that regulatory control alone, is sufficient to provide a positive safety response from individuals at work. Probst and Graso (2013) and Probst, Graso, Estrada, and Greer (2013) examined worker attitudes and workplace safety barriers and posit that many times, managers and supervisors are the catalyst for a failing safety management system and not the facilitators of successful safety outcomes. Tucker et al. (2016) felt that organizational leaders and top management influence positive safety outcomes by convincing managers and supervisors that it is necessary to endorse safety in the workplace positively.

Vaughan (1997) showed that normalization of deviance happen by compliance, proactive safety behavior, and that management failure leads to significant safety negatives. Lievens and Vlerick (2014) showed that consistent management demand for safety compliance results in positive safety participation from workers with a lessened likelihood of workplace accidents and injuries; Probst et al. (2013) likened this as an exhibition of citizenship behavior by workers towards the organization.

White et al. (2016) believes that this citizenship behavior informs workplace training, worker engagement, and a positive working environment where worker attitudes and behavior are conducive to safe and accident-free work. That, according to White et al. (2016), is the opportunity to understand better how worker behavior impacted on safety outcomes and the identification of possible ways to eliminate conditions and situations that encouraged a diversion from that course.

## Safety Theory

### Planned behavior.

Worker choice involves a process of decision-making that individuals are intrinsically motivated by and adopt. The 1991 Ajzen Theory of Planned Behavior (TPB) is such a decision-making model (Ajzen, 1991). White et al. (2016) used this model to examine safety behavior and the direct and indirect determinants of decision making among electricity workers. White et al. (2016) described that intentional influences are deliberate plans that describe actual individual behavior while indirect influence align with the individual's beliefs. From TPB, there is support for thinking that intentions are a direct and proximal catalyst for personal behavior. White et al. believe this to be true and extend the logic to the willingness of an individual to exhibit a given behavioral response or subjective norms. Antecedents or background of intentions have roots in individual attitudes whether positive or otherwise (White et al., 2016). Social pressure from working groups and co-workers lead individuals to either perform and sometimes to desist from performing tasks that can be dangerous or risky. White et al. believe that this risky behavior can be a subjective norm that is catalyzed by social group pressure at work. TPB crucially link the predictors of behavior and belief with attitudes, perceptions, and subjective norms such as thinking and response. Attitudes result from beliefs - as ideas and assumptions - about the advantages or disadvantages of the desired behavior. Attitudes, therefore, likely make a difference in whether an individual takes undue risks or believe that safety rules are cosmetic and not relevant to the tasks at hand (White et al., 2016). Subjective norms, such as individual action and response, are dependent on normative beliefs or merely the individual's expectations of approval or disapproval from particular groups or individuals. It implies that a worker's response  links to ideas of acceptance or criticism from supervisors, managers, or coworkers and work-groups (White et al., 2016).

White et al., also feel that behavioral perception of control is influenced by controlling beliefs linked to individual motivators such as recognition and rewards.  That logic extends to negative motivators such as barriers, restrictions, prohibition, and rules which inhibits positive performance outcomes and behavior.  White et al. (2016) concur with Ajzen (1991) that information about beliefs can shape interventions designed to encourage positive behavioral performance.  That happen if the altering of existing beliefs become possible.  White et al. feels that exposure to new beliefs is a reasonable way of changing attitudes.  With an understanding of TPB, researchers can explain variability in behavior and intentions especially when applied to predict workers' safety behaviors towards workplace safety practices (Ponnet, Reniers, & Kempeneers, 2015).  White et al. (2016) investigated these variabilities among electrical workers in Australia to better understand underlying beliefs about safety decisions in the workplace and to identify the full range of different safety beliefs that resulted.  That included behavioral advantages and disadvantages, individual and group-level normative behavior, and barriers and motivators as control beliefs.  These were to identify the different effects of individuals who influence others at work, the hurdles that can prevent optimal workplace safety and the impact of an individual thinking about other individuals in the workplace.  White et al. (2016) indicates that they aimed to understand how electrical workers beliefs and approaches to workplace safety lead to the prevention of injuries and fatalities.  The feeling is that with the identification of underlying beliefs that influenced safety behavior; strategies could be adopted to teach and to encourage safe behavior and therefore better outcomes.  White et al. postulates that consolidating proactive-safety beliefs and a working environment which facilitates open-challenges to unsafe-beliefs lead to the development of better safety attitudes and normative behavior as well as improve control perceptions.  White et al. found that in some cases, there is concern about legal and work consequences of reporting workplace incidents, near-misses, and accidents and that this negatively influence safety because of vulnerabilities induced by the uncertainty about liabilities.

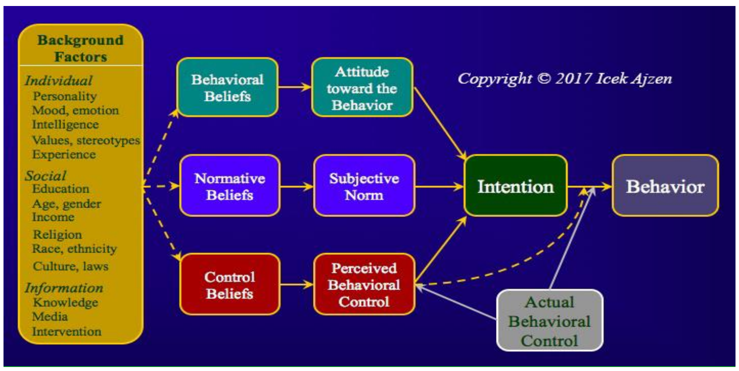


*Figure 3:* From “The Theory of Planned Behavior “Adapted from Ajzen, https://people.umass.edu/aizen/tpb.background.html and as captured by White et al. (2016, Section 1.2.2). Reprinted with permission.

White et al. (2016) found that there are cases where supervisors and managers discourage the reporting of accidents, but these were a minimal number when measured against the overall response from managers and supervisors.  Worker knowledge and training are critical to individuals being able to identify hazardous conditions and to mitigate the associated risks.  Most participants acknowledge that the training and experience gained are relevant but expressed concern about insufficient and infrequent follow-ups, especially regarding younger electrical workers.  Participants also indicated that at times, there was inadequate time to conduct full work pre-planning and that added safety challenges and compromise (White et al., 2016).

**Self-determination theory.** Scott, Fleming, and Kelloway (2014) indicated that self-determination theory provides a good indication of individual work motivation. Scott et al. (2014) described the human problems frequently associated with personal protective equipment use. These devices, are uncomfortable, slows work processes, and therefore conflicts with productivity levels (p.281). Intrinsic motivation is an internalization done by an individual. If personal protective equipment use is irritating and cumbersome, then individuals internalize that safety is not designed to be enjoyable. As a result, safety is not an excellent intrinsic motivator since it is in place to ensure that errors do not occur more than to keep the employee comfortable. Scott et al. (2014) suggests that for the best safety outcomes, managers shall reward individuals for safe behavior and deal with situations in cases where undue risks are taken to get tasks done as that constitute unsafe behaviors.

**Social learning theory.** Social Learning theory describe how people learn by observing the behavior of high-status and significant individuals and how that behavior is reinforced and recollected in the future (Tucker et al., 2016). Social learning can be an individual experience or a collective experience for a group of individuals. Tucker et al. (2016) suggests that a CEO who engages executive management through shared intent and observations to facilitate a positive safety culture at work is involved in a collective social learning process. The executive team that follows the CEO in espousing a safety climate encouraged by the CEO is itself vicariously learning from the CEO and explained in the social learning theory. The learning process continues through the managers and supervisors to the front-line workers. It implies that the safety focus of the leader percolates through the organization to the front-line workers; a safety conscious leader can impact a safe organization (Tucker et al., 2016). Also, the supervisor can impact workplace safety outcomes by ensuring that work procedures and safety rules are fully integrated to influence individual worker learning, collective learning among groups of workers, and actions to ultimately prevent errors and accidents by the maintenance of safety margins (Tucker et al., 2016). Conchie, Moon, and Duncan (2013) indicates that work demands can positively engage worker safety behaviors and involvement depending on the context of the instruction. This context can be set by the leadership of the organization especially if a strong safety climate is supported by the leadership if there is a traceable record of meaningful employee engagement and supervisor support for safety. Conchie et al. (2013) explains that workplace demands are the combination of physical and other aspects of the job which result in a worker's physical and mental engagement and which can result in exhaustion. Conchie et al. (2013) further describe exhaustion as physical, emotional, and psychological.

**Heinrich theory.** Figure 4 is a depiction of Heinrich's theory (Capelli-Schellpfeffer, Floyd, Eastwood, & Liggett, 1999). From the depiction, there is a significant amount of at-risk behaviors usually interpreted as unsafe acts by individuals at work (Dekker, 2006). These generally are undetected until a near miss, or first aid event occur. Assuming that this model is correct, even if unsubstantiated, there is a ten-fold situation of undue risks taken before an opportunity to learn from these become available through a recorded near-miss event. Capelli-Schellpfeffer et al. (1999) found that near misses are generally not investigated and if they are, the findings and other pertinent information is not available from an accident and near-miss events repository that organizations and workers could benefit.

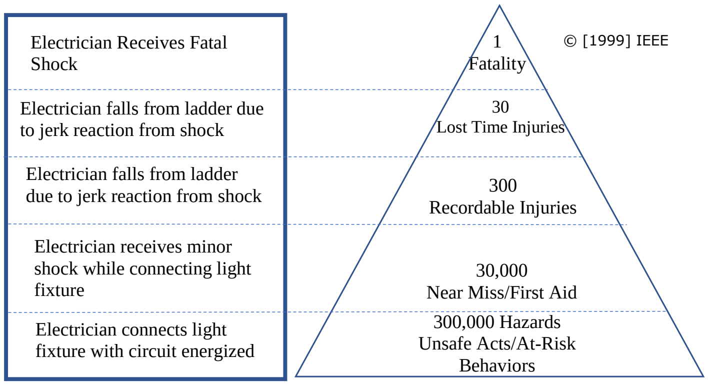


*Figure 4:* How we can better learn from electrical accidents. Adapted from M. Capelli-Schellpfeffer, H. L. Floyd, K. Eastwood, & D.P. Liggett(1999). Reprinted with permission .

Fordyce, Kelsh, Lu, Sahl, and Yager (2007), Salguero-Caparros, Suarez-Cebador, and Rubio-Romero (2015), and Volberg et al. (2017) echoed the same opinion about the non-availability of near-miss data in the EPRI OHSD and other databases. According to Capelli-Schellpfeffer et al., interpretation of Heinrich's theory, a workplace injury occur after more than 30 000 near misses. If correct, it means that conditions where the likelihood of equipment damage or injury to individuals exist and are not investigated for each of the 30 000 incidents. Understanding the real causal factors that contribute to near-misses are as relevant and essential opportunities to learn from and to prevent accidents which can result in worker injuries or deaths.

Capelli-Schellpfeffer et al. (1999) indicated that once the conditions necessary for an incident event exist, whether an accident or a near-miss, the eventual outcome is determined only by chance. That chance outcome is equivalent to an injury, fatality or a near-miss. When near-misses occur, false understanding that there is no real danger is common. Work arrangements that contribute to the incident can become accepted as good practice. That is akin to deviance described by Albright (2017); normalization of deviance would require a real understanding of the causal factors of near-misses, just as those for accidents (Price & Williams, 2018; Vaughan, 1997). The analysis of causal factors can be opportunities to identify the underlying latent and systemic reasons for near-misses and accidents.

**The self-regulatory resource theory.** Kao, Spitzmueller, Cigularov, and Wu (2016) used the self-regulatory resource theory of individual self-regulation to show that insomnia lessens safe-behavior and this lead to an increased risk of injuries in the workplace. Insomnia is an issue that individuals regulate on their own: supported by self-control and personal behavior (Uehli et al., 2014). Kao et al. (2016) believe that safety behavior is a self-regulatory act specifically aimed to prevent injuries and the avoidance of unsafe actions. Safety behavior, therefore, can be a complex sequence of behavioral activities which requires volition, determined, and deliberate individual control. The results of this investigation substantiates that insomnia causes unsafe behaviors in cases where the individual suffer from the condition. Also confirmed is that behavior describes the relationship with workplace injuries. Kao et al. (2016) extended understanding of insomnia and its impact to how supervisors can recognize workers inflicted with this condition, and still encourage safe work operations by setting up work arrangements and barriers that will prevent any possible unsafe behavior. Kao et al. (2016) found that when supervisors are safety proactive and aware of particular individuals inflicted with insomnia, the likelihood of workplace injuries lessens: This study links workplace safety outcomes with individual behavior and organizational factors such as the quality of supervision, and supervisor safety consciousness. It describes how organizational-factors can align to mitigate safety outcomes; in this case, the effects of insomnia on safety errors and worker injuries. It also raises the possibility of other conditions, medical or otherwise, that would affect a worker to the extent were behavior can be impacted and how that impact would influence work outcomes, safety, and worker injuries. Clarke (2013) supported the thinking that supervisor-behavior can result in improved worker safety performance and posited that supervisor safety training is critical to individual-level supervisor appreciation of their effect on safety at work. Kao et al. (2016) extends this logic to introduce a concept of worker engagement by supervisors and suggests that a lack of this is more an explanation of why insomnia results in accidents and worker injuries; supervisor effect is more significant than the impact of hazardous work conditions leading to worker errors, inattentiveness, and fatigue. Kao et al. (2016) described sleep as a process whereby an individual restores cognitive or attentive capability, and rejuvenates physical strength, with the result as the individual becoming alert and energetic. A lack of sleep, insomnia, is the leading cause of a person growing fatigued and restless; and a diminished individual capacity to maintain safe behavior.

**Safety models.** Labib (2015) suggested a modeled approach to analyzing accident events and used it to explain what happened in Bhopal; Figure 5 – The second model of FT below is the reproduced model. In this Fault Tree Analysis (FTA) Labib introduced accident-causing factors as a system and plant design, workforce training and performance, inadequate and unsatisfactory maintenance, and management decisions. Any combination of these is logically analyzed and deemed as crucial to the accident event.

Labib (2015) indicates that the concept of learning is a prominent research posit, but the idea of un-learning is particularly important; the fact that un-learning went unnoticed is likely the main reason for repeat accidents. Labib describe disasters and significant industrial accidents as low frequency and high impact events. Two inferences come from this perspective. First, disaster events are usually infrequent but severe, and second, the likelihood of un-learning is high. It means that for prevention of recurring accidents, organizations would be best served by arrangements where individuals are often remind about the accident experience.

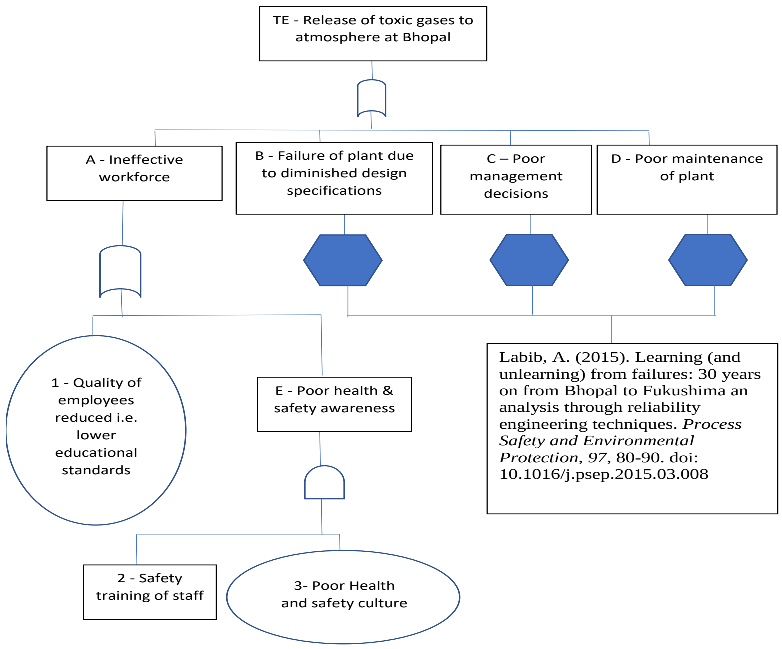


*Figure 5:* Learning (and unlearning) from failures: 30 years on from Bhopal to Fukushima an analysis through reliability engineering techniques. Adapted from Labib, A. (2015). Reprinted with permission.

Labib noted that NASA experienced two accidents that are similar in many ways; the Columbia and Challenger. The nuclear power industry disasters at Chernobyl and Fukushima Daiichi and the Piper Alpha, Deepwater Horizon and Bhopal are comparable experiences from the oil, gas, and chemical processing industries. The similarities identified by Labib (2015) supports earlier comparisons done by NASA (2013) and Singh, Jukes, Wittkower, and Poblete (2010). There are cases identified where, just like NASA, the same organization experienced more than one significant accidents; Air Malaysia and British Petroleum (Allen & D'Elia, 2015; Huber, 2013; Sienkiewicz, 2015; Lee & Han, 2016). The MH370 flight on March 08, 2014 disappeared from radar and was never found, and all 227 persons on the aircraft are presumed dead. This aviation disaster is unlike the 1989 Dryden crash where Moshansky (1992) found a compounding of problems because of issues that rested with the regulators, airline industry, the organization, and individuals who worked on that particular aircraft on the day of the accident. Lee and Han (2016) describes many different challenges that stems from transnational cooperation, the technological capability to track an aircraft that lost communication with air traffic control, and possible individual actions that went unsubstantiated but factored and promote skepticism.

Malaysia Airlines in 2014 experienced another incredible event: On July 17, MH17 with 298 persons on board was downed in Ukraine by a Russian-made missile (Sienkiewicz, 2015). From this disaster other considerations are brought into focus: Was MH17 a coincidental victim of an unrelated tragedy, either orchestrated or by chance? That, however, does not explain whether the aircraft was on its scheduled flight path and whether that path was one traversed by other airlines. The lessons from that experience can be used to prevent future aviation disasters. The two incidents that Malaysia Airlines experienced in 2014 left significant doubt about what went wrong.

Huber (2013) indicates that the 2005 explosion at the BP Oil Refinery in Texas City is a major indication of inadequate safety management. It is well-known that safety arrangements at the refinery were outdated and required re-engineering and upgrades (Huber, 2013). In this accident, 15 individuals died, and another 170 were injured (Huber, 2013). In 2010 the Deepwater Horizon oil rig disaster, in the Gulf of Mexico, there were 11 fatalities and 17 injured victims. BP managed the Deepwater oil rig. Huber (2013) recounted another accident in Alaska where an explosion in 2002 resulted in multiple subsequent oil spills; one in 2006 was the largest in the history of operations in that area in Alaska.

Allen and D'Elia (2015) describes the oil spill that resulted from Deepwater Horizon as the worst in maritime history and that the biological ecosystem after-effects are still not conclusively known. The social negatives, mental anguish, and the fallout that resulted are apparent and understood. The social impact of the Deepwater Horizon accident very likely is compounded because of hurricanes Katrina and Rita and the devastation that these meteorological phenomena superimposed on the population in the Gulf Coast of the United States. Allen and D'Elia (2015) calls attention to the regulatory ability to effect appropriate compensation in light of the apparent shortcomings of the existing legislation that governed the management of this disaster and compensation for the affected third parties. It is a point emphasized by their feelings of disenfranchisement by the legal system and its apparent shortcomings in addressing this issue (p.587). The point about regulatory ability is consistent with the views of Moshansky after the Dryden accident (Lecture, 2007).

Allen and D'Elia (2015) posits that the disaster management main aim from the BP Deepwater oil-spill seems to be on remedial attention such as containment and saving fauna rather than the long-term consideration for the severe human and emotional consequences. Affected parties received small financial settlements to claims against *the Responsible Party, BP* (p.588). Human issues of neglected communities, mental health problems, anxiety, Post-Traumatic Stress Disorder (PTSD), suicide, drug, and substance misuse directly attributed to this oil spill are of particular interests (Allen & D'Elia, 2015). Mac Sheoin (2015) and Singh, Jukes, Poblete, and Wittkower, (2010) shows how different this was in Bhopal and Piper Alpha. That difference referred to the more than twenty years that surviving victims of Bhopal had to wait for compensation adjudicated by the legal system in India: The different ways that the human issues are handled in the Bhopal case when compared to the Piper Alpha case makes a referencing of the non-attention of human and emotional consequences of accidents. Allen and D'Elia (2015) went further to identify the effects that industrial accidents have on responders; especially those who are injured or suffers long-term health effects afterward. Allen and D'Elia also examined the impact on families and friends of responders and victims killed in industrial accidents. Family members of a Flight Attendant who died at Dryden in 1989, had to petition the Canadian courts for relief against the two deceased pilots, the airline, and the regulator. These are among the corporate secrets that remain untold from industrial accidents (Lecture, 2007). Allen and D'Elia (2015) suggests that legal constraints add to the challenge and that government and regulator intervention are required for appropriate relief to affected individuals and communities after industrial accidents.

**Sociotechnical and safety management models.** Manuele (2014) developed a sociotechnical model which caters to the human element consideration and interaction as well as the other system elements for assessing safety management systems, especially when investigating accidents in the workplace. Manuele believes that workplace accidents are symptoms of significant safety management system problems and that accident investigations presents opportunities for the identification of system deficiencies that when corrected can prevent future accidents. Manuele called this an opportunity to employ root-cause analysis to determine the system weaknesses. Manuele reviewed reports from about 2000 accident investigations and indicates that there are definite gaps between how to do accident investigations and what the procedures for these investigations require. Manuele suggests that the average report would receive a grade of 5.7 out of a possible 10 representing significant missed opportunities to learn from accidents and to mitigate against similar future accidents. The accident investigation procedures come from the ANSI/AIHA/ASSE Z10-2012, Standard for Occupational Health and Safety Management Systems and from specific organization and industry developed arrangements. Labib (2015) and Murata (2017) suggests that a similar Safety Management Systems (SMS) existed in the Piper Alpha accident and the Lord Cullen Report from that investigation was instrumental to the development of SMS in other industries.

Manuele (2014) highlights two very critical issues; these surround the bias by investigators. First, Manuele suggests that supervisors are more than often required to investigate accidents and this is usually not adequately done, and second, there is an overwhelming focus on finding the unsafe acts committed by the employee or employees involved in the accident. By focusing on the unsafe act committed by individuals just before the accident event is a shortcoming and a *blind-eye* turn on the other systemic problems that contribute to the single or "last" error before the actual event. Manuele's view is supported in other studies such as Dechy et al. (2012), Singh, Jukes, Wittkower, and Poblete (2010), Labib (2015), and Murata (2017).

**Swiss cheese model.** The Swiss Cheese model is a simple model built to analyze the reasons for accidents (Singh, Jukes, Poblete, & Wittkower, 2010; Wahlström & Rollenhagen, 2014; Murata, 2017). The Swiss Cheese shown in Fig 6 below is a popular linear accident causation model developed by James Reason (1970 – 1977). For an accident event to occur, several breaches of different organizational barriers occurs. The last gate before the accident is usually one that likely involves the individual or individuals at the accident site or breach when the accident happen. This barrier can include worker training deficiencies or workers' failure to follow work procedures correctly (Hosseinian & Torghabeh, 2012).

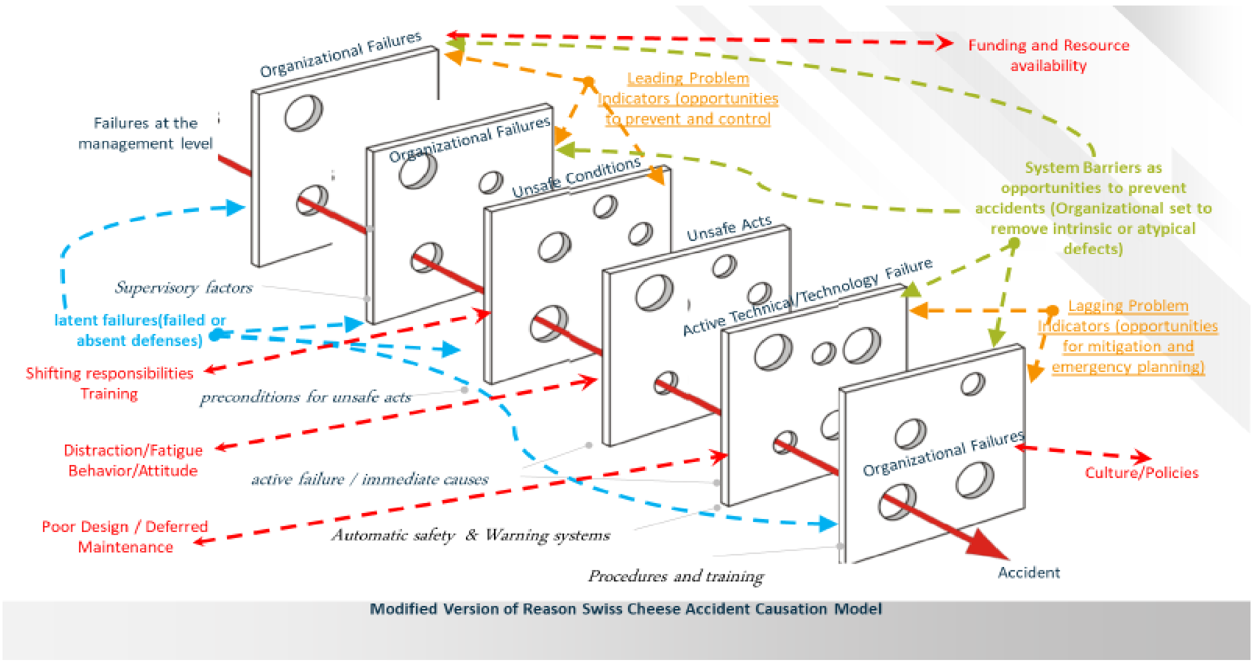


*Figure 6:* Human error: Models and management. Adapted From Reason, J. (2000).

Workers not following procedures or not applying training on the frontline is what Manuele (2014) feels are the significant predominant investigative findings from accidents. Stopping at this point or accepting these as the real cause for appropriating responsibilities usually, lead to deficiencies and lost opportunities to identify the deeper organizational problems that are breached up to the final barrier. The barriers reflect breakdown and breaches on warning and alarm systems, issues on other automatic technical systems and devices, unsafe design, poor work planning and permit to work violations, unsafe conditions, inadequate supervision or supervisory failure, organizational failures at the management level (Hosseinian & Torghabeh, 2012, p.58). Manuele (2014) believes that frontline workers and operators inherit work problems compounded in different ways. These include poor design, incorrect installation, inadequate and reduced maintenance.

Manuele (2014) suggests that accident investigations conducted by supervisors are sub-standard and at times only focused on the human error on the frontline just before that accident event occur. The barriers as in the Swiss Cheese model include supervisors as deep and latent barriers to prevent accidents (Hosseinian & Torghabeh, 2012). When supervisors are untrained, incapable of lending assistance, or tardy in not following up on active supervision of workers, the occurrence of accidents in these situations can be due to breakdowns initiated by the supervisor (Manuele, 2014; Dekker, 2006). It is, therefore, difficult for the supervisor to focus elsewhere but on the frontline breaches and to associate these breaches with workers not following procedures or not applying the knowledge gained through training (Lee & Dalal, 2016).

**Accident causation and prevention.** Mitropoulos, Howell, and Abdelhamid (2005) described an accident causation model that offers a better understanding of the different influences that can impact a workplace accident. Figure 7 shows how work processes can become complicated and difficult to manage, even if it remains simple at each stage in the workflow. Individuals in the different stages of the work process will be skilled and technically proficient to function at that stage in the process (Miller, Raysich, & Kirkland, 2016). Supervision remains a critically important glue for the effective and efficient management of work processes (Mills & Koliba, 2015). Mitropoulos et al. (2005) focusses on the work considerations from technical skills of individuals to work arrangements that can be influenced from the very top of the organization and impacted at the frontline where the work activity occurs. There are definite advantages with this model as it is sufficiently generic for application in different workplaces, working environments, industries, and complex conditions while not removing or lessening the requirements of any safety management system, work procedures, work design, or working arrangements. That is an advantage when compared to the Swiss Cheese model.

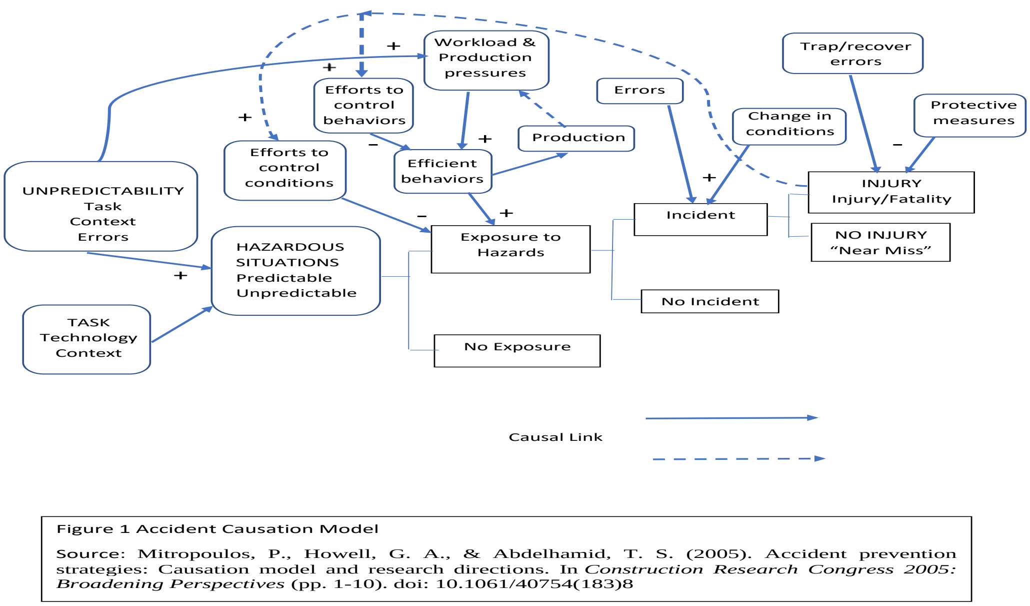


*Figure 7:* Accident prevention strategies: Causation model and research directions . Adapted from P. Mitropoulos, G. A. Howell, & T. S. Abdelhamid (2005). Reprinted with permission.

The impression from the Swiss Cheese is that it is a linear profile of breached barriers before an accident will occur. These barriers can spatially exist over long time-periods, and therefore it can become complicated to manage effectively and to appreciate (Dekker, 2006; Manuele, 2014). An example of how difficult the Swiss Cheese model can become is in an accident where design occurred in year A, construction occurred in year B, and an accident occurred in year C. This become difficult to track if the difference in years increases. If a power transformer is designed in 1990 and installed at a substation on the electric grid in 2005, this transformer can realistically remain in service until 2055. It implies that if an accident occurs in 2035, then the accident can be because of a design flaw that went undetected until the event in 2035. If the design flaw is recognized earlier, a decision can be taken to keep the unit in service but to operate it within limits set by the organization (Mills & Koliba, 2015). These procedures can be detailed but not adequately archived. The point is; it could become a tough challenge to trace the failure of the transformer back to the original design flaw problem. It, therefore, lessens the usefulness of but it did not remove the apparent validity of the Swiss Cheese model. The Mitropoulos et al. (2005) model provides opportunities for tasks to be less unpredictable by impacting the importance of individual awareness; it promotes safe production behavior by supporting hazard identification while mitigating safety risks due to these hazards. It also allows for feedback systems to initiate control of new safety challenges that can develop as work ensued (Merlin et al., 2016; Miller et al., 2016). This feedback system is analogous to the feedback control of closed-loop systems. It represents the opportunity to manage errors and to prevent unplanned events from developing into unmanageable situations (Moffatt-Bruce et al., 2017).

Mitropoulos et al. (2005) suggests the focusing on compliance to reduce hazard exposures. That is consistent with Vaughan (1997), Albright (2017); Price and Williams (2018), and Murata (2017). Mitropoulos et al. (2005) further suggests that compliance promotes a limited view of accident causality. It leads to unnecessary attention to and on individuals at fault, not on system factors that fails to address hazards, and eventually encourages unacceptable worker behaviors. Price and Williams (2018) counters this thinking, just like Vaughan (1997) and Albright (2017) do, in positing that compliance promotes normalization of deviance and focuses on safety margins instead of risks that lead to system reliability, service continuity, and product availability. Mitropoulos et al. (2005) acknowledges that safety compliance conflicts with production and operating cost factors and that the resolution of the conflict is usually in favor of productive activities. Murata (2017) suggests that the KLM4805/Pan Am 1736 crash at Tenerife may have been due to production conflicts with safety and where safety margins became sacrificed. Singh et al. (2010) suggests that production schedules led to the Piper Alpha accident as the permit to work system, safety arrangements for blanking critical pipes and other safety systems became breached to allow for production activities; it promoted a series of assumptions before confirmation. Murata (2017) discusses the production approach at NASA in favor of safety margins despite the issues with the O-rings. Labib (2015) notes that in Bhopal, numerous safety breaches by operators such as the shutting down of refrigeration contributed to the accident. None of these example studies explains why the safety breach happened; the emphasis, instead, was on confirming that it happened.

Mitropoulos et al. (2005) explains that work production factors and pressures influence workers to take shortcuts, disregard safety procedures and apparatus to get jobs done faster. A fallout of this is a safety climate where the attitude that supports risky-behavior is acceptable. It encourages individuals to become overconfident and to become complacent. Murata (2017) describes this as the worst possible consequence; a cultural difference or even a groupthink bias. Murata confirms that cultural difference is a crucial consideration if accident prevention are possible and for a real alignment of cognitive bias with optimal safety performance. None of the studies examined led to a belief that making work arrangements more efficient and reducing times taken for tasks were specific indicators that safety requirements are bypassed or ignored.

The skill levels and expertise of individuals who conduct work cannot be undervalued or disregarded in favor of work arrangements that do not allow for their genuine involvement and input. Therefore from the perspective that workers are skilled, technically proficient, and knowledgeable, reducing the time taken to do tasks cannot automatically be equated to risk-taking and irresponsible behavior (Mitropoulos et al., 2005). It may be understood though, that skills and knowledge are excuses for the deliberate reduction of safety margins where errors, accidents, and failures are possible and likely outcomes. Instead, it will very likely be acceptable if workers can recognize hazards and initiate appropriate mitigating responses. If errors or underestimation occur, then workers shall be sufficiently competent and capable to avoid further problems and to recover from the error conditions while trapping and containing the problem or exposure to the problem. None of this will be acceptable when the outcome can result in significant danger and possible injury or loss of life. In these situations, reasonable safety margins should be maintained (Mitropoulos et al., 2005).

**Complex linear model.** Toft, Dell, Klockner, and Hutton (2012) suggests that a successful approach to accident prevention hinges on an accurate understanding of accident causation. The early causation models allows for the identification of a single cause of the accident. This single-cause is the result of a linear and almost regimental sequencing of activities and actions until the accident event occurs. This causation methodology was accepted until the 1980s when a series of serious industrial accidents such as the Piper Alpha, Bhopal, and the Challenger caused a major rethinking about the appropriateness of the simple linear accident causation model in the era of complex technological, industrial operations. The complex linear accident causation models started from the 1980s up to the 2000s when the next generation of super technology made previously tricky operations possible. Business conducted in the 21st century is different; this difference is possible because of advanced communication ability especially in the online arena. That became the age of emergent technology where the workplace requirement is for individuals with different skill sets that in times before were unavailable. Technologies that previously were only available in the advanced workplaces like in NASA, for example, are now commercially available and within reach of smaller organizations and different industries. The accident causation models, suitable for previous eras, are replaced by complex emergent non-linear models more ideal for the changing workplace. Complex emergent non-linear models are considered suitable for multiple influencing factors that interact and evolve to lead to the accident event.

Manuele (2014) indicates that accident investigators shall be trained to develop the necessary skill and for the real causes of accidents to be determined. Dekker (2006) feels that investigations are entirely the result of investigator focus as it is individual bias that guide investigators more than procedures and standards; this is likened to an invisible accident model imagined by the investigator and which supported the investigator's pre-conceived belief of the accident and events surrounding the accident.

Dekker (2006) describes three different accident causation models: sequence-of-events, epidemiological, and systemic sequence-of-events which treats accidents as the failure outcome of chain-events of events. Dekker believes that this is equivalent to one domino causing the next in a chain to fall. Hosseinian and Torghabeh (2012) equates this domino chain to the Domino theory developed by Heinrich.

**Heinrich.** Heinrich developed his thinking on the relationship, as understood in the early 1950s, between human and machine. This model was used to determine some of the most widely used safety statistics, accident severity rate, frequency rate, and reasons for unsafe acts by individuals at work. Heinrich's theory was and still is popular; especially by individuals who believe that accidents due to human error are caused mainly by frontline workers. Heinrich suggests an 88:10:2 causal relationship to workplace accidents: 88% of all accidents caused by workers, 10% were due to equipment failure while 2% were unexplained and considered as *acts of god* (Hosseinian & Torghabeh, 2012). Manuele (2014) and Dekker (2006) counters this thinking as outdated and not in line with the current reality in the workplace. Manuele used the Deepwater Horizon accident to explain why the teachings of Heinrich are outdated. The investigation team did not identify one party or reason for the Deepwater Horizon accident: They found complex situations that evolved from an interlinking of poor designs, operational inefficiencies, mechanical failures, and human judgments (Manuele, 2014). Manuele conducted a survey in 2014 among safety professionals and found that more than 73% of safety practitioners searched for unsafe acts committed by workers which they treated as the latent or real cause of the accident.

**Human error.** Reason (2000) suggests that the human error accident causation view supports two distinct problems, one as an individual issue and another as a system problem. Reason further indicates that each perspective presented different views which results in diverged resolution philosophies and methodologies. The impact of these different directions are that opportunities to prevent accidents go unaddressed and similar accidents follow when the conditions reoccur (Holland, 2018; Miller et al., 2016).

The focus on the individual perspective to find human error problems is prevalent and concentrated attention on the individual responsible for the last-act before the accident event occur. The last-act usually equates to an unsafe act, error and even violation, sometimes willful, of work procedures with individuals tagged as being forgetful, inattentive, careless, reckless, negligent, and poorly motivated (Reason, 2000). Corrective actions are, as well, aligned to suppression of negative behavior through the adoption of disciplinary actions against the involved employee, instituting revised work procedures, and retraining of employees who perform similar tasks (O'Donnell, & MacIntosh, 2016). Reason (2000) associates this focus on an intent by management to blame deviant workers for the failure and loss as if the worker is morally obligated to be error-free and that the failure is only due to the untrustworthiness and negligence of the worker (Paludi, 2015). It does not factor that the problem can be an error in judgment despite the worker taking the steps that were believed to be sufficient to prevent injury or even death. It also places a moral barrier between the involved worker or workers and the remainder of the organization; as if separating the bad from the remaining good.

Reason (2000) indicates that it is more satisfying for some managers to blame workers for accidents than to focus on fixing the organizational problems and issues. The prevailing impression is that individuals are capable of making decisions and therefore should have chosen a safe work approach rather than the method they adopt before the accident event. That runs contrary to the thinking that the accident event can happen in a quick time and the individual may not have sufficient time to reconsider any decision that contribute to the event (Dekker, 2006; Manuele, 2014). Reason (2000) suggests that it is in the manager's interest to de-link responsibility for any accident from the organization. Probst (2015) aligns this impression to managers' bonuses and supervisors encouraging workers to underreport accidents. Manuele (2014) explains how this thinking influence the conduct of accident investigations and what findings result from these exercises. Reason (2000) reveals that in medical incidents individual doctors or other healthcare professionals are blamed for and held personally liable for medical accident events. Whereas, in the aviation industry, it is common to interpret maintenance-worker errors as linked to systemic problems connected with an events chain and which culminate with the final act as the accident happen. Judgment errors and lapses in concentration in the aviation industry are treated differently for the same issues in the medical industry. Reason (2000), just like Salguero-Caparros et al. (2015), Dekker (2006), and Manuele (2014) consider the analysis of accidents and near misses as critical to averting recurrent accidents and opportunities to recognize situations and conditions when these can happen.

**Human error thinking.** McCall and Pruchnicki (2017) notes the prevalence of holding individuals accountable for accidents happening is significant in industries where outcomes are high-consequence, and that remains a significant barrier to a favorable safety climate at work. McCall and Pruchnicki further posits that other pressing organizational requirements such as production find favor over safety behavior. Workers in these settings are required to recognize and observe different accountability boundaries as part of the regular working arrangements. McCall and Pruchnicki (2017) indicates that these accountabilities are: political, hierarchical, professional, and legal. These can explain why it is common to misinterpret accountability boundaries. The difference between political and professional may become blurred if the issue is one where human influence is more significant than other system components.

On the other hand, in cases where organizational games, such as departmental or divisional rivalry, are prevalent, legal accountabilities can be shrouded in professional and even political machinations. These blended well with the complex evolving workplace that was common today. McCall and Pruchnicki (2017) describes these challenges while explaining the events that contributed to the 1998 Swiss Air Flight 111 Airline crash in Nova Scotia, Canada and how these led to different and shifted employee response versions and behavior. McCall and Pruchnicki (2017) indicates that operator conflicts occurs as individual priorities directly impact accountability boundaries which result in safety breaches that cause the accident. McCall and Pruchnicki (2017) also notes that operators are negotiating across accountability boundaries to the extent where errors are reported on a timely basis and contributes to mitigation efforts which add to positive safety performance and organizational success. In effect, McCall and Pruchnicki describes a new culture, which they called *just culture* that can aid safety management in abnormal situations.

**Epistemological model of accident causation.** Dekker (2006) describes the epistemological model of accident causation as one where a search for the cause of the accident is possible from a management decision-making perspective, an equipment design criteria, and consideration of work procedures. Dekker (2006) also suggests that the systemic accident causation model incorporate the view that accidents are caused by an interaction that occurs when different components of the system are designed to coordinate activities and processes that links different working units and elements of the system. Dekker believes that these interactions overshadow the internal-to-individual component or segmental failures. Manuele (2014) supports this Dekker perspective of systemic accident causation and suggests that this was an opportunity to view workplace errors that lead to accidents as the consequence of a mismatch between worker-demands and their capabilities, and the existence of a less than appropriate safety culture within the organization. These, Manuele stresses, were the responsibility of and could be managed by the leaders of the organization. The safety culture in an organization can explain the underlying conditions due to design problems, unrecognized material and equipment flaws when purchased, inadequate or inefficient supervision, and work procedures that complicated working requirements without adding to safety margins. Maintenance failures including non-maintenance and automation make it difficult for operators to manage processes and devices that are otherwise functioning properly; training that do not prepare workers for the challenges they face at the workplace but links to organizational safety culture. Each of these factors influence worker attitudes and opinions and encourage a safety culture where suppressing of cognitive bias occur in favor of heuristic bias (Labib, 2015; Manuele, 2014; Murata, 2017; Dekker, 2006). Manuele extends the original Heinrich thinking about humans and machines by adding that these relationships are integrated, inseparable, interdependent, and shapes a sociotechnical arrangement that provides for organizational success and the facilitating of worker needs.

**Multi-cause models, ferrel, and arctm.** The Multiple Cause Model is a simple arrangement where several different factors are deemed to influence either an unsafe act or produced an unsafe condition. The accident, in which injury or death, equipment damage or process loss occurred, or even a near miss incident, is the result of an unattended unsafe condition and unchecked unsafe act (Hosseinian & Torghabeh, 2012). The Multiple Cause Model, just like the Domino theory and Reason’s Swiss Cheese, were not sufficiently versatile to cover for accidents like Piper Alpha, Fukushima, and the other significant accidents identified in my study.

Ferrel's Theory of accident causation is one that focuses on human errors. The logic applied to this model is a good one to understand the principle of how to pinpoint the individual or individuals who have direct and indirect impact on an accident event (Hosseinian & Torghabeh, 2012). Despite this, the model offers an opportunity for investigators to only focus on the last error and to treat that as the underlying cause of an accident. Manuele (2014) and Geller (2014) shows how this thinking likens to safety bullies and for the deep causing problems to go unnoticed.

There were other accident causation models: One example is the Accident Root Causes Tracing Model (ARCTM). The ARCTM model is a hybrid built from the Swiss Cheese. ARCTM grew upon the following underlying assumptions; unsafe condition, worker reaction to a dangerous situation, and unsafe act by the worker (Hosseinian & Torghabeh, 2012). The base assumptions are the same as for the theory of multiple causes except for a definite focus on the reaction of employees to an unsafe condition. Fundamentally, this accident causation model can be critically analyzed and deemed to have the same flaws as the other models that formed the basis for this hybrid. The main weakness, however, is the opportunity to still focus only on the frontline worker and the actions of the frontline worker.

**Behavior-based safety.** Behavior-based safety (BBS) techniques can enhance safety management but only if implemented in a supportive environment. Management will hold significant responsibility for setting the right safety climate for worker behavior to positively reflect the tenets of BBS. If leaders resort to error- finding and to attribute blame to frontline workers only, the result of a BBS system will not be as desired. In many workplace settings, production and operational challenges and demands easily escalate into a blame game and *tit for tat* sequence of *finger-pointing* that reduce the BBS to reflect the Multiple Cause Model even though not envisaged (Albright, 2017; Geller, 2014; Hosseinian & Torghabeh, 2012; Manuele, 2014). Albright (2017) notes that deviance must not become treated as the usual. Deviations, however, are a fact of life as people are prone to making mistakes. Procedures, if not tightly enforced can be easy to breach. Management must afford appropriate supervision and change deficient work procedures when these become known. Safeguards design must be so that it would not be simple to infringe or violate. No single individual at work should possess the autonomy to singularly divert from set procedures and not be found wanting; even if an accident did not happen. This desire to enforce compliance might be the real test to the normalization of deviance.

**Behavior based safety management.** Jerie and Baldwin (2017) shows that behavioral-based approach to safety management (BBM) is a successful approach if an organization's management will actively encourage this initiative. It is possible to influence worker attitudes and behavior when managers and supervisors show support for meaningful worker involvement in safety arrangements at work and a resultant reduction in the number of workplace accidents (Jerie & Baldwin, 2017; Miller et al., 2016). In each case, the success superimpose on developing a working environment where workers are able to intervene and mitigate accidents by causing the removal of risks posed by hazards that previously went unidentified and unaddressed. Jerie and Baldwin (2017) further highlighted the procedural support that workers have; if the task was unsafe, the worker had a right to refuse to do it. Miller et al. (2016) stressed not being another statistic.  Both studies promoted working arrangements where workers were allowed to be the eyes and ears of the organization and were expected to help in the removal of dangerous conditions that could result in injuries and even death.  Jerie and Baldwin (2017) describe BBM as focused on worker behavior link to or as causal factors in safety-related problems including near misses and accidents.  Miller et al. (2016) describes this as an opportunity to move from an employer-centric to an employer-employee-centric mode of safety management where workers can impact on work arrangements especially when the risk of injury or death is high.  BBM is different from a familiar model for behavior-based safety (BBS) management.  BBM is integral to the involvement of all individuals at work in the safety management arrangements at work; BBS is about the use of personal protective equipment (PPE) and the range of available PPE for the job (Jerie & Baldwin, 2017).  BBM results in meaningful involvement, worker *buy-in* as keepers of the system and employees caring for one another while BBS is more aligned to compliance and non-compliance with set procedures and job requirements (Jerie & Baldwin, 2017).  BBM is, therefore, transformational while BBS is transactional.  Transformational as postulated by Jerie and Baldwin and Miller et al. is superior and preferred; both studies show that a significant number of workplace accidents and injuries occur because of causal factors link to human factors and individual behavior, hence their focus on behavior modeling.  Worker training and reorientation are integral to successful outcomes in both studies.  Jerie and Baldwin (2017) promotes worker incentive for correct behavior.  Miller et al. (2016) raises the issue of preventing worker distractions and conditioning by the Balance Incentive; this is not financial, but the medical and social benefits are evident.  An adverse effect of BBM is underreporting of accidents and near misses.  Miller et al. (2016) allude to this by describing cases where the causal factors of injuries are unknown when the victim can be distracted by the use of cell phones. Jerie and Baldwin (2017) recognizes that accidents go underreported because of the financial incentives offered to workers for safe behaviors. Probst (2015) also indicates that accident underreporting can occur when management and supervision bonus are affected and negatively impacted. Another critical aspect of BBM is the availability of an appropriate database of accidents and near misses (Jerie & Baldwin, 2017; Miller et al., 2016).

**Safe is safe – right.** Price and Williams (2018) notes the difficulty experienced in organizations when deviance occur; once entrenched, it was almost impossible to turnaround and to revert to the normal. Price and Williams (2018), unlike Manuele (2014), Huber (2013), Singh et al. (2010), Dekker (2006), and others feel that high-reliability organizations automatically infer that these organizations were safe. Labib (2015) shows that unless un-learning occur, these high-reliability organizations are prone to repeat accidents and disasters.

Murata (2017) describes two crashes where cognitive bias factored; the 1977 KLM Flight 4805 crash and the 1986 Challenger explosion. Neither of these is due to or attributed to cultural difference. The contributing factor is loss aversion. A terrorist bomb at the scheduled destination airport on the Canary Islands influenced a diversion of the aircraft to the Tenerife airport. The KLM airline landed at Tenerife. The accident occurred on its take-off from Tenerife. The terrorist action led to air traffic congestion at Tenerife Airport. KLM 4805 and Pan Am 1736 collided on the single runway killing 583 people. There were 61 survivors. Pan Am aircraft. It did not have sufficient time to move off the runway when the KLM 4805 commenced its takeoff. Murata (2017) believes that a combination of possible factors may have influenced the KLM crew to begin the takeoff. These include reasonable costs due to delays, passenger accommodation, and other factors that started a chain reaction similar to what Moshansky (1992) found at Dryden. In both cases, it is possible that these factors caused the flight crews to lose a reference to safety and were more focused on operating cost. Murata (2017) attributes the Challenger explosion to groupthink that prevented confirmation but encouraged a consensus type thinking based on an illusion of unanimity.

**Workplace culture, new influences, and bias.** Murata (2017) describes a cultural difference between individual and group behavior and how that influence cognitive reasoning, judgments, and decisions that contribute to inadequate safety margins and the occurrence of accidents. Murata is cognizant that most times, there exists time-constraints that cause artificial needs to factor quickly and seamlessly; this requires a form of intuition and almost automatic thinking that generally do not always align with diagnostics and technical verifications necessary to confirm maintenance of safe work arrangements. A heuristic approach to decision making almost always suffers in preference to a cognitively biased decision. Murata supports similar arguments as posited by Vaughan (1997), Singh et al. (2010) about group-think and how that contributed to the Challenger explosion. Murata also highlights a hindsight bias which explains how after a series of accidents, individuals cognitively overestimate the likelihood of accidents and the future possibility of the event reoccurring. Hindsight bias is a form of cultural difference; just as social loafing, a fallacy of plan, an illusion of control, and groupthink bias (Murata, 2017). Dekker (2006) and Manuele (2014) in a different way suggest that hindsight thinking do not allow investigators to appreciate the real experience or for a correct diagnosis of an accident event. Lee and Han (2016) independently conclude, just like Murata (2017), that passengers tend to shy away from airlines that were involved in accidents: A direct inference to an overestimation of the possibility of future accidents.

Murata (2017) believes that cognitive bias lead to poor judgments, intentional violations, and unsafe conditions. Heuristic bias grows on a confirmation and verification process that is generally slower than cognitive bias. Overconfidence tendency become ripe in cognitive arrangements; this usually escalates to an illusion of control and that plans are adequate when that was not so. Gladwell (2007) indicates that this is not always negative and many times quick thinking is spot on correct; this is acceptable as a form of adaptive thinking that lead the brain to make conclusions quickly, like a super-computer. Gladwell describes the possible action of an individual seeing an approaching truck and jumping out of the way. This action is the correct one, quick, and made cognitively. Gladwell believes that quick decision making can be as good as cautious and deliberately made decisions. It does not mean that errors will not occur. It also does not infer that slowly made decisions, based on diagnostics and elaborate calculations are always correct.

**Safety culture and safety climate.** Griffin and Curcuruto (2016) differentiates the terms safety climate and safety culture; Safety climate involves a sharing of perceptions whereas safety culture depends on values and resultant behavior. Safety culture is, therefore, more implicit and process related while safety climate is about the interpretation of people reactions and attitudes. Safety climate is more likely to be situational and time-stamped while safety culture can be a more long-term and deeply rooted in the mission and vision of the organization. Therefore safety climate is akin to an immediate view of organizational safety culture. From this perspective, Lee and Dalal (2016) shows that group interaction is situational and therefore do factor the safety climate as an influence on employee behavior. Lee and Dalal studied the impact of safety climate, on organization construct, employee conscientiousness, employee construct, when predicting employee behavior. Griffin and Curcuruto (2016) indicates that there is no generally accepted consensus or theoretical approach to measuring safety climate even though there are distinct directions; attitudinal and perceptual; beliefs, risks, and work stressors as elements of measurement. Lee and Dalal (2016) found that safety climate is strongly influenced by situations that encourage desirable individual and group behavior albeit without profound influence on individual conscientiousness and other personality traits. A strong safety climate weakens the relationship between safety behavior and individual personality traits (Lee & Dalal, 2016). It is imperative to understand how personality traits become motivational and lead to individual and group behavior. Lee and Dalal postulates that for a condition where the widespread belief among workers was that the management is more focused on production than on employee safety, safety behavior will almost uniformly be unacceptably low. That condition, for example, will remove the likelihood of employee conscientiousness affecting safety outcomes or behavior. If, for example, the reverse is true and management show definite signs of treating with safety as necessary as other organizational outcomes, conscientious and other workers will operate safely; if only because of management attention. In both scenarios, safety climate attenuate personality trait and its influence on behavior. It is unclear whether this result will hold if the study is repeated to reflect supervisor to worker interactions and relationships and how that impact on worker safety behavior. Lee and Dalal (2016) indicate that strong organizational safety climate can be used to maintain compliant employee safe behavior.

Griffin and Curcuruto (2016) indicate that in testing a multi-dimensional safety climate model to determine safety outcomes, management values, safety communication, and safety training are necessary to operate safety systems for optimal safe work performance. Management values are indicative of the importance of safety in the workplace. There is a preference for open exchange safety communication arrangements. Safety training is necessary, expected, relevant, and adaptive to meet the working needs of employees and in the conditions that they operate.

**Safety climate.** Griffin and Curcuruto (2016) describe safety climate as an organizational phenomenon that comprise of perceptual, collective and multidimensional influences that impact individual and group behavior. The influence is a subjective-normative sense-making one superimposed on individual differences, level of understanding, appreciation, feelings as well as group dynamics. Work team members share similar perceptions concerning safety in the workplace. Murata (2017) indicates that safety behavior commensurate with performance and safety outcomes. It, therefore, means that if Murata is correct, that the organizational safety climate is a critical catalyst to organizational success, safety in the workplace, and productivity. The idea of enhanced productivity in an excellent safety climate is not one that was universally accepted; productivity is negatively affected by enhanced safety arrangements is popular. Lee and Dalal (2016) posited that organizational climate, meaning safety climate, is a situational factor in organizational performance. This Lee and Dalal posit aligned with Griffin and Curcuruto (2016) in the thinking that safety climate can impact on organizational performance in a bi-directional manner. Lee and Dalal (2016) further suggest that safety climate influence individual consciousness and moderate safety behavior of individuals in a positive safety climate.  Lee and Dalal accept that in organizations where work is usually in hazardous conditions, there is an interest in employee safe-behavior.

**Measuring safety climate and new norms.** Zohar (2014) highlights two ways to measure safety climate.  One approach is general, and for use, in different organizational contexts.  It involves the development of general safety climate considerations.  The next approach is organization-specific and make it possible to examine safety climate history and concerns across diverse settings.  Zohar (2014) indicates that industry-specific management practices, structures, operational arrangements, and business make the safety climate significantly unique.  There exists cultural differences occurring from country to country as well as in diverse workplaces.  Differences influence personal perception and perception of risk can change despite the recognition of hazards.  Zohar (2014) notes that there is limited research information on how diversity could impact safety in high-risk environments.

Organizations conduct business with foreign organizations in areas of specialized technologies which impact safety at work primarily in the cases where energy sources exist.  It is essential that safety management commitment, safety-specific arrangements, and safeguards are in place to prevent accidents and injuries to personnel.  Different social and cultural orientation can have significant implications for the understanding of and compliance with safety procedures, safety training, risk mitigation strategies, and safety behaviors as these can vary in diverse settings or across national contexts (Reader, Noort, Shorrock, & Kirwan, 2015).  Some national cultural traits promote the highlighting of mistakes and providing feedback. In this environment, supporting others at critical times can be misinterpreted by individuals from other cultural backgrounds.  Reader et al. (2015) examined the aviation industry safety culture in diverse cultures and environments by employing multigroup analysis. Reader et al. (2015) found that specific industry safety culture can successfully support different workgroups in different countries. Reader et al. (2015) also found that cultural traits from different nations can influence organizational safety culture even if the organization is multi-national.

**Workplace bullying.** Rockett, Fan, Dwyer, and Foy (2017) describe bullying as composing of three different elements. These are repeated incidents that involve the same individuals; the episodes occur over long periods that extend into months, and where there exist a power imbalance between the individuals involved. The implication is that the individual with significant power is the person with authority to instruct and to direct the other individual who had less or no workplace authority. Salin (2015) indicates that the victims of bullying in the workplace are more prone to be less committed and to experience lowered productivity levels and outcomes. Paludi (2015) identifies that supervisors and managers are three times more likely to instigate workplace bullying of individual workers than their coworkers. It implies that coworkers are the catalysts for workplace bullying episodes in one out of every four situations where this occurred (Paludi, 2015). The effect of bullying on individuals who witness incidents against other workers is also a significant problem (Hansen, Hogh, Garde, & Persson, 2014). O'Donnell and MacIntosh (2016) examined workplace bullying, how organizational culture promote it and the resultant behavioral challenges among the workforce and actual work outcomes.

**Safety bullies.** Geller (2014) describe safety bullies as individuals who only search for employee behavior issues and unsafe acts in accident investigations. Geller further indicates that safety bullying inhibits worker engagement and negates the best opportunities for injury prevention. Geller (2014) notes that placing blame on worker behavior which contribute towards and result in injuries, deaths, and equipment damage remove focus on supervisors and management: In fact, workers behave in ways that reflect the work culture of the organization, the system as well as societal, individual, environmental, and engineering or technological factors. Manuele (2014) added that if individuals and teams performing accident investigations and safety practitioners within the organizations are not up-to-date on the current philosophy regarding the systemic approach to investigations, these individuals are unfit to perform such. Manuele suggests that these individuals are not allowing for the best opportunities to prevent similar future accidents. Manuele further indicates that errors committed at the management level present particularly tricky challenges for safety professionals within the organization. Manuele (2014) describes different instances when accidents are likely to occur. These include situations where work activities are non-routine or unusual and if the operation is not job-related. Workplace accidents are frequent when significant modifications are necessary or if critical units or systems are being shut down or re-started after work activities. Manuele also suggests that when doing work in hazardous conditions or when energy sources are present, accidents can occur. One critical type of accident situation involve work arrangements where a routine change occur. This change, considered as an upset or a work arrangement, move from a regular and normal state to an abnormal state that workers are unaccustomed. The process of change present a significant challenge to workers experiencing the situation (Manuele, 2014).

**Insomnia.** Insomnia is a public health problem described as a condition whereby the individual has difficulty in falling asleep or staying asleep for a long enough time. It is widespread and considered as a causal factor for worker injuries (National Institutes of Health, 2014). Symptoms ranged from or included a struggle to fall asleep, frequent waking up during the night, waking earlier than expected and not falling asleep again, and waking up without feeling refreshed (National Sleep Foundation, 2014). Individuals afflicted with sleep problems are almost two times more likely to be injured at work than for employees who are not affected; this is an increasingly significant workplace safety and worker injury risk factor (Uehli et al., 2014). Kao, Spitzmueller, Cigularov, and Wu (2016) accept that insomnia is common among workers and that it can be a causal factor in workplace injuries. Cigularov and Wu attempted to explain how and why that was happening.

**Other contributing factors.** Mathieu et al. (2014) found that job satisfaction convolute on other real but almost invisible factors. These are the number of hours worked, work-family conflicts, psychological distress, and interpersonal influence from leadership to colleagues. Mathieu et al. (2014) agree that organizational induced psychological distress can be toxic, disruptive, abusive, tyrannical, but at the same time did not find that this resulted in lower levels of organizational commitment and job satisfaction.

Work-family conflict was a more significant influence on job satisfaction while leader-worker and worker-colleagues relationship influence individual attitudes and behavior at work and organizational commitment. Long work hours lead to work-family conflicts. Organizational culture impact leader-individual and individual-colleagues interpersonal influence and relationships.

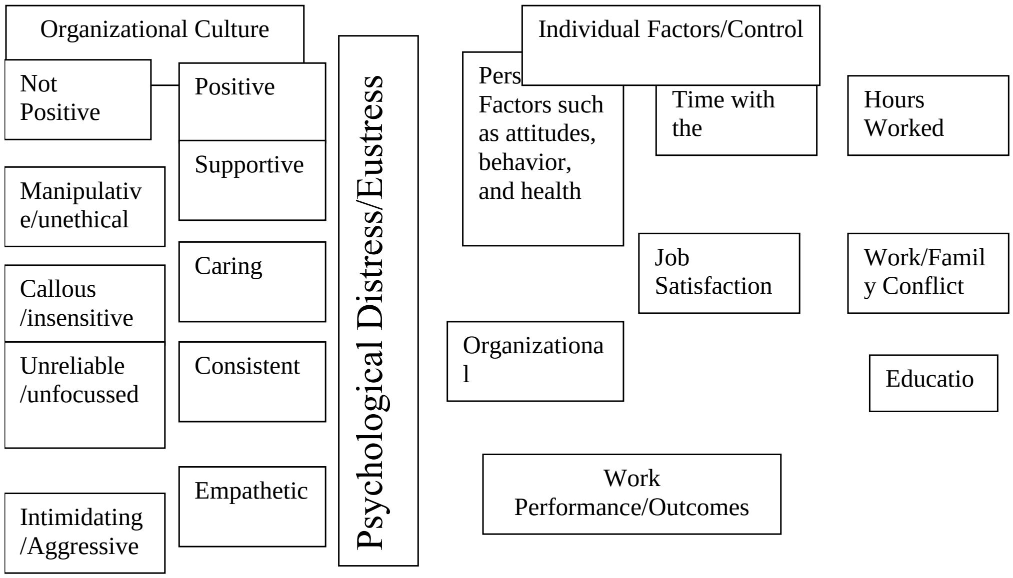


*Figure 8:* Factors that influence the level of job satisfaction and organizational commitment. Adapted from Mathieu et al. (2014)

**Major accidents and lessons to learn.** Accidents like the Piper Alpha, Bhopal, Dryden, and Tenerife disasters are chosen in this review not to exaggerate the message but because of the real opportunities that exist to learn from them and for these lessons to be applied for the prevention of other and future accidents, worker deaths, and injuries (Kletz, 2007; Labib, 2015; Mac Sheoin, 2015; NASA, 2013).

**Dryden.** On March 10, 1989, 24 persons died when a commercial airliner crashed on takeoff at Dryden Airport in Canada. The victims were 21 passengers and three flight staff including the pilot, co-pilot, and a flight attendant. The crash investigation involved a comprehensive review of the Canadian aviation system and how that impacted and contributed to the actual accident and the events on that day. Transcripts from interviews from 166 witnesses totaled more than 34 000 pages. Other documentary exhibits and evidence reviewed in this investigation amounted to more than 177 000 pages (Moshansky, 1992).

**Piper alpha.** Nearly one year before, July 06, 1988, on an oil rig in the North Sea, 167 workers were killed when an explosion and chain reaction occurred on the night shift and which also destroyed the oil rig. That was the deadliest oil industry off-shore disaster. The findings from this accident investigation have been widely reviewed and found applicable even beyond the oil industry (NASA, 2013).

Dechy et al. (2012) suggest that there are repeated accidents and that lessons from none of these accidents are being learned and applied to other instances to prevent other accidents. Singh et al. (2010) examined the piper alpha accident from a new paradigm; a safe design concept and second-tier interest into corrosion and other technical problems that were not adequately addressed and remain valid.

**Piper alpha, challenger & cherynobyl.** Singh et al. (2010) compared the Piper Alpha accident with other major engineering disasters including the Challenger, Chernobyl, and Three Mile Island. Dechy et al. (2012) conducted a similar assessment of previous accidents involving the NASA space shuttles, Columbia and Challenger, and believed that possible lessons could come from these accidents. According to Singh et al. the Lord Cullen findings from the Piper Alpha resonate in the other widely known accident events; this is in spite of the difficulty that encompass the specific knowledge, safety management arrangements, and industry-specific terminology and practices that influence particular safety-related attitudes and behavior. That did not lessen the impact of industry or organization specific factors which impact workplace accidents. It more alludes to lessons learned from workplace accidents being used to make other workplaces safe and for the prevention of future similar events. Singh et al. (2010) points to the damning reasons for the piper alpha, from the Lord Cullen Report, which are fundamental and can factor in other organizations, industries and countries where major and epic accidents occur. These include plant design, a factor that is also identified by Dechy et al. (2012) and Wahlström and Rollenhagen (2014). Breakdown of work systems, also identified by Moshansky (1992), less than adequate management control (described in similar frames by Dechy et al. (2012), Wahlström and Rollenhagen (2014) and Moshansky (1992) are also listed. Poor or less than adequate communications, emergency management, regulatory control, legislative relevance, management fail-safe systems, training (content and arrangements), and attitudes and behavior are shared findings from these accidents. Swuste, Groeneweg, Van Gulijk, Zwaard, and Lemkowitz (2017) stress that human errors are still the dominant focus for investigators of workplace accidents and that this prevent the more in-depth assessment and identification of other dynamic and socio-technical factors that are more relevant and impacting. Swuste et al. suggests that suboptimal system(s) are more likely to result in workplace accidents than any induvial at fault. To improve knowledge about workplace accidents, promote management initiatives, and lessen the likelihood of future problems, a database of relevant information on near-misses, incidents, accidents, disasters can be developed and made available for use by organizations. Regardless of the industrial sector or geographical location where operations exist (Dechy et al., 2012).

**Deepwater horizon and common accident problems.** In a separate but similar paper on the Deepwater asset integrity, Singh et al. (2010) focused on the likelihood of no single cause of the accident and that it was more a confluence of several critical factors that evolving into a *perfect storm* (p. 84); and made, comparisons with the Swiss Cheese accident causation model, first proffered by Reason (1997). Wahlström and Rollenhagen (2014) investigated different management systems and models for safety management recognizing that risks exist from old as well as new and contemporary technical systems. Wahlström and Rollenhagen recounted lessons from previous large industrial accidents including nuclear power stations, chemical facilities, and offshore oil facilities and summarized investigative focus on technological issues, human factors, and safety culture. It is a clear indication in favor of a holistic review of accidents rather than a focus on the events that surround any one specific accident event. Moshansky (1992) scrutinized the relationship that Transport Canada, Air Ontario and its partner organizations, as well as the aircraft handling and management at the Dryden Airport to identify failings and safety-related problems in Air Ontario, the aviation industry and the industry regulator Transport Canada. These, according to Moshansky, were the profound and latent shortcomings that impacted the events of March 10, 1989.

**Bhopal, fukushima & deepwater.** Labib (2015) describes how accidents like Bhopal in December 1984 share similar contributing factors to the Fukushima, and Deepwater Horizon industrial accidents; all labeled as human-induced and which did not have to happen. Labib further propose a hybrid reliability technique and fault analysis for the evaluation of the causal factors of these events and to inform on how to prevent similar disasters. Labib (2015) compared the Bhopal and Fukushima disasters, even though one was a chemical disaster not a naturally occurring event; the March 11, 2011, 9.0 earthquake off Japan that led to the Fukushima nuclear power disaster. Labib found similar areas where factors contributed to these disasters. These similarities represent areas where learning opportunities exist. Labib (2015) suggested the *un-learning* opportunities also exist; a pointed reference to what should change. Labib attributed un-learning opportunities to the steadfast lock on organizations struggling to derive maximum profit margins and to sub-optimal and compromised arrangements for safety. That lock is highlighted by leaders of these organizations initially not admitting to the extent of the disaster and a delayed response that could have exacerbated the problem and caused further loss of lives in communities and damage to the environment that surrounded these industrial plants. Labib's view is that pre-empting industrial disasters is a socio-technical problem that require the involvement of policymakers, social and natural.

Bhopal 1984 is a multiplicity of the simultaneous breakdown of safety barriers and compounded on the associated dangers not being fully known or appreciated by the victims of the disaster. This situation was a convolution of regulatory, organizational, operational, and management issues that were compounded by individual errors on December 02, 1984 (Labib, 2015; Mac Sheoin, 2015).

**Electric power industry disaster.** The effects of failure in the electric power industry are similar to that in aviation. In 2003, for example, an electricity blackout in the northeast United States and Canada resulted from the failure of critical components in the Cleveland-Akron area in the United States. The consequences of an un-cleared tree from a power line resulted in a cascading series of events that left approximately 50 million customers without power for, in some cases, up to two days (Abraham et al., 2004). In aviation, hundreds of deaths can occur in a single aircraft accident. In both the aviation and the electric power industries, there are complex systems and high demand for customer satisfaction. These compound and evolve in ways that are difficult to predict, mainly when there can be other situational factors that co-mingle with other existing challenges and which developed into unmanageable situations. Technical and human errors in these low probability but high consequence situations can compound and grow into problems that are not simple to address or easy to predict (Atak & Kingma, 2011; Abraham et al., 2004; Moshansky, 1992). Organizational success and corporate image are critical for survival, as such; there are almost constant tension and demand for system reliability, availability, and production levels to satisfy customer demands.

Additionally, the public need safe organizations where high-quality products matched an equally high level of safe operations are the paradoxical reality (Labib, 2015; Murata, 2017). Objectively, it is challenging to exercise safety margins without impacting on an organizations production targets and customer demands. The converse is also valid. It is equally challenging to sacrifice safety and simultaneously to maintain customer satisfaction; Moshansky (1992) describes this dilemma during the Dryden investigation. The result is entirely dependent on the organizational values, human resource strengths, its safety arrangements, the technologies adopted by these entities, and the prevailing business climate (Atak & Kingma, 2011).

Further, the sequence of events and connectivity between the point where significant problems initiated and the time when the accident event occurred can prove extremely challenging to identify and to manage in a fail-safe and high-reliability work setting. That is primarily pertinent since a single human, or mechanical failure will usually not result in a catastrophic event, except for the very last occurrence (Abraham et al., 2004; Labib, 2015; Manuele, 2014). The Challenger disaster (Price & Williams, 2018; Vaughan, 1997), the Chernobyl nuclear disaster (Reason, 2000), and the Piper Alpha disaster (Labib, 2015; Mac Sheoin, 2015) all mirror the chain of events where the real influence for the accident began elsewhere and before the actual event. These all support the focussed change from individual-level factors to organization-level factors as the core reasons for accidents (Labib, 2015; Manuele, 2014; Moshansky, 1992; Murata; 2017; Price & Williams, 2018; Vaughn, 1997).

**Electric power accident.** Felmine (2012) describe an accident involving the electrocution of a lineman which occurred while the individual was conducting hotline work on an energized 12000 volts power line. That is a specialist type of lines work which require that the lineman is specially trained to work on energized power lines. Work on energized power lines required specific work arrangements and special permits for work to be done. It is not the same as work conducted on lines which were de-energized, isolated, and grounded before workers could perform work. In this accident, the investigating team found that the victim was an appropriately trained worker. All other individuals on the job site when the accident occurred were also appropriately trained. The technique adopted for the work on that day was one of the approved methods for the job. The victim was, from workplace records of training and experience, deemed as competent. Acceptable and appropriate permit to work and conditions were correctly applied. The worker, despite all of the pre-arrangements, received electrical shocks and died. The investigators were unable to determine a direct cause of the accident except that better onsite supervision might have averted the workplace accident. The underlying reason for this accident was that hotline work rules were being reviewed and was not completed even after lengthy deliberation by another working team tasked with the review and development of the rules. The Tucker et al., (2016) description of leaders influencing workers safety performance through a layered arrangement whereby safety support through managers and supervisors is apt. Work rules development is an organizational responsibility. Managers set the climate where the setting of rules happened and work procedures set. The absence of appropriate work rules is a negative reflection on management commitment to safety (Conchie et al., 2013; Probst, 2015). Onsite supervision is the last barrier that can be installed between workers and accidents or near misses; there is no other defense if onsite supervision control is less than adequate (Capelli-Schellpfeffer et al., 1999; Labib, 2015; Murata, 2018; Price & Williams, 2018).

## Gaps in Current Literature

### Training

Training cover a multi-level dynamic and workplace need which span from personal and professional development, workplace safety, technical skills, and technology, to emerging policy issues (Cascio, 2017). Cascio focuses on micro and macro details and policy issues and how that impact effective-learning for superior work outcomes. A better understanding of and quality of training sessions, the use of digital tools and lessons, the optimizing of knowledge for skills development, and a continuous reflection of training content are significant training advantages. Cascio (2017) also focused on ways to maintain trainee skills after individuals are certified as trained.

Business today require organizations to support new technologies and arrangements that were not possible before. In the electric power industry, technology-induced a similar change and caused new demands for worker skills that were previously not required. Devices with communication capabilities are now standard in the 2000s just as poles, transformers, and overhead power lines were since the beginning of the 1900s. Electric power industry workers must now possess training and proven skilled at the traditional requirements as well as to safely and efficiently operate in a new environment where automatic and remote-operated devices are common-place, and electrical sources are more distributed than ever. Remote and automated operability of the power grid is crucially necessary because of the newer and more sophisticated devices that make customer demands stricter than in previous times (Cascio, 2017). Customers interact with electrical company operators via mobile devices and systems. They even proactively request service on electric grid components and systems that employees can be actively engaged in work activities. That can either mean that the worker skills must be such that work is possible on energized systems for the duration of the exercise and where customers do not experience power outages.

On the other hand, remote operated devices can allow for the minimization of the number of customers who may be affected if work is on systems that were de-energized and isolated from the remainder of the power grid. In each case, the worker skills, training, knowledge, and experience are critical and combined with the number and mix of employees to ensure that the work activity is safely negotiated (Manuele, 2014). The technical skills necessary for work on de-energized electrical power systems is paramount and to a significant extent, a precursor on the skills essential for work on live systems (Fordyce et al., 2007; Volberg et al., 2017). Training is a significant element available to organizations in the current work environment for the best-suited employees to remain fully cognizant and capable of the existing demands (Friedman, 2016). Qi and Tapio (2018) further indicate that keeping skilled workers, especially in areas where significant shortages exist, is vital in preventing situations where the shortfall could result in unsafe working conditions and contribute to worker injuries and deaths and for organizations to remain competitive. That challenge extends to promotion policies, review of employee performance, and worker recognition arrangements. Abadzi (2016) blends technical skills training with personal development, responsible behavior, critical thinking, with worker ability to take initiatives, to be flexible and to support collaborative efforts. Abadzi deems these as necessary for workers to cope with workplace stress and customer demands.

**Industry to industry – learning from experiences.** NASA (2013) considered how relevant the Piper Alpha Accident was to NASA as an organization. Organizational secrecy was evident after the NASA Apollo 1 fire. It is a structural shortcoming of the organization that prevented the transfer of critical information for decision making. The non-transferral of crucial details lead to safety problems that are not adequately understood and addressed. Production activities overshadow safety concerns and directly impact deliberations which occurred ahead of the 1986 Challenger disaster. NASA leadership preferred to focus on reliability engineering over safety concerns; paralleled in the Piper Alpha disaster (NASA, 2013). Both the Piper Alpha and NASA were organizations where a risk-informed approach and methodology guided safety response. The emphasis rested on thinking that systems were safe and that hazards that could compromise reliability would improve safety, once abated: A belief was that reliable operations would guarantee and maintain operating safety (NASA, 2013). It is a significant miscalculation that support production in favor of safety margins. That will require a more conservative approach to projects and operations as the premise is unproven. The Piper Alpha disaster remain the beacon example of production overriding safety arrangements with the worst possible consequence (NASA, 2013). The 1984 Bhopal experience concerning production is similar but was different in design. The Bhopal design is a lingering question that is still unanswered as other plants installed in the United States at that time were considered as superior designed (Mac Sheoin, 2015).

Labib (2015) indicates that there are similarities between Bhopal and Fukushima Daiichi, in 2011, just as NASA (2013) found between Piper Alpha and NASA. The Fukushima Daiichi, in Japan, and the Bhopal, in India, were organizations where reliability outdid safety (Labib, 2015). That is a standard feature of organizations in the oil and gas industry, just as those in power, nuclear, aviation, and other industrial sectors where workers are accustomed to hazardous working and ecological environments (Labib, 2015). Labib went further to suggest that, after Bhopal, and despite new legislation in different countries worldwide, old habits were seemingly impossible to break. Labib described a form of organizational loss of memory; this had significant possibilities for repeat disasters unless an un-learning occur. Labib also highlighted the insufficient and under-par handling of safety warnings, listed as accident warnings. Labib stressed that training, improved communication and appropriate handling of issues surrounding hazards are crucial to keeping organizations safe.

**Society, legal hurdles, and geography.** Mac Sheoin (2015) laments the lack of action on the part of the Indian regulators and the organization responsible for operating the Bhopal chemical plant to treat with the surviving victims and the families of persons who died in this catastrophe. Mac Sheoin, further suggests that this response exposed the significant shortcomings of the safety management systems employed at the Bhopal chemical plant. The corporate and regulatory deficiencies only amplified their failure regarding appropriate compensation for the survivors and to bring relevant regulatory restrictions on the responsible parties effectively. Singh et al. (2010) indicates that the Piper Alpha accident amounted to $3.4B(US), with no criminal charges initiated against anyone and legal proceedings taken against the company. That Piper Alpha experience is in stark contrast to the Bhopal case as more than

20 years elapsed before the courts in India delivered a definitive judgment. By that time twelve persons from the company were committed to serving time in prison. The majority of the persons found guilty were either not alive or outside of India at the time of the judgment. In 2007, Moshansky suggested that judicial, administrative roles in Canada for safety in aviation were to guide on unresolved issues such as oversight, confidential and secrecy issues, and accident causality Lecture (2007). Moshansky reviewed the aviation system as it was before the accident, the unique challenges, and the direct actions that impacted on March 10, 1989. He found that the Canadian legislative and regulatory arrangements were deficient and needed revamping (Moshansky, 1992; Lecture, 2007). In the Bhopal case, Mac Sheoin (2015) found that there is a deliberate reluctance by legislators and regulators to initiate acceptable and responsible actions. Moshansky recommended a permanent judicial role in accident investigations (Lecture, 2007). Moshansky also recommended a judicial-role in safety management in aviation.

**Legislation, enforcement, triangle, and cocoanut.** Robinson and Robinson (2016) describes how the emergency exit at a shirt-making company in New York in 1911, locked from the outside, to prevent workers from stealing cloth and other textile material resulted in one of the worst fires in history: A locked exit that prevent workers from escaping. As a result, 146 workers died. Robinson and Robinson (2016) recounted the 1942 Cocoanut Grove fire where 492 military and civilian personnel died because of locked emergency exits. Robinson and Robinson (2016) notes that building safety is problematic and very difficult to fix. There are different U. S, building codes models, for organizations and other workplaces. These are industry-specific and not uniform across regions, industries, or on design criteria for fire prevention and safety. Lee and Dalal (2016) considers the possibility of hiring individuals with a preference and biased disposition for safety consciousness and believe that this might encourage safety behavior and enhance organizational safety climate. Lee and Dalal (2016) further indicate that corporate control, practices, and regulatory arrangements are greater influences than individual safety consciousness and behavior. Therefore, safety outcomes are a function of organizational work arrangements more than employee influence.

Lee and Dalal (2016) did not rule out the impact of employees on safety outcomes altogether. They examined individual behavior and explored how these affect safety outcomes in cases where these individuals work and apply a measure of control. An individual's safety behavior, actions, and approach to workplace safety supports compliance with safety procedures set by managers and organizational leaders. Lee and Dalal (2016) further separate this behavior into task-related and context and explain how they impact on the maintenance of workplace safety requirements set by the organization. Contextual safety is a safety helping attitude where the individual advise others on safety requirements and help by accepting safety responsibilities. Safety behavior, however, is built upon the individual's trait of conscientiousness towards safety performance and the safety climate in the organization. Lee and Dalal (2016) examined how these two influences interact and describe the result of that interaction. Conscientiousness was a safety goal and behavior (Lee & Dalal, 2016). This safety behavior was described further as inclusive for the individual following rules and safety requirements. It encourages thinking before acting and differing gratification before safely completing an exercise. Conscientiousness, emotional stability, openness to experience, agreeableness, and extraversion are the big-five personality traits that support safety in the workplace.

Lee and Dalal (2016) examined previous research and believe that conscientiousness is the most potent when compared to the other traits; it is socially acceptable and allow the individual to remain focused on safety goals: conscientious employees are generally more careful about how they perform work and exercise self-control when compared to individuals who are not as meticulous. A positive indicator of organizational safety climate is vital since a strong climate perspective is a consensus which indicates that the organization is safe and that workers may remain unharmed. Lee and Dalal (2016) questioned about situations where a good safety climate exist, but individuals experience bias difference; They describe that as variation in the psychological environment. This mental variation premise on the thinking that individuals who experience a similar stimulus should react or generally respond in the same manner. This variation obviously depend on the stimulus. If there are a fire in a place where individuals are, then evacuation would likely be their general response. It will be strange for someone, in that setting, to remain in the location until instructed to evacuate, for example. Lee and Dalal (2016) describe the act of staying in danger as a psychological variation and further indicate that when groups of individuals worked together for lengthy periods, psychological variation tended to diminish. Group dynamics involve not only similar influences but typical behavior. It meant that not all everyday actions of a group are due to internal group dynamics and controls but due to natural and social behavior where the responses result from automatic triggers induced by the situation or condition (Lee & Dalal, 2016).

**Near-misses and opportunities.** Capelli-Schellpfeffer, Floyd, Eastwood, and Liggett (1999) indicated that the benefits of a trustworthy and very comprehensive database on electrical safety errors, near misses, and accidents is crucial to the effectiveness of organizational decisions on the choice of equipment, system design, workplace training, and improved work procedures and practices. Capelli-Schellpfeffer et al. recognized that investigation into near-misses are opportunities to understand why problems occur. These opportunities are the prelude to preventing accidents where workers become injured. Capelli-Schellpfeffer et al. believed that the findings from investigations into and analysis of accidents and near misses show that workplace accidents and near misses impact on business operation, individual behavior, and regulatory arrangements and oversight. The quality of findings from workplace accidents investigations is dependent on the available data and the analysis conducted by the investigators (Capelli-Schellpfeffer et al., 1999). Safety problems and accidents can occur if the introduction of electrical hazards occur in the engineering design, procurement, installation or operating and not recognized for the employment of appropriate protective measures to mitigate the dangers (Capelli-Schellpfeffer et al., 1999).

**Beliefs and attitudes.** Capelli-Schellpfeffer et al. posited that incorrect worker beliefs and poor attitudes emanate from poorly conducted accident investigations which compound situations where hazards are unnoticed and unidentified; and can contribute to future accidents. The information derived from an accident investigation and the analysis can encourage the continuance of worker held beliefs and the support of bad attitudes. The reverse is also valid as a well-done investigation can be used to improve worker attitudes and for correctly referencing understanding and beliefs among workers. Capelli-Schellpfeffer et al. further suggest that workers' decisions can be deemed as unsafe when these may be influenced by perceptions and opinions which are linked to poorly done investigations of previous workplace accidents; directly due to the poor-quality data sourced in the inquiry. That logic extends to the possible advantages derived from a repository of information from previous accidents and investigations.

**Optimal learning.** Optimal Learning, from accident experiences, impact profoundly on the likelihood of event recurrence and injury to workers. Knowledge come from improved standards and regulations resulting from identified shortcomings, renewed training for individuals involved and others who conduct similar job functions, as well as for all other organizational personnel responsible for the design and procurement of related systems and equipment. The most important learning would probably be with workers as an opportunity to reflect on what went wrong and what could have contributed to that event; individual behavior, attitudes, overwork, and any other human factor that could have contributed to the accident. Near misses, according to early accident causation models that support Heinrich's theory, are at least 10-fold more common than accidents where the victims are injured. Capelli-Schellpfeffer et al. (1999) believe that the frequency of near misses over actual events where individuals are injured and that near misses are due to the same weaknesses that contribute to accidents, except that there are no wounded human victims. The opportunities to learn from near misses is premium in preventing worker injuries and fatalities.

## Safety Culture and Workplace Accidents

Capelli-Schellpfeffer et al. (1999) describe the undesirable chain of events that lead to near misses and accidents as people factors that are explained by behavior and human-equipment interface challenges; which are evident at the level of organizational culture, structure, work design, safety management, system operations, training and maintenance functions (p.2). Figure

9 is a replica of how Capelli-Schellpfeffer et al. explained how organizational culture contributed to accidents and near misses.

That thinking extends to the possibility of improving organizational culture as a latent contributor to the prevention of near misses and accidents.  Probst (2015) believes that safe work arrangements and accident prevention are linked to actions by organizational managers and supervisors to encourage the reporting of accidents and near misses.  Tucker et al. (2016) posited that organizational leaders set the safety agenda from top management level and can influence, through managers and supervisors, the frontline workers to adopt a safe approach to conducting work.

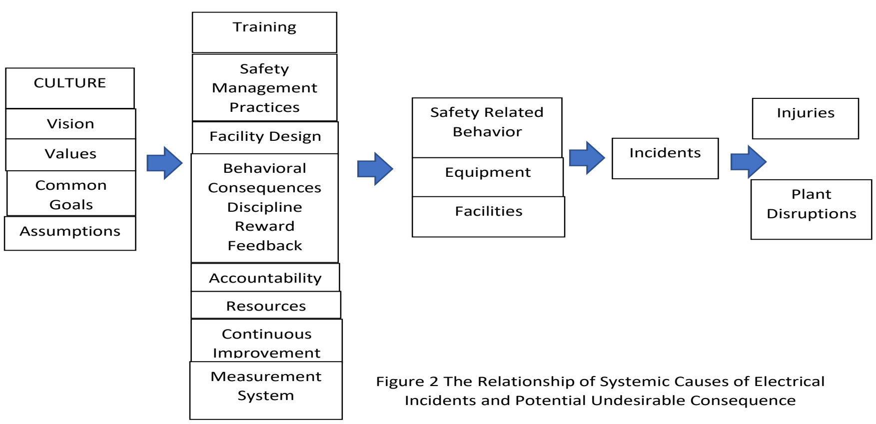


Figure 2 The Relationship of Systemic Causes of Electrical Incidents and Potential Undesirable Consequence

Reproduced from p.2 of Capelli-Schellpfeffer et al. (1999)

*Figure 9*:  How we can better learn from electrical accidents. Adapted from M. Capelli-Schellpfeffer, H. L. Floyd, K. Eastwood, & D. P. Liggett (1999).  Reprinted with permission.

In 2006, there was an explosion and fire at an electric power station in which two employees died (Mohammed, 2006).  This accident occurred when the workers were conducting maintenance work.  The investigation into this accident was done by a team which comprised experts, a representative from the workplace safety regulator, worker union representatives, as well as management from two companies; the company that the victims worked for, and the electric utility company that managed the electrical power system. This investigation occurred over one month, and the team interviewed more than 18 witnesses including the lone survivor of the explosion. Five of the individuals were re-interviewed as the investigation ensued. The approach adopted in this investigation included:

> An inspection of the physical evidence retrieved from the accident site;
>
> A review of the electrical switchgear and its operating design parameters, using schematic diagrams and manufacturer's information;
>
> A review of the relevant high voltage electric system configuration;
>
> A review of all relevant documents;
>
> Conducting interviews with all appropriate personnel;
>
> A review of the autopsy report of each of the deceased employees;
>
> Analysis of the electrical system protection scheme and all associated equipment;
>
> The co-opting expertise or resources that the investigating team deemed necessary;
>
> A gathering of photographs of all work permits, relevant to the job and other associated plant and for instances where similar work activities were involved, for review, comparison, and analysis;
>
> An examination of the original equipment manufacturer's manual for the failed apparatus for specific information on the operating conditions necessary for activities of the type conducted when the explosion occurred;
>
> A review of employee training records and certification for confirmation that the individuals satisfied regulatory and company requirements for the work activity;
>
> A review of the company's maintenance management system requirement for this work activity. Performing a similar review and examination of other maintenance work orders for similar past maintenance on this equipment and other similar units;

A review and analysis of audio recordings of all communication between the electric utility company and the power company where the accident occurred for specific details of the process adopted in making the equipment safe for work were analyzed;

Reviewing all test results sanctioned by the investigating team after the explosion.

Among the interviewees were the power plant manager, senior managers and supervisors at the power plant, the work planner, the individual who made the equipment safe for work, and the individual who received the permit to work. Also interviewed were the electric utility representatives who managed the equipment safe isolation process. Of particular importance was the permit to work, the procedures for issuing the permit to work, the communication at different stages and times when planning the work and when it was being made ready for workers on the day. A comprehensive review of the previous history of work arrangements and how these impacted, particularly those that required the electric utility involvement, the individuals who planned the activity and those who worked on the day of the accident. Capelli-Schellpfeffer et al. (1999) describe how full understanding of the circumstances and contributing factors can result in accidents long before the final error event.

The main conclusions from this investigation are that there were immediate and underlying causal factors that contributed to the explosion which resulted in two deaths. The direct factors involved the inserting of a metallic component inside an oil-filled compartment with energized conductors, and; where the permit to work issued for this job did not cover the work done. The underlying causal factors were inter-departmental communication especially on daily job assignments and supervision, work planning, scheduling, flow, permit to work management, job safety briefings, and auditing of work processes and systems. These causal factors are the underlying issues that went unnoticed and unaddressed and eventually became deviance that skewed the standard work requirements to a new norm (Price & Williams, 2018; Vaughn 1997). Capelli-Schellpfeffer et al. (1999) allude to this as a behavioral pattern resulting from the culture of the organization.

**Difficulties experienced with permit to work systems.** One way of making work safe is the employment of a permit to work system. It represents a systemic approach; adopting organization approved procedures, to make equipment or apparatus safe for workers to perform their repair activities and scheduled overhauls. It involves isolating the device or work-equipment from hazardous energy sources, described the safety measures and precautions adopted for the exercise, and the responsible person who ensured that the energy sources were locked off and tagged. The process of issuing the permit was usually clearly itemized and documented in organization-approved procedures; so too the permit cancellation process. Many times, permit to work issues arise when investigating accidents; the 1988 Piper Alpha explosion is an excellent example of what happened in breached permit-to-work systems and procedures (Dekker, 2006; NASA, 2013). To get a proper understanding of why workplace accidents happened, investigators approach these challenges primarily in two ways. The first way, which is born from the conventional safety management Heinrich-like thinking, was that the causes would reside in the last moments and how those activities and the individuals contributed to the event. These constitute the direct causes of the accident as the actual breach that resulted in the failure event. The Swiss Cheese model indicated that the immediate causes of accidents were just as significant a problem as the more profound underlying causal factors which reside at levels where supervisors, managers, and the management would control (Kletz, 2007; Labib 2015; Reason, 1997).

Kletz (2007) focused on the prevention of and the causes of accidents, not human interest or superficial cleaning-up afterward.  The repeat of accidents occurred because of and due to insufficient knowledge; not because there was no desire to prevent injuries or death.  Human error could be due to a momentary episode of forgetfulness or overconfidence.  If that weren't so then, it would likely not be an error, but a deliberate act and injury would not have occurred as a result of an accident but from a deliberate act of unsafe behavior.  The problem was, many times, the victim, injured or killed, were usually the party found to have committed the error especially when only direct causes of accidents factored.  Victims of workplace accidents typically raised issues of design and operating methods which were answers to questions about what should be done differently rather than pinpointing who did what or what caused the problem Kletz (2007).

**Deviance and normalization challenge.** Vaughan (1997) believe that technological failure is not the underlying reason why the NASA space shuttle Challenger exploded on takeoff on January 28, 1986.  The brittle O-rings, pinpointed as the component that failed, led to the explosion of the spacecraft.  Vaughan felt that NASA, the organization through the leaders of the 1986 launch, knew about the likelihood of failure and decided it was not sufficient to stall or to prevent for the expedition and many other previous expeditions.  Vaughan (1997) indicates that the earliest record of possible danger regarding the O-rings was dated back to 1977 and that its use on space missions commenced in 1981.  Vaughan (1997) coined a now familiar and common term *Normalization of Deviance* about the production of the O-rings and also in the performance after that (p. 78).  These are referenced to work groups that normalize the statistical deviation in accepting components, technical difference while forging a culture creation process through group interaction.  At the same time, Vaughan (1997) notes that once formed, this new culture of deviance is challenging to stop and it affects later group decisions and processes. Price and Williams (2018) support Vaughan's view that the repeated decision by NASA officials to sanction shuttle flights was the potential latent cause that resulted in the Challenger disaster; because of the overwhelming evidence that the O-rings were brittle and unsuitable. Price and Williams (2018) also support Vaughan's idea of normalization of deviance and suggested that this involve feelings among persons in organizations where the impression of wrong is not as clear. Price and Williams felt that this is an insensitivity that develops over time, even in years, and with repeated situations where the worst consequence is unrealized. Price and Williams (2018) also felt that the critical factor that align with major accidents and disaster event can anchor in activities that are mutually exclusive and time-spaced in years. As an example, an equipment design could result in accident years afterward and under circumstances and conditions not anticipated when the model is accepted. Working conditions in which warning and alarm systems become decommissioned, breached or removed from service and not envisaged when the plant, equipment, and work procedures are developed, tested, and accepted, contribute to dangerous conditions ripe for accidents to occur. Price and Williams (2018) focussed on the health-care and medical profession and suggest that the Swiss Cheese model was ideal for showing the effects of failure leading to death and injury; especially when normalization of deviance occurs. Clinical procedures, procedural breaches, and less than adequate arrangements for infection control are some of the factors highlighted by Price and Williams (2018). Singh et al. (2010) expressed a similar view to other industrial operations.

**Procedures and actual practice.** Dekker (2003) suggested that it would be better for individuals in organizations to understand the gaps that exist between procedures and actual practice.  None of the studies examined show that there were deliberate efforts by individuals or groups of individuals to act and cause a cascading, unmanageable situation, chaos, or accident events.  Price and Williams (2018) suggest that deviation that led to accidents occurred when safety margins and barriers to prevent shifting away from procedural requirements were removed or changed.  Price and Williams believe that managers justified barrier removal to allow for assessment of risk from a reliability perspective and not from a safety margin perspective.

Murata (2017) conducted case studies on accidents and concluded that cognitive bias, mental predisposition,  and cultural difference are trigger factors in severe accidents and crashes. Murata attribute group bias and group-validation processes that promote social loafing as integral to a cultural gap that contribute to accidents.  Similar claims came from Vaughan (1997) and Price and Williams (2018) through normalization of deviance, and from Dekker (2003) through gaps between procedures and practice.  Dekker (2003) examined situations where safety procedures are accepted as the way to make the workplace safe. Dekker found that in organizations, individuals could fail to adapt processes and systems when that became necessary, or they implemented changed procedures when that was not necessary.  These are mistiming activities and emphasis that lead to an increase in compliance demands, workplace chaos, and judgment errors.  Murata (2017) went further to identify overconfidence as a bias which cause an illusion that work plans and arrangements were feasible when they were, in fact, risky and dangerous. Overconfidence is ubiquitous when factored in critical errors that caused accident events studied by Murata.  Murata found that framing and group confirmation bias, such as normalization of deviance, distorted decisions to give the impression of maintained safety when production and system reliability were the influential motives. Murata (2017) then posited that by preventing cognitive prejudice in favor of compliance, accidents might not happen.

**Engineering design and confidence.** The Fukushima Daiichi nuclear power station meltdown that occurred after a 2011 tsunami due to a 9.0 earthquake is attributed by Murata (2017) as an insufficient design convoluted by cultural difference. One problem is that the main power supply to the cooling pumps and a designed alternative supply were from the same source. This design flaw is critical. The power source became submerged when the tsunami occurred. Robust and redundant arrangements are necessary. Murata (2017) suggests that overconfidence, optimism, and normalcy bias all influenced a confirmation bias that the system was safe. That is despite a widespread belief that safety is a top priority in Japan. Envisaging that a tsunami would have breached the safety barriers in place at the Fukushima Daiichi power station never occurred. Dekker (2006) stressed that for the prevention of workplace accidents, it is imperative to consider and factor lessons from other accidents. Murata (2017) reviewed the cultural difference bias by comparing nuclear power station operations in Japan and the United States and found that there are cultural factors that contributed to the disaster. A Japanese belief that nuclear power plant safety was guaranteed is itself one of the critical cultural difference bias: Skepticism in the United States caused by the Three Mile Island experience where a radioactive leak, due to a loss of coolant, occurred in 1979. Lessons from this incident, according to Murata (2017), are seemingly ineffective for Fukushima Daiichi.

Murata (2017) suggested that safety values, safety strategies, safety climate, and safety activities (performance) should replace the orthodox, conventional safety culture. This traditional thinking relied on underlying values and assumptions which are unquestioned, organizational strategies that are leader driven, and supported individual attitudes, and behavior. Behavior was directly related to safety performance. All of the other parameters, whether conventional or contemporary, supported this behavior or performance(Murata, 2017). Figure 10 shows how mistaken behavior result from cultural difference, distorted judgment, and cognitive bias: It shows the standard, conventional arrangement where the apex result is behavior that support safe work. For this to happen, organizational values, including safety, must be actively built upon by leaders so that a stable base for supporting safety behavior is assured. This foundation must also help and promote safety climate and attitudes that can evolve into the expected behavior.

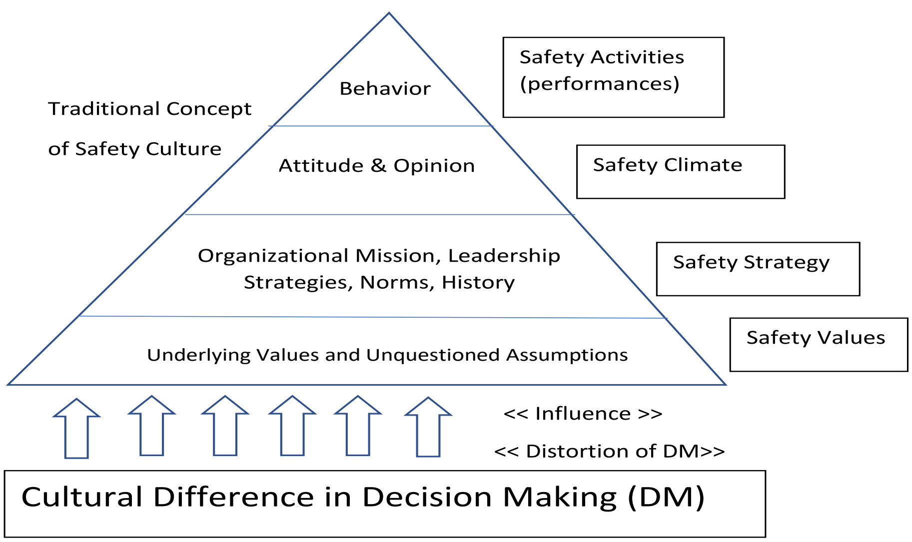


Figure 4 Model on Safety Culture that takes Cross-Cultural Differences into account

Source: Murata, A. (2017). Cultural difference and cognitive biases as a trigger of critical crashes or disasters—evidence from case studies of human factors analysis. *Journal of Behavioral and Brain Science*, *7*(09), 399. doi:10.4236/jbbs.2017.79029

*Figure 10:* Cultural Difference and Cognitive Biases as a Trigger of Critical Crashes or Disasters—Evidence from Case Studies of Human Factors Analysis. Adapted from A. Murata (2017). Reprinted with permission.

**Positive outcomes and openness.** Favorable outcomes are possible only when social workplace relationships are treated in the same light as technical challenges and facilitated by non-rigid organizational structures aware of changing demands and situations. Bobabeau and Meyer (2001) show how Southwest Airlines solved bottlenecks and inefficiencies in handling freight by examining how ants followed simple rules and found efficient ways of getting seemingly complex tasks done. Southwest found that flexibility allowed for a different form of organizational robustness which led to organizational success (Bonabeau & Meyer, 2001). This robustness is built on group performance even when individuals within the group may fail. That happened because of the self-organization among individuals is not restricted by rigid-organizational arrangements. McCall and Pruchnicki (2017) describe these as shifting boundaries of accountability. McCall and Pruchnicki (2017) acknowledge that managing safety in high-consequence organizations where the work-environments are continually changing and evolving is a very challenging task. That required a form of organizational resilience supported by managers with the ability to address the safety challenging demands. McCall and Pruchnicki (2017) believe that promoting openness in the free reporting of errors without reprisal and encourage learning from mistakes and a just organizational safety culture can result. McCall and Pruchnicki (2017) also believe that this would only happen if the organization support a sociotechnical safety management arrangement. Collective perceptions, suggested by Griffin and Curcuruto (2016) is a similar sociotechnical safety management arrangement: Organizations, either directly or otherwise, influenced safety outcomes which included near misses, accidents, and worker injuries. Griffin and Curcuruto found that shared personnel perceptions define the nature of organizational safety climate, and this was not dependant on or specific to any particular organization or in a given country. Griffin and Curcuruto (2016) also found that safety climate in an organization impact on the cognitive bias of individuals in the organization. Murata (2017) found that the reverse was also true: individual motivation and behavior change depend on the safety climate and eventually safety performance outcomes. Griffin and Curcuruto (2016) further suggest that cognitive bias influence safety outcomes and productivity levels. Murata (2017) show that cognitive bias is also a safety performance influence and indicated that this could be both positive or negative. What is necessary is for organizational values and vision promoted by active leadership support. Murata (2017) believe that this would encourage a favorable safety climate and appropriate work behavior and safety outcomes. Griffin and Curcuruto (2016) indicate that safety climate is not static: It is a dynamic phenomenon that is always changing.

**Difficult and strained relationships.** Jiang and Probst (2015) posited that safety–production relationship conflicts are negative influences on high-productivity arrangements and that both these considerations reduce the likelihood of reported accidents. An improved probability of accident reporting is possible if there is a reduction in safe working conflicts. Probst (2015) found that supervisor-employee(s) relationship bidirectionally influence safety compliance, accident reporting, and safety climate. Probst (2015) investigated three different issues. First, on how organizational safety climate influence employees to report workplace accidents. The second focus was on how transactional supervision encourage reporting of workplace accidents and finally, how each of the two influencing factors interact and what that impact is on accident reporting. An integral finding is that the influence of supervisor encouraged underreporting is weakened when the organization safety climate is strong and positive. Probst (2015) suggested that when organizations treated accident reporting as opportunities to correct safety-related problems, safety personnel had opportunities to assess problems better and to propose corrective actions that could mitigate the occurrence of future accidents. Fordyce et al. (2007) suggest that accident underreporting is supported by management, especially with management bonus tagged to workplace accidents. Probst (2015) linked accident underreporting to employee demographics such as tenure and age, and fear of losing the job or job-related perks. Jiang and Probst (2015) tied this to individual perception of adverse safety outcomes and how that can heighten feelings of job insecurity. Jiang and Probst (2015) indicated that accident data reveal that nearly four in every 10 workplace accidents where an injury occur, there are clear evidence of safety procedures not being properly conducted, or a total case of safety procedures and practices being left out. Jiang and Probst (2015) explored safety-related consequences in situations where effective job insecurity factored into safety attitudes and behavior. Jiang and Probst accepted that insecurity strongly linked to workers' safety, and safety outcomes. Injury underreporting as described by Jiang and Probst (2015) and Probst (2015) is diametric to the position espoused by Tucker et al. (2016) where top management and supervisory efforts could positively impact safety outcomes.

## Leadership and Supervision

**Epistemological and leadership from the top.** Dekker (2015) describes the benefits of investigating workplace accidents as epistemological by allowing for establishing details of the accident, preventative by identifying how to avoid recurrence, moral tracing of the breaches that occurred, for reinforcing work procedures, and existential to genuinely understand the suffering. Dekker (2015) postulates that finding out what transpired when a workplace accident happens, allow for the best opportunities to learn from the event and to avoid recurrence. Dekker (2015) also indicated that accident investigations could provide meaning-making opportunities for organizations to develop a strong safety consciousness. Tucker et al. (2016) suggest that a strong safety culture supported by top management can permeate the entire organization up to the front-line workers to promote worker safety and safe work outcomes. Conchie, Moon, & Duncan (2013) indicated that workplace demands like the underreporting of accidents reduce worker engagement, supported emotional burnout, and increase negative safety behavior. Conchie et al. (2013) suggested that the downside of work demands is that it is particularly tricky for safety management especially when supervisors time and energy are primarily into follow-up actions from unplanned issues and requirements.

**Indirect supervision and positive work.** Huang et al. (2013) developed a safety climate measurement guide for workers who operate from remote locations and use electric power industry employees as exemplars to justify their technique. Perception of safety is a crucial indicator of the multi-level safety climate which differentiated organizational focus from group-level safety priority. From this study emerged the advent of shared understandings from the workers from remote locations (Huang et al., 2013). Huang et al. conducted a survey and followed that with a 15-day observation of electric utility workers as these individuals performed their regular duties. Among the electric utility participants were trainers, managers, supervisors, and workers.

Safety climate is an instantaneous and discrete reflection of shared worker-perception of the importance and value at the organizational level, especially with regards to policies, work procedures, and accepted practices (Huang et al., 2013). Safety climate, in this Huang et al.

study, is determined through self-reports by participants of safety behavior and injuries; these are then analyzed and linked to near misses, recordable incidents, vehicular accidents, lost days due to injuries. Organizational safety climate measured and analyzed through accounts of accidents and safety behavior in six distinct ways; proactive safety acts, workplace training, equipment familiarity, fieldwork orientation, investment finance, and scheduling challenges and flexibility (Huang et al., 2013). Group-level safety climate determined from an analysis of three particular perceptions are; the level of supervisor care, worker encouragement and participation, and straight talk about and on safety issues. Huang et al. (2013) found significant statistical relationships between safety climate with safety behavior and workplace injury at the organizational level, and the group-level.

Huang et al. (2013) believed that organizational policies are formal, explicit, and visible. Enforcement of these policies is implicit, effected through management actions and aimed at maintaining work production arrangements, and there are consequences for non-achievement production targets in favor of safety. It is therefore understandable when comparing safety issues to the speed of conducting a given task or the production flow process. Managerial safety commitment aligned with the relative importance of safety and production and how well the leadership communicate these; in worker training, meetings, or workplace discussions. Safety climate thrive when safety outcomes support the experience of infrequent accidents which are not severe or serious. Huang et al. (2013) accept that electric power industry workers generally work at different locations and when supervisors and managers are not present. The reduced in-person supervision, in an industry where working conditions are varied and hazardous, workers need to be exceptionally capable of determining risks and mitigating dangers that could make safe work conditions unsustainable. These workers must be technically skilled and competent so that if situations existed where safe work arrangements could not be developed and sustained for the entire work task, then appropriate communication with the supervisor would become necessary and imperative for individual safety. Factors which contribute to injury risk include long and physically demanding working shifts and conditions, emergency work, a rapid influx of technology, and driving long distances sometimes in dangerous terrain (Huang et al., 2013). Huang et al. added that electric utility restructuring, increased competition, and profitability that result from the restructured business, together with worker diversity and demographics are challenging factors that also impacted on workplace safety. Huang et al. (2013) depended on participant self-reporting of safety behavior as a critical input for analysis in this study. Information derived from the self-reports include conditions on jobs before work tasks began, arrangements for communicating work-related hazards and mitigating actions to workers on job-sites, how workers conducted work, and supervisor response to requests for assistance for safety-related challenges. Huang et al. (2013) indicated that workers were positively influenced and exhibited safety behavior when organizational safety climate is strong; even when working in situations where direct supervision is absent.

**Leadership and safety outcomes.** Tucker et al. (2016) recounted from social learning theory and suggest that individuals who are high status and powerful could and did influence the behavior of other individuals. Tucker et al. then extended the logic to organizational leaders and their influence on workers behavior; especially the advent of worker injuries and workplace accidents. The Top Manager’s (CEO) impact on organizational safety climate is through a series of influential alignments from the CEO to the executive management team, managers, and supervisors before bearing on worker performance levels and outcomes. Collective top management support for a positive safety environment lead to work arrangements where this focus encourage and promote safe work behavior among front-line workers (Tucker et al., 2016). Strong safety culture is dependent on management commitment and organizational support (Huang et al., 2013). Tucker et al. (2016) postulate that supervisor safety support lead to a lessening of worker injuries. Front-line supervisors are deemed crucial by Huang et al. (2013) for encouraging workers safe behavior especially regarding workplace communications, provision of timely feedbacks, flexible work scheduling, and encouragement of safety work procedures despite other work challenges such as customer demands and productivity targets.

**Leadership and sub-standard safety.** Blinder (2015) describe a case where 29 employees died at work, and the CEO of that organization is held responsible but not liable for the accident by a US Federal Court in Charleston Western Virginia and did not serve prison time. That judgment held that the CEO is responsible for ensuring and maintaining safety standards. In this case, the main point was that the leader of an organization is responsible for treating the safety of workers as a high priority and that all reasonable measures were always in place to prevent workers injuries and deaths.

McGrory, Bedi, and Dawson (2017) reported that the US Occupational Safety and Health Administration (OSHA) charged a Florida Power Company for willfully disregarding and violating federal safety rules in an accident that killed five employees including a senior manager. Charges of willful violations were associated with and tagged to organizations that intentionally disregarded safety requirements and procedures designed to keep individuals safe at work. OSHA indicated that the dangerous situation which led to the accident existed for 13 hours whereas company rules required that the hazardous equipment was shut down after four to six hours of the condition (McGrory et al., 2017).

Amorim and Pereira (2015) studied workplace accidents that were caused by the improvisation of safe-work arrangements and breached safeguards and barriers. Among their findings is that improvised work safety arrangements are creative and innovative means of getting work done. That usually extend to disregard of work safety rules as these tend to make the work activity longer and more cumbersome. The desire to overcome barriers is a natural inclination of individuals and a product of the knowledge and ability of the workforce. The need for shorter outage times, higher customer satisfaction, improved technologies, and work procedures all added to the level of worker knowledge and the desire to even better that. Amorim and Pereira (2015) indicated that this work mentality proved successful but the likelihood of accidents always is elevated as changed procedures, and work sequence tend to introduce different hazards in the working environment. Usually, these hazards are unrecognized before an accident. Reason (2000) noted that sometimes the best people would make mistakes and this is a commonly overlooked issue in situations where the cause of accidents is seen only from the direct causal factors perspective. Reason (2000) further suggested that by considering direct causal factors as the real cause of errors, near misses, and accidents opportunities to understand systemic flaws and how they contribute to the last act before an accident are futile. These strategies miss opportunities and are significant disadvantages. The systemic approach is built on the premise that errors are symptoms and not the cause of workplace accidents and other more relevant flaws normally attributed to working schedules, task assignments, and employee workload, all of which indirectly impact work outcomes (Dekker, 2015; Holland, 2018; Labib, 2015; Murata, 2017).

Atak and Kingma (2011) indicated that the safety culture in an organization is dependent on the growth phase of the entity and this phase explicitly determined the safety culture and production relationship. In this study, technicians highlighted how difficult and challenging it was to balance the demands from maintenance managers, the quality assurance team, how that resulted in stressful the working arrangements, and where a compromise always existed between production and safety. Atak and Kingma (2011) recognized the challenges which are prevalent in the aviation industry, the consequences of possible errors, and the high impact of adverse work outcomes.

**The mitigating role of supervisor safety priority.** Barnes, Ghumman, and Scott (2013) suggested that economic reality and social environments often encourage individuals to increase waking hours; either due to expanded working hours or from other activities that the individual may be involved. Kao et al. (2016) posited that organizational response should be to employ situational control and to require individuals to conform to safety arrangements. Kao et al., also suggested that supervisors communicate and enforce organizational policies and procedures; so supervisors should remove individuals who were not capable of performing safety-sensitive and challenging tasks. Kao et al. (2016) affirmed that supervisors are structurally well-placed to influence worker attitudes, job behavior, and performance outcomes, and at the same time, promote organizational values and policies (Tucker et al., 2016). Supervisor safety behavior and attitudes are critical to the maintenance of safe working conditions. Probst (2015) countered that supervisors could also encourage safety rule violations, unsafe employee behavior, and accidents by not enforcing organizational policies, rules, and work procedures especially when they encouraged the underreporting of accidents and near-misses and if untrained and unskilled workers were assigned difficult and dangerous tasks. Kao et al. (2016) looked at workers' reactions to supervisors who enforced workplace safety arrangements and requirements and believed that safe-work without undue risk-taking would result in accident-free conditions. Supervisors who promoted safety at work were the ones who would review and monitor work activities, understand the worker challenges, and intervene on a timely basis to avert near misses and accidents. That also encouraged worker self-regulation and response where safe work outcomes were realized (Kao et al., 2016). The results obtained from this study are two-fold; insomnia affected worker safety directly by injuries sustained on the job and indirectly through worsening individual behavior and its consequences. Insomnia also contributed to workplace safety problems because of the effect of supervisor actions; a failure to address the issue led to an increase in safety violations, risky operations, near misses, and accidents; A direct approach to maintain safe work operations, resulted in worker self-regulation and compliance with organizational safety requirements (Kao et al., 2016).

**Leadership and Gaps**

Mills and Koliba (2015) indicated about the Deepwater Horizon Oil Rig on April 20, 2010, that regulatory governance needed to be balanced with the democratic accountability of elected officials especially when the existing arrangements convolute into safety challenging situations. Tucker et al. (2016) supported this by adding that organizational leaders are very much aware of their responsibilities for the prevention of workplace accidents, injury, and death to workers, and environmental disasters that result from these accidents. Tucker et al. (2016)

recounted the public confirmation by the British Petroleum (BP) CEO at the time of the Deepwater Horizon industrial accident that organizations and its leaders had a duty of care to ensure that operations were safe. The Deepwater Horizon accident resulted in 11 workers killed and an oil spill that was and still is the worst in the history of offshore drilling operations: The CEO at BP in 2010 was not able to positively impact on safety performance and outcomes. Tucker et al. (2016) indicated that organizational leaders influenced workplace safety performance in two ways: by measuring safety through managers and supervisors in the organization and actively fostering a safety climate promoted by collective social priorities for safety. Tucker et al., believed that the CEO had a significant responsibility to influence the executive management on workplace safety and how this could be diametric to other organizational demands; akin to use of positional power to drive organizational performance through a strong executive management safety climate. Top management, once influenced, would also engage the active support of managers and supervisors. Once set, supervisors and managers arrange work in line with organizational safe work procedures and will encourage workers to adopt safety at work. A safety climate supported by the CEO would likely promote shared perceptions of safety by individual and groups of front-line workers, especially when safety priority was on worker well-being; It was a form of social learning encouraged by the CEO (Tucker et al., 2016).

## Electrical Power Industry Experience

Fordyce et al. (2007) investigated employee-suffered burn injuries from information contained in the Occupational Health and Safety Database (OHSD) for electric utility accidents, managed by the Electric Power Research Institute (EPRI). They found that while burn injuries were infrequent, it was usually severe and resulted in more days away from work than for other workplace injuries suffered by electric utility workers.  Fordyce et al. (2007) separated the burn injury data into different categories; thermal burns, chemical burns, and electrical burns. Electrocutions or death due to electricity was in the group of electrical burn injuries.  Fordyce et al. indicated that the victims were predominantly electricians, welders, and line workers who suffered injuries in the head, upper body, and hands.  Line workers sustained the majority of fatal injuries: Despite extensive state and federal regulatory oversight and organizational safety management efforts and program, electrical hazards represented significant safety risks for electric power industry workers (Fordyce et al., 2007).

Fordyce et al. (2007) lamented that the EPRI OHSD database used for this study consisted of incomplete information and data from only 15 utility companies.  That was a significant disadvantage as the data was self-reported and contained several omissions. Fordyce et al. suggested that accurate data on accidents were difficult to source and the information at hand were challenging to code for useful analysis: this challenge was as a direct result of the variation in injury-reporting requirements across the United States and the different requirements for state-managed injury compensation plans.  There were cases of non-reporting of accidents which was supported by management.  Fordyce et al. (2007) explained the advantage of sufficient information on near misses, which were not available from the data used in this study; and near misses were opportunities to appropriate actions that could have addressed problems before accidents where workers became injured.  Fordyce et al. (2007) found that line workers frequently injured were experienced and in their 30s and 40s and inferred that younger workers were still in training and likely not exposed to more risky and challenging tasks.

Fordyce et al. (2007) described the working arrangements and conditions for some of the cases they analyzed and suggested that despite line workers extensive training and apprenticeships, there were instances where personal protective equipment was necessary, available to workers, and not used as required. Some of these situations included working close to energized conductors, non-use of flame-retardant clothing, and failure to detect hazards. To this end, Fordyce et al. (2007) suggested that workplace training was a possible way of overcoming the problem, and to address inappropriate worker actions.

Fordyce et al. (2007) recommended that workers must use personal protection and other equipment to ensure safety arrangements at work; these included the use of flame retardant apparel, insulating blankets, non-conductive ladders, and other safety devices. Training improvements were to include provisions for ensuring that systems were safe to conduct work as well as to include modules aimed at developing an excellent workplace safety culture.

Volberg et al. (2017) recognized the vast array of work tasks and the hazardous nature of these activities and working environments that electric power industry workers regularly faced. Volberg et al. (2017) conducted a similar analysis to Fordyce et al. (2007) and used the same EPRI OHSD database. In this study, with the updated database, there were 18 contributing utility companies instead of the 15 in 2007. Line workers and welders remained as the working groups that were most times injured at work even though there was still a significant level of uncertainty about accidents in the electric power industry. The EPRI OHSD was not an entirely representative database of the US electricity industry: there were more than 200 different electric power companies conducting business in the electric power industry. On the other hand, the available data from the US Bureau of Labor was a combination of information from electricity distribution, transmission, and generation as well as from other utilities such as natural gas, and wastewater and sewage companies.  It was therefore complicated to filter information from this database effectively for proper analysis (Volberg et al., 2017).

Volberg et al. (2017) indicated that there were 63, 194 recordable injuries reported by the 18 companies that contributed data to the EPRI OHSD database from 1995 to 2013 and that not all of these companies provided information for each year.  It meant that for the missing years, there were accidents that occurred in these organizations that did not form part of the database. Typically, safety statistics calculation was on a reference of 200 000 hours per year, often referred to as the OSHA 300 rate, which reflected the working hours of 100 employees working 40 hours per week for 50 weeks (40 X 50 X 100 = 200 000).  The frequency, severity, and other accident rates were then determined.  From the EPRI OHSD database, primary data for all the contributing companies were used to determine a value for employee-years.  Volberg et al. estimated that the data represented a total of 1 977 436 employee-years; it also indicated that 60% of the workers came from five companies.  It was not possible to link the accidents to particular companies as there were missing data confirm that the larger companies provided data for the entire period from 1995 to 2013.  The data contained information on the location where the accident occurred, the event description, the activity which resulted in injury or death, the injured body part, and the nature of the injury.  Additional information about the injured worker and the arrangements for medical treatment and possible claims were also analyzed.

There were 21 line worker deaths and another 12 fatalities among electric power industry workers from data used in this study:  A total of 33 deaths among 18 companies that contributed to the EPRI OSHD database.  Volberg et al. (2017) indicated that only six of the companies provided information from 1995 to 2013 while another six provided data for the last decade. The data presented were incomplete and therefore insufficient for exhaustive analysis. Fordyce et al. (2007) were hampered by similar data integrity flaws a decade earlier. Just like Fordyce et al. found, Volberg et al. indicated that welders were among the group of workers frequently involved in workplace accidents. Younger welders, under-20 years old, predominantly suffered injuries to the eyes or head. Older welders, over 65, were more likely to fall at the same level. Generally, though, welders were less severely injured than line workers and therefore were less often away from work due to injury. Meter Readers and line workers were the groups of employees who mostly suffered from cuts and puncture wounds or sprains and strains. The majority of meter readers were females while the opposite was true for line workers. Sprains and strains injury victims suffered back and trunk type problems that tended to be long-term and high cost. Contributing factors included overexertion, twisting, awkward motion, and task frequency and duration. Most injuries occurred in summer while the least was in winter and linked to fewer working days in winter. Slip, trip, and fall (STF) injuries occurred mostly in winter. Volberg et al. (2017) found that Meter Reader injuries were difficult to explain and believed this was likely a result of insufficient and ineffective training. Training in this context was both formal and informal. Volberg et al. (2017) recommended further studies in this area. Office staff predominantly suffered injuries to wrists and hands. That was not fully explained but could be cumulative trauma disorders (CTD) and repetitive strain injuries; linked to office ergonomics.

Volberg et al. (2017) observed that the number of fatal accidents and injuries tended to lessen each year from 1995 to 2013. It could have been due to higher safety consciousness among workers, a proactive safety management approach, and improved workplace design and procedures. It could have also been a uniqueness of the database itself, underreporting of accidents, the non-reporting of contractor related accidents, and the non-reporting of dangerous near misses. Contractors in the electric power industry were usually hired to perform high-risk tasks not done by the permanent workforce. Keeping and reporting of accidents involving contractors were not a mandatory or compliance requirement for electric power companies (Volberg et al., 2017). A significant shortcoming and limitation in this Volberg et al. study was the voluntary nature of the reporting done by the companies that contributed to the EPRI OSHD database and the incompleteness of that data. That was unchanged from the 2007 study conducted by Fordyce et al. The different regulatory arrangements from different states and regions in the United States also presented significant challenges and very likely led to critical data being underrepresented. Underreporting of workplace accidents might even have occurred because of management remuneration schemes that hinged the number of workplace accidents to bonuses and other performance-related factors. There were other cases where an interpretation of incidents as not recordable or near-misses when injuries occurred was not entirely ruled out by Volberg et al. (2017).

## Accident Investigation Techniques

**Spain-wait, riatt.** Accident investigations offered opportunities to discover the real causes of workplace accidents for individuals at work to help prevent recurrence of similar future accidents, and for proactive informing of workers about accidents that occurred. Salguero-Caparros et al. (2015) recognized that accident investigations were necessary for identifying the contributing factors in an accident event. It was an essential input in the design and implementation of barriers and other systemic protection against similar future accident events.

Salguero-Caparros et al. (2015) reviewed accident investigations conducted in Spain for the period 2009 to 2012. These accidents occurred mainly in construction, agriculture, manufacturing, and the service industry. Salguero-Caparros et al. identified omissions and investigative flaws which they believed resulted in missed opportunities for regulators, organizations, and managers to understand how accidents occurred and how best to mitigate recurrence. There was an impression that with only the active fault identified, the investigations were short on the in-depth latent organizational and management contributing factors. A reasonable investigation was, therefore, one in which investigators extracted all the contributing risk factors and analyzed them to determine how they combined to result in the accident event. The control of these risks was critical to keeping workplaces safe from the effects of hazards. Salguero-Caparros et al. (2015) recommend the adoption of the European model for accident investigations and access to accident investigation databases by investigators. Salguero-Caparros et al. ascribed that accident investigations should involve investigation planning, an initial report, a data collection exercise, analysis of that information, report writing, recommendations, the initiation of appropriate corrective action, implementation of recommended actions, and follow-up activities for identification and evaluation of the effectiveness of preventative measures.

Salguero-Caparros et al. (2015) described the early accident causation model by Reason (1997) as organizational accidents and another model by Hollnagel (1998) as human error. These were two models that became widely used in accident investigations. There had been an over-emphasis on the human error causes instead of the identification of systemic problems outside the control of the accident victim (Dekker, 2006; Manuele, 2014). Salguero-Caparros et al. (2015) preferred the Jacinto and Aspinwall (2004) work accident investigation technique (WAIT) as the systemic model that was simple to understand and implement even by inexperienced investigators. Jacinto and Aspinwall (2004) posited that WAIT was a 9-step process over two main phases of an accident investigation. Phase one involved legal and regulatory requirements and constraints regarding the information about accidents and how that information could be analyzed to determine the causes and factors that contributed to the accident. These represented the *what-happened* observations about the accident. Phase two involved an in-depth analysis of weaknesses and circumstances that were organizational systemic and which contributed to the failure event. That represented the opportunities for organizational control and for preventative action to be initiated.

Salguero-Caparros et al. (2015) further indicated that the WAIT methodology later evolved into a recording, investigation, and analysis of accidents (RIAA) model. Salguero-Caparros et al. (2015) found that in accident investigations, data collection was a significant issue factored in the accident findings; if the data was congruent and homogenous, the findings were credible; heterogeneous data were difficult to use in determining the exact cause of accidents in the workplace. Salguero-Caparros et al. (2015) forwarded a coding of data recommendation for converting accident information into a homogeneous dataset. They found that these codes led to the causal factors of accidents. Coding was also useful in understanding the circumstances relevant to the accident. It was by following the factors that contributed to accidents where opportunities for the implementation of adequate preventative measures to avert other accidents existed.

Salguero-Caparros et al. (2015) suggested that the Phase one stage of accident investigations was necessary to determine unsafe acts and unsafe conditions that actively contributed as the immediate causes of the accident. The underlying causes, however, were not found from the active, direct, and immediate reasons for accidents. These evolved from an analysis of the reasons for the immediate factors which resulted in the event occurrence (Salguero-Caparros et al., 2015). Latent causes from the evolving interactions of individual and job factors with organizational procedures and work arrangements led to an understanding of situations where errors could lead to a severe or fatal injury type accident. Salguero-Caparros et al. (2015) proposed that direct, indirect, and ancillary cost estimates, of accident investigations, could be used to indicate the monetary value of the effort. That way, the report, the financial impact, and not only of the losses due to the accident event could be useful and help to determine how best to prevent other accidents. Salguero-Caparros et al. (2015) also suggested that the number of days that elapsed during an accident investigation should indicate a value of opportunities lost, including time for other organizational activities.

**Counting on everything for safety.** Griffin and Curcuruto (2016) posited the thinking that organizations through management and supervision application of safety values, policies, rules, and procedures could influence workplace safety performance and outcomes in line with expected organizational objectives. At the worker level, attitudes, behavior, and motivation were shaped by the way that management and supervision implemented the safety arrangements; considering the level of worker involvement and commitment to worker well-being. Safety climate, in this context, represented the common perceptions regarding an organizational safety program and the practical functioning of that program. It was a reflection of a shared understanding of organizational safety policies, safe work procedures and rules, and other safety arrangements.

Miller et al. (2016) researched slip, trip, and fall (STF) in the workplace. STF was a major workplace safety hazard and a causal factor in numerous cases where employees suffered injuries. Miller et al. (2016) suggested a four-part model analyzing STF incidents stemming from their company database, to determine hazard awareness among workers, an examination of the effectiveness of preventive measures to mitigate the risks, and to institute a training focus on how to maintain proper personal balance; especially when workers negotiated wet and slippery work conditions. Miller et al. (2016) stressed the lifelong struggle of fall survivors to keep good health and pain-free living; STF was the second leading cause of worker deaths after motor vehicle accidents and more than one-fifth of all emergency room visits in the United States (Miller et al., 2016). The traditional approach to identifying and mitigating STF challenges was to focus on the environment and to encourage constant vigilance from workers. With vigilance workers were expected to identify flooring problems, weather-related issues caused by rain, snow, and ice, surface transitions, conditions and unevenness, and a combination of different permutations of these factors (Miller et al., 2016). In this study, Miller et al. included the orthodox review and analysis of previous incidents, actively encouraged the identification and mitigation of hazards and risks, and supported worker training for maintaining personal balance. This approach promoted changes to individual worker responsibility and actions, attitudes, and behavior. It grew on a foundation where employees were able to identify and assess hazards and the dangers that these presented. It was more an exercise in information management and initiation of proactive actions to possible problems before these escalated into accident situations. The balance initiative was an organizational led initiative where workers were re-oriented to appreciate newer techniques about human dynamics and how each person should compensate for their unique requirements. It was a way for individuals to remain in control of their actions, all aimed at ensuring that individuals were not injured and that near-misses did not occur. Miller et al. (2016) showed that the ratio of slip, trip, and fall was 33:43:24 for all STF cases. That was a simple but powerful breakdown. It was evident that snow and ice were not the greatest STF factors.

Trip incidents were due to poor housekeeping, inappropriate supervision, and worker inattention. These resulted in cases where debris, doors, stairway, carpet, cable/hose, bump stop, and chairs all factored in similar ways. A closer focus of slip incidents revealed that wet surfaces were the leading factor in 4 out of every ten slip-cases. Oily surface, vehicle entry/exit, debris, ladders, tiled surfaces, and stairs were cumulatively less than wet surfaces as a contributor to slip-cases. For almost one in every three slip-cases, the reason was listed as unknown (Miller et al., 2016). For falls, one in every five cases was leg or ankle related. One in three was due to an unsafe act or an undefined causal factor. Broken chair factored in one of every nine instances while missed steps, walking too fast and an unknown factor each figured in one from every twelve accident situations. Footwear, loss of balance, and foot placement were separately identified as the causal factor in one from every twenty-five accident (Miller et al., 2016).

Miller et al. (2016) identified employee training as critical to shaping new attitudes and behavior. The training was to encompass a common-sense approach to preventive actions as the primary strategy and covered topics such as cell phone use and how that contributed to worker distraction, especially in trip and fall situations (Miller et al., 2016). Another common-sense approach was to encourage a renewal of watching where one was going, using the right footwear, not standing or rolling on chairs, and the benefits of keeping the work zone free from debris and other unnecessary objects. Safety slogans developed for this purpose included eye-catching phrases meant to encourage worker safe-behavior and the idea of not becoming another injury statistic.

Miller et al. (2016) indicated that the balance initiative was one where employees had to individually consent to the program as it required confidential medical information that was personal to the individual. That information was for personalized training on the balance initiative. This STF program has been at NASA since 2013, and actively supported by the top management and employees (Miller et al., 2016). The 4-plan program was aimed at an organizational safety culture shift from employer-centric arrangements to make and keep the workplace safe to an employer-employee-centric culture where employees could initiate actions to mitigate hazards and to keep the workplace safe (Miller et al., 2016). That change was possible because of changed attitudes, behavior, and appreciation for personal safety responsibility.

**Electric power industry.** Fordyce et al. (2007) and Volberg et al. (2017) showed how difficult it was to get appropriate near miss data for the U.S. electric power industry. The unavailability of relevant data on electric industry accidents was also a significant negative. Considerable difficulty in applying information derived from one study to other situations and industries was that the prevailing conditions in both cases were not identical. Taking the results obtained by Miller et al. (2016) for example, and applying that thinking to the electric power industry might result in an entirely different outcome; because of the uniqueness of the electric power industry arena.

**Missing data.** Fordyce et al. (2007) and Volberg et al. (2017) lamented the absence of near-miss data from the EPRI OSHD used in their respective studies in the U.S. electrical power industry. Reason (2000) likened this absence of necessary information to not making the best use of free lessons to help recognize when the precipice was very close: Reason further suggested that it was a primary reason for the 1986 Chernobyl nuclear power station accident. Reason (2000) connected trust, a workplace culture that supported fair treatment, and a blameless working environment as critical elements for a favorable safety climate in an organization. Reason (2000) believed that by only considering accident causal factors as worker-related and not organizational or systemic, finding the actual causes of accidents remained elusive and challenging. The systemic factors such as work planning, equipment purchase, material unavailability, inadequate planning, changed work procedures, work team selection, and insufficient supervision control were among numerous other organizational factors outside of worker control which contributed to accidents (Fordyce et al., 2007; Volberg et al., 2017; Reason, 2000).

## Delphi Research Technique

Using the Delphi technique, researchers could add to informed decision making in a myriad of different technical, business, and policy environments and situations. The objectives of this study included an understanding and explanation of the reasons why fatal and serious workplace accidents were occurring in the electric power industry and the promotion of possible ways to prevent future accidents. The aim developed through a Delphi technique where selected experienced and knowledgeable electric industry practitioners and professionals deliberated on this high impacting topic. The Greek origins of the Delphi described a process where predictions were the natural order. Today, however, methodological design drives this type of research for results in cases where expertise and experience were significant influencing factors (Novakowski & Wellar, 2008).

No suitable similar studies were found in the literature search to indicate that the Delphi technique was ideal for research on how to prevent fatal and serious accidents in the electric power industry. It was logical to approach this topic from the perspective that the experts would be knowledgeable and experienced: That alone was an opportunity to gather valuable information from them since an analysis of information they provided could be sufficient for a critical and unbiased examination of the deep and underlying factors which could prove important to this study. The approach adopted for the present study was to elucidate the Delphi technique and describe the different study conditions that it was applied; with an explanation of how previous study experiences could likely lead to positive results in the current circumstance.

In 1953, Dalkey and Helmer working at the Rand Corporation, developed the Delphi technique. They aimed to explore the different strategies that the then Soviet Army could adapt to deploy nuclear bombs (Novakowski & Wellar, 2008). The Rand Corporation was contracted by the United States Air Force (USAF) to decipher this complicated and possibly dangerous task. The Dalkey and Hemler approach were to poll American knowledge possessed by individuals throughout the United States. Their aim was for each expert to provide critical information while not being influenced by the communication challenges usually associated with *in-person* interpersonal interactions. Linstone and Turoff (1975) indicated that one characteristic of the

Delphi technique was a structuring of the communication process, especially group interaction on complex problem resolution, for active participation by all members.

In this research, I was the monitor or facilitator. I facilitated group communication. I coordinated the process so that the experts could address the research questions. I hosted the questionnaires forwarded through Survey Monkey. Communication to the designated experts was through emails sent via Survey Monkey. The experts then responded to each item on each of the questionnaires. The response allowed me to conduct data harvesting, coding and summarizing. The rounds of deliberations continued until consensus for each item occurred, or to the point where agreement could not occur.

For the first round, I forwarded a list of reasons why accidents happened and invited the participants to add to the list and to provide suggestions on how to possibly prevent accidents. The participants each had two weeks to respond. This information and feedback, from the research participants, were summarized, coded and used to generate questionnaires for the second and subsequent Delphi rounds. A five-point Likert-type scale for the participant to register their response to each of the questions in the second round was in the questionnaire. Round 2 of the exercise commenced when participants received notification of Round 2 via Survey Monkey.

After the second round, I reviewed each response and calculated statistical measures from the received data to indicate what the leading answers were. The criteria, set as 70% or more of the participants selecting a score of three or greater on the Likert-type scale for each item on the questionnaire, was necessary for including the issue in the next round. These responses would be used to determine the degree to which the respondents agreed or disagreed with a particular item (Novakowski & Wellar, 2008). I proceeded to develop a third-round questionnaire which showed a summary of the answers to the items in the Round 2 questionnaire and what the overall results for the entire group were.

Linstone and Turoff (1975) indicated that the greatest opportunity for response convergence occurred in Round 1 and Round 2 of the Delphi. In this study, the Linstone and Turoff (1975) Round 1 and Round 2 were the Round 2 and Round 3; This study was more in line with the exercise done by Heitner, Kahn, and Sherman (2013). Novakowski and Wellar (2008) described three different Delphi technique study categories: Normative, Forecasting, and Policy. Normative Delphi explorations aimed to derive consensus on a challenging issue when starting from a reference set by the level of current knowledge and thinking (Novakowski & Wellar, 2008). The Delphi technique could enable researchers to evaluate different frameworks used to ascertain which future-plan or program may provide the best solutions based on the information currently available. The electric power industry managers, supervisors, trainers, and workers exposed to situations, where employees were at risk of becoming injured or even killed while at work, provided opinions on how to prevent these from happening. The many different hazards, hazardous conditions, work procedures, safety systems, work commitment, planning, techniques, scheduling, and other micro details were known to these experts. Expert knowledge and information were what this researcher relied on to derive an understanding of how to prevent fatal and serious accidents in the electric power industry and to support future initiatives to prevent worker injuries and death from workplace accidents.

A forecasting Delphi focussed on future predictions of events in situations where there was little knowledge, or in cases where there were a diverse array of or conflicting information and ideas about the issue under examination (Novakowski & Wellar, 2008). Forecasting could happen in different ways; from data extrapolation, indicator examination, to modeling, and also by stochastic analysis type methods. A researcher employing the Forecasting Delphi technique would likely process data from one or a combination of all of these methodologies. The Delphi participants could even be experts at these analytical competencies, and their responses might require me to also be capable and competent with these tools (Novakowski & Wellar, 2008). The policy Delphi preference occurred in studies that involved political interests and matters or consequence: In this type of study, the aim was not to generate consensus but with identifying the range of possible contextual and politically relevant and influential parameters and variables (Novakowski & Wellar, 2008; Sinclair, Oyebode, & Owens, 2016).

Despite the different Delphi categories, the fundamental approach to the Delphi technique remained unchanged. These revolved around participant anonymity, an interaction between me and the participants, coordination of group information, and the statistical measures used to analyze data derived from the process. However, I aligned the method with the actual study for best results from the exercise. In this current study, the preference was for a normative Delphi as it allowed for consensus derived from the experience and knowledge of the experts as research participants. Appendix C, shows the different forms of Delphi research as described by Hasson and Keeney (2011).

**The relevance of the Delphi technique to electric power industry accidents research**

Linstone and Turoff (1975) promoted that when a research problem was not one where precise quantitative assessment and analysis was preferred, the Delphi technique could be beneficial particularly when a collection of ideas and subjective judgments would be available .

In this context, the Delphi technique was ideal for investigating, understanding, and analyzing how to prevent fatal and serious accidents occurring in the electric power industry. The Delphi technique allowed for experts in the electric power industry to apply and utilize knowledge and experience, and understanding of issues that contributed to workplace errors and accidents to the extent that individuals were killed or permanently injured, and equipment destroyed. Novakowski and Wellar (2008) extended the Delphi as being relevant in situations for analysis of philosophical and conceptual issues with simple statistics and where objective observation was neither easy to confirm nor deny. These conditions existed in the electric power industry, so it made the Delphi methodology useful for examining the study topic.

Participants in a study done using the Delphi technique enjoyed equal and the same opportunities to contribute towards the research. There were no interpersonal challenges; situations where any individual views or mannerisms were dominant over others. Participants expressed opinions, which I considered without ranking nor weighting. Each participant's response contributed equally to the statistical measures derived from the Delphi technique. Workers' contribution to the research was treated similarly to those from managers and supervisors. It also made the value of each input essential: That removed bias which could have existed in other research methods, including phenomenology, case studies, or quantitative. I developed questions were crucially important as careful crafting elicited the best responses from the expert participants: If not adequately designed, the value of the expert deliberations might be affected (De Loë, Melnychuk, Murray, & Plummer, 2016).

**Transparency and Research Design**

The literature review was critical for the preparation of a comprehensive description of current information, knowledge, and thinking about the research topic. It was apt for identifying where gaps existed in current knowledge, what the research interests and direction were, the theoretical challenges and misdirection, and how difficult relevant data was to find. The literature review guided the determination of what new research was necessary, and what needed clarification. The literature review was also be used to guide me on how to effectively identify which subject area expert would be best for the Delphi exercise. The literature review guided me on the research design determination. Research can be exploratory to find out more about the research topic. It can also be confirmatory if the focus was on substantiating that a real phenomenon remained valid. From the literature review, I effectively developed the research content, and this helped to determine the best research direction and what research methodology should be adopted. It was crucially important from the points highlighted that conduct of a proper review by me was for the best indication of current knowledge and research direction on a given research topic.

Novakowski and Wellar (2008) indicated that the more common literature review strategies included an acknowledgment of the prevailing ideas about the topic, the *learning* direction, and polling of the best topic repositories on the subject; professional associations, industry journals, research academicians, regulatory resources among other resources. Novakowski and Wellar (2008) cautioned that the omission of critical resource sources and overemphasis on other sources were equally likely to produce research bias as I could be influenced by one thinking and neglect another body of ideas about the same topic. That was likely to affect the overall credibility of the entire research. Novakowski and Wellar (2008) indicated that pretest and trial run were distinct research activities even though there were significant confusion and misuse of the terms among researchers. Ackoff (1956) indicated that the pretest was done by a researcher when the research methodology was undecided and for effective finalization of the best approach for the actual research.

Acoff further indicated that the trial run was conducted to determine and to fine-tune the research instrument and so enhance the research viability and efficiency. Novakowski and Wellar (2008) suggested that when there was insufficient research information on how to proceed, engaging experts was acceptable for researchers to contact for suggestions and ideas to consider. I must first accept that an expert-based technique was suitable for the study and contacting individuals before the research commenced, were only for me to eventually crystallize and settle on the most suitable way forward. Aside from the Delphi, suitable expert contact methods included surveys, professional polling, roundtables, workshops, and brainstorming with each approach providing research advantages confirmed in a pretest (De Loë, Melnychuk, Murray, & Plummer, 2016; Miller, 2006).

A background report for each expert participating in the Delphi technique was necessary so that they could understand the reasons for conducting the research, what the research topic was and how the research process could work. It specified who were possible candidates (skills, experience, knowledge, interests, and expertise). It was essential that I included the research problem statement as part of the background report to the experts. That prevented time delay and eventual participant disinterest if they were fully aware of the specific research before committing to taking part in the exercise. Helmer (1983) referred to this process as the Delphi

Round 0. It was essential that I sent sufficient information to each expert for the most informed decision to be made by the participant. That proved to be a financially wise decision as delays added to the overall cost of the research.

Novakowski and Wellar (2008) suggested that in some instances, even with the provision of sufficient information to the participants, a Round 0 was required primarily due to the complexity and the vagueness of the research topic. In this study, once the selection of experts occurred from experienced and knowledgeable industry practitioners, the initial thinking was that a Round 0 was not necessary. The mitigating factor was how time-consuming the entire research was and how likely participants could maintain interest for that duration. There were different ways that a researcher could circumvent research delay: these included expert interviews, conducting focus group sessions, and brainstorming with a group of experts who were not be engaged otherwise in the study. The focus group option was impractical for this study.

The selection of research participants covered the entire United States. That made a focus group interaction almost impossible unless there could have been a video conference in which all the participants could simultaneously attend. Even if this was likely, it was not a first choice option and therefore was ruled out entirely. The interpersonal challenges that could occur would only compound the overall difficulties in the research exercise. Conducting interviews was an attractive option and was likely to factor in this research. Therefore, it was a possible consideration until I was satisfied that there were sufficient candidates for a Delphi study. Novakowski and Wellar (2008) suggested that interviews could replace the Round 1 of the Delphi. This approach was not adopted but remained a viable option up to the commencement of Round 1 of the Delphi.

Linstone and Turoff (1975) cautioned that care must be taken to ensure that questions were clear, written in language that was not ambiguous, and used terms that the experts would have a common understanding. The content density of each sentence must not be such that the participant would be overwhelmed and taxed. Novakowski and Wellar (2008) suggested using a diagram or a pictorial as a representation of the process and how the different stages would follow: That would be an excellent way for the researcher to convey crucial information to the expert about the research exercise and how the exercise should progress. The approach preferred for this research was a modified version of the Novakowski and Wellar (2008) flowchart for normative Delphi, is shown below in Figure 11. Professor Wellar provided permission for replication of their flowchart for normative Delphi in this study; This permission forms part one of Appendix A (Novakowski & Wellar, 2008). Professor Wellar confirmed in an email that Dr. Nonakowski had passed before the request for permission to use the flowchart in this study, reproduced in Appendix D, was with the permission of Professor Wellar (Novakokowski & Wellar, 2008).

A normative Delphi was employed to determine how to prevent fatal and serious workplace accidents in the electric power industry, is shown in Figure 11: This was a modification of the Novakowski and Wellar (2008) model as shown in Appendix D.

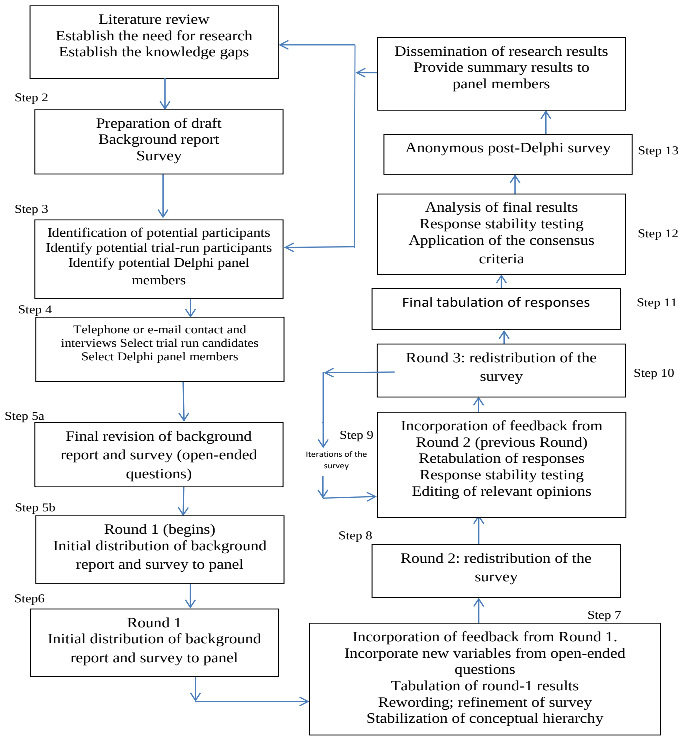


*Figure 11*: Modified Flowchart for a Normative Delphi. Adapted from N. Novakowski, & B. Wellar (2008). Reprinted with permission.

## Summary and Conclusions

Chapter 2 is built on a platform informed by previous research into the same area of study or from similar studies even if those are not identical or from the same setting. The learnings derived from earlier studies and research literature are carefully crafted to build support for the current research on the accidents that were occurring in the electrical power industry. These are credible and from the most recent and relevant research work. The importance of peer work and emphasis is tempered for a balance with the research literature from books, periodicals and research dissertations from sources that are credible for this particular research. These are, for this exercise, assumed to be valid, at least, to ensure that the research learnings and knowledge up to and before conducting this actual research and the information synthesized to show how the prior findings are crucial in determining the exact knowledge base on the topic (Patton, 2015; Ravitch & Carl, 2016). This literature review is interpreted and informed by unbiased intent and fairness. That is possible because it shows how the information is relevant to the current study (Rubin & Rubin, 2012; Saldaña, 2016).

The primary intent was to conduct a Delphi research exercise and to use the Bolman and Deal four-frame model. Selection of the Delphi participants came from electric utility experts in the United States. Electric industry regulators were different for different regions in the United States, but industry practice is closely aligned. Professionals practicing throughout the industry were university and professionally trained and came from the geographical span covering the United States (Feng, Teo, Ling, & Low, 2014). That made for well-informed industry experts effectively helping in determining how best to prevent workers from being killed or severely injured at work.

# Chapter 3: Research Method

The purpose of this normative Delphi research was to prevent workplace accidents and serious and fatal worker injuries by gaining consensus on the reasons why these occur and desirable and feasible solutions from a select group of experienced U.S. electric power industry experts including trainers, employees, supervisors, and managers. This chapter contains a description of specific research methods and practices I used to conduct this study. In it, I also discuss the tools and strategies I used for analyzing the collected data.

## Research Design and Rationale

### Research Design

I explored the following research question:

What is the consensus of opinion of a panel of experts in the electrical power industry regarding desirable and feasible solutions to fatal and serious workplace accidents occurring in the United States?

The focus of this study was two-fold. First, I sought to determine what trainers, employees, supervisors, and managers experienced with electric power industry accidents, attributed as the real causes of workplace accidents, worker fatalities, and serious injuries. Second, with an understanding of the real causes, my focus was on identifying ways to prevent future accidents, worker fatalities, and serious injuries.

I used a qualitative method for this study. Qualitative researchers attempt to understand human behavior and actions by focusing on unique people and factors. Quantitative researchers develop and test hypotheses to prove or disprove researcher thinking. Mixed methods research combines elements of qualitative and quantitative studies (Barnham, 2015). Qualitative research promotes the likelihood of understanding and appreciating human factors, and from that, evaluating unique world experiences and environments (Fassinger & Morrow, 2013). Qualitative research methodologies support flexible, evolving, and emerging research exercises, unlike quantitative studies where boundary conditions are rigid and tested for acceptance (Barnham, 2015). Practical application of quantitative research had traditionally been more useful in natural sciences than in social science despite a sizeable percentage of social science studies done using a statistical approach (Fassinger & Morrow, 2013). While quantitative studies are premised on clearly delineated researcher-set conditions for acceptable and not acceptable results, they do not clearly explain the human influences that significantly impact those results. Qualitative studies are thus better suited for exploring the human factors where the delineation of acceptable and non-acceptable is difficult to accomplish (Fassinger & Morrow, 2013).

In this qualitative study, I used the normative Delphi technique (Novakokowski & Wellar, 2008; Yousuf, 2007). The normative Delphi technique was referred to as the classical Delphi technique by Hasson and Keeney (2011). In it, the primary focus is to obtain a consensus among experts as research participants. A full discussion of different aspects of a Delphi study from its origins to its limitations follows in this chapter. The discussion includes different applications where the Delphi technique is preferred, the rationale and benefit of this research method. Hasson and Keeney (2011) listed several different Delphi techniques and showed how these were relevant for different research perspectives. These techniques ranged from the *classical*, where the emphasis was on gaining consensus of expert opinion among the research participants, to the e-Delphi which depended on the nature of the research topic (Hasson &

Keeney, 2011; Novakokowski & Wellar, 2008). Aligning successful and reliable outcomes with safe work strategies to achieve organizational safety objectives is a difficult task. Barnham (2015) noted that qualitative research involves a psychological approach where the focus is on understanding why individuals think and behaved in unique ways.

The Delphi technique supported a process of iterations to establish consensus among the research participants through questionnaires and feedback I coordinated (see Heitner et al., 2013). The Delphi technique involved a process of expert participant selection based on qualifications, knowledge, and recognition of experience and exemplary practice (see Heitner et al., 2013). Participants' interacted with me while remaining anonymous to the other expert participants (see Brady, 2015). Information gathered from each participant was collated so that only I was able to redistribute information to participants over the subsequent iterations (Cegielski, Bourrie, & Hazen, 2013), and only I combined and analyzed individual participant responses (Eleftheriadou et al., 2015).

**Rationale for Using the Delphi Technique**

Generally, the safety management systems employed in the electric power industry are superior to minimal standards guaranteed by industry, federal, state, and regional regulators in the United States (OSHA, 2017). Therefore, accidents are an indication that significant problems exist. The versatility of and straightforward approach of the normative Delphi technique made it appropriate to this inquiry into accidents in the electric power industry. The literature review done as part of this research allowed me to set questions for Round 1 of this normative Delphi study. The existing lack of knowledge, the gap between extant research, and data on electric power industry accidents was sufficient reason for conducting this study. A phenomenological approach was possible. This method would have limited the geographic span to a particular region. That was inconsistent with my focus. Groenewald (2004) listed core phenomenological research principles as involving field notes, unstructured interviews, memo writing, participant essays, and group discussion. None of these were relevant to this study. Larkin, Watts, & Clifton (2006) indicated that phenomenological research demands required the researcher to balance judgment with the broader context of the lived experiences of the participant. In this study, I was not focused on individual consciousness and experience, but rather on the extraction of knowledge possessed by the research participants about workplace accidents that they know about in working conditions and arrangements that they, as experts and specialists, knew.

A case study was also possible. Yin (2013) indicated that case study research is used to explore a phenomenon that is bounded by time and space. Case studies are good when researchers seek answers to "how" or "why" questions and on real-life events over which there is little control (Yin, 2017). Yin (2013) also indicated that the research design and analysis must align with the research method for research success. My study was incompatible with the specific focus that case studies support. For this study, I wanted to understand the issues that resulted in workers becoming fatally or severely injured and to find solutions to prevent fatal and serious workplace injuries. I did not select the case study option because it would have required the specific involvement of individuals with detailed information about particular circumstances, locations, working conditions, and detailed information about accidents that occurred. That approach would require research participants to agree to conditions where they might be or could be liable for contributing to accidents where individuals were killed or seriously injured at work. This result was not the focus of this research.

## Role of the Researcher

Sanjari, Bahramnezhad, Fomani, Shoghi, and Cheraghi (2014) noted that a researcher in qualitative studies is a process tool used for completion of the study. Patton (2015) extended this by suggesting that qualitative research depends on clearly defined and identified researcher roles articulated to the research participants. The first research quality management opportunity was in the research literature search. Another chance to remove bias was in the identification and selection of suitable experts for this Delphi study (see Yin, 2013). A third opportunity to remove bias was for me to declare beforehand that while there was no familiarity with prospective U.S. electric industry participants for this study, I was an industry practitioner with extensive knowledge in the Caribbean and Canada. In this study, I was responsible for data collection. Because there was the potential for individual bias, I made a deliberate effort to maintain research integrity throughout the process. I was particularly careful during data processing and analysis, thematic categorizing, summarising, coding, and development of questions for the Delphi rounds so that my thinking and perspectives were not actively influential in the shaping of the research (Sanjari et al., 2014). Development of the questionnaire items for the subsequent rounds were opportunities for me to remove bias that could influence the research direction and credibility (see Gobo & Mauceri, 2014).

One significant researcher influence, as coordinator of the research exercise, was the maintenance of anonymity among the Delphi Panelists as research participants. The entire study grew on a foundation that participants should freely contribute in an uninhibited manner supported by individuals remaining anonymous. I was the critical axle for the maintenance of that trust. I maintained all safeguards for research reliability, credibility, and trustworthiness by strict and confidential handling of the identity of the Delphi panelists and the integrity of the data provided by these experts (see Golkar & Crawley, 2014; Houghton, Casey, Shaw, & Murphy, 2013).

Tufford and Newman (2012) indicated qualitative researchers use bracketing to mitigate preconceptions that may taint the entire process. I was mindful that familiarity with the research topic because of professional practice must remain subservient to the quality controls barriers necessary for removal of research bias. Failure to recognize and to remove this bias could have been deleterious to the study.

## Methodology

The normative, commonly known as classical or conventional, Delphi technique involved a process of iterations which commenced with an open-ended question or set of questions shared with expert contributors (Donohoe & Needham, 2009; Hasson & Keeney, 2011). Open-ended questions encouraged a free sharing of information by expert contributors (Yousuf, 2007). The responses ranged from a first-hand recollection of a sequence of events and how that impacted on a particular research topic, to the opinion of the participant on items where there were no set or agreed to guidelines or common knowledge (Novakowski & Wellar, 2008). From the initial responses to the Round 1 questions, I developed the Delphi second round questionnaire. For Round 1 of this study, participants commented on a list of reasons for accidents in the electric power industry, provided additional reasons for accidents, proffered possible solutions to accidents, and suggested ways to prevent further and future accident events.

In the second round, participants provided information on the desirability and feasibility of possible issues identified in the first round. The solutions then formed the basis for the Round

3 questionnaire where participants explored the importance of the issues that met the acceptance criteria from Round 2. In Round 4, participants provided their confidence and final agreement on the relevant and important solutions to accidents, where electrical power industry workers were seriously injured or killed, derived through the earlier rounds of this study.

In Round 2, participants responded to two different and distinct 5-point Likert-type scales; one for responses that they considered as desirable and another for what they considered as feasible. Where 70% or more of the participant responses selected a score of 3 or more on both Likert-type scale for an issue, the same item remained for inclusion in the Round 3 questionnaire (Brady, 2015). In Round 3 I provided information feedback on Round 2, via Survey Monkey, to each participant, and this contained comments about the overall responses that differed from the response from that particular participant. For each Round 3 question, the participants were invited to review the feedback and to provide a response on a 5-point Likert-type scale developed to measure the importance of the solutions (Brady, 2015; Heitner et al., 2013).

This process continued until the results from the exercise met the consensus condition that I set or if there was no likelihood of a consensus. If there were no consensus, the study would have ended prematurely with a contrary conclusion. I set the necessary conditions for consensus or agreement condition. As an example, more than 70% of the participants must support a point by selecting a score of more than 2 on the Likert-type scale for any item to reach a consensus after the study. This condition signified that the item is desirable, feasible, important, and with the confidence of more than 70% of the Delphi panelists. If for any question, 70% or more of the participants selected a score of 1 or 2 on the 5-point Likert-type scale then the consensus point remained unmet. Heitner et al. (2013) used a similar approach to determine consensus: A statistical determination made with more than 80% of the respondents' responses for each question.

I assumed great responsibility for ensuring that information shared with the research participants were correctly analyzed and did not misinform the experts about progress on the study. I could have influenced actual expert-participant responses and effectively bias the study in this way. The main research aim was to encourage free thinking and not to condition reactions in an artificial and biased manner (Hsu & Sandford, 2007; Sandrey & Bulger, 2008). If the research did not end after the fourth round, participants might have become disinterested and not continue to provide quality feedback (Hsu & Sandford, 2007). Research delay was also possible if I was unable to return feedback on the participants' responses promptly (Hsu & Sandford, 2007).

Linstone and Turoff (2011) indicated that a weakness of the Delphi was that researchers did not press expert participants far enough to encourage them to change opinions, to think differently, and to challenge their fundamental assumptions. Linstone and Turoff (2011) further suggested that researchers should focus more on divergent thinking and why experts feel differently about critical issues rather than shared and convergent positions that provide consensus. A low drop-off rate of research participants was usually a good indication of research credibility and resulted in confidence. The acceptable sample size for a Delphi technique was often around 12 to 20 participants (Hsu & Sandford, 2007).

**Participant Selection Logic**

Electricity was a widely known hazard, and it was dangerous if not managed, just like fire (Capelli-Schellpfeffer et al., 1999). Experienced electric power industry managers, supervisors, skilled workers, and trainers were practitioners with the ability to recognize the dangers associated with electricity and the other hazards associated with work activities in this sphere. Practitioners with more than 10 years in this industry should possess sufficient industry knowledge, understanding of systems, technologies, rules, procedures, and regulatory framework that drive this industry (Albert & Hallowell, 2013).

Hsu and Sandford (2007) advised that a careful selection of research expert participant candidates was crucial to the eventual success of the study. Linstone and Turoff (1975) and Hallowell and Gambatese (2010), indicated that experts for Delphi studies must be highly regarded, respected, and well-known in the area of focus for the study. Baker, Lovell, and Harris (2006) described experts suitable for Delphi technique as individuals with knowledge, experience, understanding of policies, procedures as well as the practices and how these were relevant for the field.

For this study, practicing, experienced, and knowledgeable electric power industry managers, supervisors, workers, and trainers formed a purposive sample of experts. This normative Delphi approach aimed to determine how to prevent fatal and serious accidents that were happening in the U.S. electric power industry. Experts were individuals sourced through Social Media (LinkedIn).

For this study, an expert panelist satisfied three criteria: (a) was a manager, supervisor, trainer, or worker in the electric power industry; (b) had more than 10 years of industry practice and experience; and (c) had knowledge about accidents in the electric power industry in the United States. Five participants in each category, manager, supervisor, trainer, or worker, were originally considered as adequate for this study. A minimum sample size of 20 was sufficient. Heitner et al. (2013) considered an acceptable sample size of 30. For drop-offs, higher than 10% would negatively impact research influence and success (Hsu & Sandford, 2007). To cater for this possibility, I focussed on prompt feedback to participants and careful analysis of data so that consensus could become possible without participants compromising their individual views in favor of group thinking (Hsu & Sandford, 2007). For this study, a similar approach to that used by Heitner et al. (2013) was an acceptable option. The number of research participants would vary depending on the research topic and my preference. Saturation of information depended on the actual research problem, the number of participants, and my focus (Heitner et al., 2013). Hallowell and Gambatese (2010) cautioned that the sample size must always accommodate possible participant drop-off during the study and therefore the minimum sample size must be avoided and not researcher preferred. That avoidance was essential for maintaining research credibility. Hsu and Sandford (2007) cautioned that a large expert sample could make the data difficult to manage and thus can require longer times for researcher processing and analysis. Table 5 lists different sample sizes used in previous studies. For this study, the expectation was that 20 participants would provide credible results and saturation especially if there were five individuals in each category of participants. Another five panelists were enlisted to start the study to allow for panelist drop-off before the conclusion of the process; to equal the 25 participants who contributed to the Heitner et al. (2013) study. A panel size greater than 30 could contribute to researcher inefficiencies and delays that could promote panelist drop-out (Yousuf, 2007).

Table 5

| Recommended Sample Size | Source | Different Source |
|---|---|---|
| 7 – 10 | Linstone and Turoff, (1975) | Donohoe and Needham (2009) |
| 3 - 80 | Rowe and Wright (1999) | |
| 15 - 20 | Delbecq, Van de Ven, and Gustafson (1975) | Hsu and Sandford (2007) |
| >20 | Heitner et al. (2013) | Van Hecke et al. (2015) |

*Note*. Sample sizes from previous studies

**Selection of participants for multi-round Delphi study.** For this normative Delphi study, invitees were potential experts from each of the operating across the United States. I sent correspondence to well regarded regulatory agencies and professional organizations requesting assistance in identifying possible participants for this study. I also searched public social media (LinkedIn) for possible participants. Participants for this study needed to satisfy the conditions listed for an *Expert Panelist* previously defined in Chapter 1. An expert panelist was an individual who met three criteria: (a) be a manager, supervisor, trainer, or worker in the electric power industry; (b) have more than ten years of industry practice and experience; (c) have knowledge about accidents in the electric power industry in the United States.

E-mail invitations via Survey Monkey went to other prospective candidates; this happened when I received feedback from potential candidates identified through LinkedIn. No participant was accepted for this study before I conducted a suitability check. I required that participants provide demographic information on their years of industry experience, particulars about their specialty, certification, and education; Participants, identified from LinkedIn, were requested to confirm their information publicly available through that medium.

Each participant received a personal request which aligned with the Walden University policies for researching human subjects. All regulatory requirements at the federal, state, regional, industry, and professional levels were satisfied in the pursuit of this study. The invitation (via Survey Monkey) included information about the purpose of this study. It included a summary of the research methodology, the level of contribution and requested participation from potential participants, an estimate of the time that they were asked to commit, reasons why the individual was suitable, and how vital and valuable this study is.

**Instrumentation**

The first round research focus came from the literature review conducted as part of this study. The reasons for accidents, worker deaths, and injuries, as identified in previous studies were I analyzed before the commencement of the Delphi process. The data derived from the literature review guided the development of questions for Round 1 of the Delphi process. Demographic information about the participants gleaned from questions added for this specific purpose. These questions are in Appendix E. I grouped the Round 1 questions in a manner that would come from the literature review and the research questions which aligned the reasons for worker fatalities and injuries from accidents occurring in the U.S. electric power industry and why these occurred.

Round 1 commenced when the expert panelists received the questionnaire, accessed through Survey Monkey. Results of Round 1 were analyzed to find the major themes about possible solutions as identified from the Delphi panelists responses and coded in line with the

Bolman and Deal four-frame model. These themes formed the basis for Round 2 questions where participants responded on a 5-point Likert-type scale to each of the issues identified in Round 1. The items derived from Round 2 provided input for the Round 3 questionnaire. In Round 2, participants responded to two different and distinct 5-point Likert-type scales; one for responses that they considered as desirable and another where they considered how feasible addressing and correcting these issues were to prevent accidents, serious worker injuries and deaths. Where 70% or more of the participant responses selected a score of 3 or more on both Likert-type scales for the same issue, the item remained for inclusion in the Round 3 questionnaire. For each of Round 3 and Round 4, participants responded to a 5-point Likert-type survey. The Likert-type scales mirrored those used by Heitner et al. (2013). Desirability in Round 2, rated as 5 for highly desirable to 1 for highly undesirable and feasibility rated from 5 for definitely feasible to 1 for definitely unfeasible. Rating in Round 3 ranged from 5 to 1 for extremely important to not at all important respectively. Rating in Round 4 ranged from 5 to 1 for definitely certain to unreliable. Questions from Round 3 where 70% or more of the participant responses selected a score of 3 or more on the 5-point Likert-type scale were treated as important, and as a consensus item. In Round 4 participants rated their confidence in the overall findings of consensus-based solutions emergent from Round 3.

**Procedures for Recruitment, Participation, and Data Collection**

Data collection from participating experts in the Delphi technique multi-round process came from details volunteered about their competencies which justified their selection consistent with a definition of expert I provided. For Round 1, participants received the questionnaire via

Survey Monkey.  This questionnaire listed questions I set , and determined from the literature review conducted as part of this study (see Appendix E).

For the first round of this study, I provided a listing of possible reasons about how accidents happened in the U.S. electric power industry and invited participants' comments and responses.  Participants provided an understanding of what to do to prevent future accidents. Novakowski and Wellar (2008) suggested that the participants should be allowed to indicate other pertinent information relevant at this stage of the process and not captured before in the set of Round 1 questions.  I conducted data collation and coding from this phase and developed a summary of the top solutions identified by 70% or more participants in Round 1.  This summary was on the opening page of Round 2.

In Round 2, participants responded, via Survey Monkey, to two different and distinct 5-point Likert-type scales; one for responses that they considered as desirable and another where they considered how feasible addressing and correcting these issues were to prevent accidents, serious worker injuries and deaths. Where 70% or more of the participant responses selected a score of 3 or more on both Likert-type scales for the same issue, the item remained for inclusion in the Round 3 questionnaire.  For each of Round 3 and Round 4,  participants responded to a 5-point Likert-type survey.  The Likert-type scales mirrored those used by Heitner et al. (2013). Desirability in Round 2, rated as 5 for highly desirable to 1 for highly undesirable and feasibility rated from 5 for definitely feasible to 1 for definitely unfeasible.  I then provided the results of Round 2 and a survey developed for the Round 3 via Survey Monkey.  The participants then responded to each Round 3 question and ranked these according to the five ratings on the Likert-type scale from "not important at all" to "extremely important" based on their understanding of the importance of the issue.

My aim in Round 3 was determining the importance of different points derived from Round 2. For Round 4, responses from Round 3 where 70% or more of the participant responses selected a score of 3 or more on the 5-point Likert-type scale; were treated as important and extracted. In Round 4 participants rated their confidence in the overall findings of consensus-based solutions emergent from Round 3. These solutions, based on the Delphi panelists responses, to accidents in the electrical power industry where workers were seriously injured or killed and derived through the different Delphi rounds of this study, might prove integral to the prevention of future accidents in this industry and elsewhere. The study ended after Round 4. A real consensus in this study came from important, desirable, and feasible factors that were agreed to by the Delphi panelists. The factors identified as desirable and feasible and important constituted the major findings of this study. The desirable and feasible factors that were not deemed important could provide opportunities for further research.

For each round of this study, I sent an email via Survey Monkey to each participant, and they had two weeks to respond to the questionnaire. I programmed a reminder email on Survey Monkey for participants who did not respond after the first week. For each round, the questionnaire closed after two weeks. Afterward, the participants were no longer be able to access the questionnaire. I performed data analysis at the close of each round and developed questionnaires for Round 2, Round 3, and Round 4 accordingly. Once the research ended, after Round 4, I forwarded to each participant a “thank you” communication to formally close the

Delphi exercise. I provided a summary document listing the main research results to each participant as part of the process close-out.

**Data Analysis Plan**

Data from participants responses derived from the Delphi Round 1 are analyzed thematically based on a review of common terms and ideas. A further grouping of the codes derived from the thematic approach according to the Bolman and Deal four-frame model (as shown in Table 2 in Chapter 2 Overview of the Four-Frame Model) followed. This grouping then guides the development of questions for the Delphi Round 2. Given that participants are electrical power industry practitioners, there were similar terms used by these individuals in their responses to the questions. I searched for these common terms and grouped them into the same data category. As an example, a high voltage power line and a high-power installation had the same meaning once I identified the context of each response. I conducted an examination and coding analysis of participant responses based on consensus and commonality of terms used, individual views, the frequency of use of words, and concepts. I then assessed the data derived from the word frequency, grouped them into broad categories, and identified fundamental ideas and issues. This approach was used to reduce different responses from Round 1 into broad categories from which I developed the Round 2 questions. This thematic analysis proved beneficial as it allowed for the organization of the questions in Round 2 in a logical, systematic way while seeking participant responses from Round 2 and in the later rounds.

Assessment and analysis of responses received from the Delphi Round 1, was done by tagging of different themes that evolved from the data derived from the Delphi process and other broader groups where multiple themes, aligned with analysis. The identification of actual themes and data categories, in this study, occurred when the responses from the Delphi Round 1 exercise are obtained and assessed. I analyzed the participants' responses from Round 1 by employing a direct transfer of data from Survey Monkey into NVivo 12 Plus. Each response from Round 1 formed the input for the Round 2 questionnaire.

The aim in Round 2 was to determine the desirability and feasibility of the issues identified in Round 1 about the solutions to these accidents, and how to prevent other accidents. The items from Round 2 with a score of 3 or higher on the Likert-type scale and endorsed by 70% or more respondents proceeded to Round 3. The aim of Round 3 was to determine the importance of possible solutions after Round 2. Data received from each expert in the Delphi Round 3 with a score of 3 or higher on the Likert-type scale and endorsed by 70% or more respondents for each item proceeded to Round 4. For each item on the Round 3 questionnaire, the Delphi panelists were asked to indicate their choice from *most important* to *not important* in determining solutions to workplace accidents. *Most important* was reflected as a five (5) on the Likert-type scale for Round 3 and *not important* was the lowest rank (Heitner et al., 2013).

In Round 4 participants rated their confidence in the overall findings of consensus-based solutions emergent from Round 3 for accidents where electrical power industry workers may become seriously injured or killed. Dalkey and Helmer (1963) suggested that these were powerful tools that could describe data in a simple but effective manner. Hsu and Sandford (2007), Heitner et al. (2013), and Linstone and Turoff, (1975) converged on this view.

## Issues of Trustworthiness

### Credibility

The primary attribute for a credible study was how believable it was. In a Delphi study, consensus promoted that belief. As the research participants remained anonymous, it was imperative that I crafted the research documentation so that the quality of the responses and the awareness of the participants blended to widespread acceptability that they were appropriate and sufficient to review the research problem and questions. That required researcher vigilance and diligence to prevent possible bias in participant selection and their responses to the items on the different questionnaires (Houghton et al., 2013). Keeping a reflective research journal (McGuinness & Brien, 2007), exercising a process of bracketing (Tufford & Newman, 2012), and achieving saturation from the responses of the Delphi panelists, supported research credibility. Confidence derived from Round 4 deliberations in this study also supported research credibility.

This researcher did not favor the pre-test as it would have been only possible after the research participants were known and selected. My dependence on previously available studies and data, an assessment of that data using the Bolman and Deal four-frame model, and data derived from the Delphi technique supported research credibility. I also achieved credibility by keeping a reflexive journal and audit traceable documentation.

### Transferability

Patton (2015) indicated that transferability surrounded the responsibility I assumed as the researcher to ensure that results derived can be scrutinized and the process can find relevance in other research areas. One risk for this current study was that it focussed on the U.S. electric power industry. It was possible that the unique nature of this industry made transferability challenging. Transferability could also depend on how convincing I was in describing the research sampling methods, the process of selecting research participants, and how well the results were crafted and believable. This study could prove useful in further studies conducted on the U.S. electrical power industry and elsewhere.

**Dependability**

The efficiency with which I recorded the research process, the quality of data and the consistency achieved throughout the study were vital for the dependability of the study (Ravitch & Carl, 2016). My first test as the researcher was to provide consistent details to each Delphi panelist for a proper understanding of the process and what their roles were. I improved the likelihood of providing consistent details as indicated by keeping and utilizing a reflective research journal (McGuinness & Brien, 2007). The best indication of research dependability was panelist dropouts from the process, before the completion of the overall exercise, as that could have brought the results into focus and possibly derail the entire study. Dropouts in a study where the participants could become disinterested or if the process was confusing and not providing for consensus negatively impact the dependability of the study (Dalkey & Helmer, 1963; Hsu & Sandford, 2007; Linstone & Turoff, 1975; Yousuf, 2007).

**Confirmability**

Patton (2015) suggested that research bias was a critical influence on research confirmability. Yin (2013) extended this into the tangible evidence from any research which, if invalid, can set conditions for research challenge and loss of confirmability. In this study, the focus on maintaining data that could be reproduced to substantiate research thinking and direction was paramount in ensuring research confirmability. Strategies for data coding, for example, were sufficient to encourage support reproducibility of the research exercise. The conceptual framework for this study, Bolman and Deal four-frame model, supported and fully explained strategic suitability, relevance, and confidence (Bolman & Deal, 2013). That was a possible risk to the research confirmability in this study. It was a versatile and practical model and not considered high risk or as a concern to the successful completion of this research. I enhanced research dependability by keeping appropriate research records that can provide for successful audit trails (Tufford & Newman, 2012).

**Ethical Procedures**

Research students at Walden University must comply with the research guidelines set by the institution. These guidelines referenced the university accepted standards of ethics and the federal regulations that governed research work. IRB review of the current research maintained these standards (Walden University, 2018). As the researcher, I accepted my responsibility to maintain the highest ethical, research, and moral standards as I aimed to accomplish this research into the prevention of fatal and serious accidents in the U.S. electric power industry.

Before contacting individuals to determine whether they may be suitable as Delphi panelists, I received IRB approval. The Walden University IRB approval number is 02-28-19-0648285 which will expire on February 27, 2020. A participant consent form was drafted and submitted to the IRB for that approval. The IRB clarified all permissions needed for this study. This approval was necessary before personal communication with prospective panelists occurred. That communication included an informed consent form which guaranteed that participation in this study was voluntary and contact information so that the individual could query concerns or questions that they had. The informed consent communication on Survey Monkey with research participants included the research question and purpose. The research risks, benefits, and a reminder that panelists can withdraw from the study if that option was preferred were also in the informed consent communication. No personal information was solicited outside of vital demographics necessary to ensure an audit trail and for research credibility. The Informed Consent form was the initial page of the Survey Monkey survey. Potential participants saw the informed consent and were asked to click that they agreed. If there was agreement, they continued with the survey. If they disagreed the survey ended, and Survey Monkey thanked them for participating. It was not possible or practical to remove the data provided in the earlier Delphi-Rounds by participants who withdrew.

The use of a Likert-type survey conducted through Survey Monkey removed opportunities to link individual panelist response to particular questions or answers. I solely maintained all research materials and data and will continue to do so for five years as required by Walden University. I was the sole individual who was responsible for maintaining confidentiality in this research. Participants were asked to provide some demographic information. No identifying information was necessary. Participant-to-participant anonymity was guaranteed. The identities of the Delphi panelists will not be published or communicated in data linked to this study. I ensured that safeguards were in place to maintain this data anonymity guarantee. First, all data was encrypted, password protected, and devoid of emails or traceable demographic indicators. I retained sole responsibility for password maintenance.

Delphi panelists were assigned a random identifier, through Survey Monkey, to maintain anonymity. All electronic data from this study is kept in an external hard-drive locked at a commercial bank safety deposit box maintained by me. I will destroy this data after the fifth year in line with the Walden University guarantee of the keeping of individual and personal information for five years after the study. I accepted responsibility for maintaining panelist anonymity and for the coordination of communications between the panelist and researcher in a manner that can be scrutinized by the IRB should the panelist have questions for me as the researcher or the IRB.

## Summary

This research was conducted to determine ways to prevent fatal and serious accidents that are occurring in the U.S. electric power industry. Included in this chapter was a description of the research methodology. A normative Delphi technique was preferred. The aim was that with this effort, the findings were meaningful and could be used to help improve working arrangements to avert workplace accidents in the U.S. electric power industry. The research structure included a detailed description of how to conduct the research and the actual research question explored. Since any research of this kind must address the human ethical and moral guidelines set by the University and the Federal Government; all actions and arrangements that followed fully complied with these requirements. The data management arrangements, as well as the advantages and disadvantages of the Delphi technique, were addressed in this chapter.

For this normative Delphi study, the panel experts had to meet three criteria: (a) be a manager, supervisor, trainer, or worker in the electric power industry; (b) have more than ten years of industry practice and experience; (c) have knowledge about accidents in the electric power industry in the United States. The measures that crucially provided for bias reduction, issues of trustworthiness and ethics are in this chapter; this consisted of the steps to support the researcher to maintain trustworthiness, such as panelist selection, bracketing, a reflexive journal, and an audit trail. The process for maintaining panelist assurance on anonymity and confidentiality against potential risks and IRB requirements also are in this chapter. Chapter 4 will involve the analysis and discussion of the research results.

# Chapter 4: Results

In this chapter, I present the results of this Delphi study on possible actions that can be taken to prevent workplace accidents in the U.S. electric power industry. This research is an investigation designed from factors identified in previous studies as causes of accidents and the subsequent exploration to determine if practicing experts believed that these factors were relevant to the U.S. electric power industry. The effort also involved consideration of how to prevent these accident causal factors on the assumption that by preventing accidents, workers will not suffer serious injuries or be killed when working.

The research question was: What is the consensus of opinion of a panel of experts in the electrical power industry regarding desirable and feasible solutions to fatal and serious workplace accidents occurring in the United States?

To answer this question, I sought consensus practicing experts from the U.S. electric power industry via a four-round normative Delphi study. Practitioners satisfied pre-set criteria before becoming participants. For this study, an expert was an individual who meets three criteria: (a) be a manager, supervisor, trainer, or worker in the electric power industry; (b) have more than 10 years of industry practice and experience; and (c) have knowledge about accidents in the electric power industry in the United States.

The study was a complex one, with 28 of the 30 questions from Round 1 being voted by participants as relevant to the U.S. electric power industry and on the number of possible solution responses in Round 1. This reality required data analysis to be much more detailed than I initially expected, and as a result, the study did not mirror the original intention as described in Chapter 3. This departure was because of the volume and varied responses that 26 of the participants provided to 28 different items in the Round 1 questionnaire. To maintain a manageable study, I preserved the same format of the questionnaire throughout the Delphi rounds. Each question required a response using a 5-point Likert-type scale, as described in Chapter 3. For Round 2, I developed the questionnaire after an analysis conducted on the solution data that participants provided in Round 1. The Round 2 questionnaire is in Appendix F. By maintaining the exact solution responses, rather than the grouped solutions responses as shown in Tables 9, 10, and 11, critical details were kept for the entire study. In Round 3, I requested that participants list their answer on a 5-point Likert-type scale to rate the importance for each item. This approach was a departure from the original intent: It was expected, but not categorically detailed in Chapter 3 that, for Round 3, participants would rank the importance of desirable and feasible solutions derived from Round 2. In Round 4, I asked participants to list their answer on a 5-point Likert-type scale to indicate confidence in the entire study. Instead, the questionnaire was done for participants to note confidence in each item. This approach was also a departure from the original intent. For Round 4, participants indicated their confidence in individual items of that questionnaire instead of the entire study.

This chapter includes sections on (a) research setting, (b) demographics, (c) data collection, (d) data analysis, (e) evidence of trustworthiness, and (f) the study results.

## Research Setting

Skulmoski, Hartman, and Krahn (2007) suggested that the Delphi study is useful for determining whether consensus could exist among anonymous individuals, as experts, on topics that are challenging and complex. The Delphi methodology allowed me to confirm that the literature review I conducted as part of the preparation for this study was relevant, appropriate, and applicable to the real focus on the electric power industry (see Hsu & Sandford, 2007; Yousuf, 2007). The four different rounds of deliberations by the expert panelists were consistent with similar Delphi studies conducted by Linstone and Turoff (2011) and Delbecq, Van de Ven, and Gustafson (1975).

Electric power industry practitioners from across the United States were invited to participate in this study. Participation in this study was voluntary. Each of the invitees had to consent to participate before being accepted and permitted access to the Round 1 questions. I received Walden University IRB approval before for seeking possible participants, which occurred by invitation on public social media. The Walden University approval number is 02-28-19-0648285. I used LinkedIn to search for suitable study candidates. Emails were sent to two of the more recognized institutions with a broad reach in the U.S. electric industry; consistent with IRB approval. One of the institutions has responsibility for reliability regulation, while the other is an internationally recognized professional association. There was no response to these emails. I then searched for electric industry practitioners on LinkedIn, a purposeful search with 320 invitations, 27 positive responses, and the only participants in this study. Each of the participants satisfied the requisite ask for an expert in this study.

I then sent a formal invitation to each candidate via SurveyMonkey. Once the candidate responded, I sent a consent request to the candidate via SurveyMonkey. The IRB approved the consent request sent to prospective participants by issuing the approval number for this study. The Round 1 questionnaire was available to participants only after the invitee provided consent and returned the form to me via Survey Monkey.

## Demographics

The geographical area from which the participants came spanned the mainland United States and included Hawaii. The average length of service for participants in the electric power industry was 25.2 years. There were three (3) individuals who started their careers as workers and remained workers at the time of this study. These individuals were a power station electrician (31 years service), a line worker/forrester (17 years service), and another electrician (17 years service). Seven (7) participants began their careers as workers and eventually became supervisors. These participants had an average of 28.14 years of service. Only two (2) of these individuals remained supervisors at the time of this study; a general foreman and a lineman/foreman/general foreman. The others became trainers, professionals, or managers. Eleven participants were supervisors at one point during their careers. Six (6) participants indicated that they were trainers at some point in their careers. Only one of these individuals was hired as a trainer and was a trainer for 15 years at the time of this study. Two individuals were supervisors before becoming trainers, with 42 and 38 years of service. Three trainers eventually became managers, while another two trainers became professionals. Eleven (11) participants were electric industry professionals. There were 12 managers, as represented in Tables 6 and 7.

Only two (2) managers began their careers as managers. Four (4) of these individuals started as professionals. Their service lengths were 43, 38, 37, and 15 years in the U.S. electric power industry. Another manager began as a trainer and had 38 years service. Two (2) managers started as workers and moved to supervisors, trainers, professionals before becoming managers. Their industry experience was 51 and 42 years. I removed participants' identities, as this was a condition set for this study included in the consent agreement between me and each participant.

Table 6

| | Participant | Yrs Service | Worker | Supervisor | Trainer | Professional | Manager |
|---|---|---|---|---|---|---|---|
| New York | #1 | 38 | | | T | | M |
| Montana | #2 | 37 | | | | P | M |
| Texas | #3 | 16 | W | | T | P | |
| Texas | #4 | 31 | W | | | | |
| New York | #5 | 16 | | | | | M |
| New York | #6 | 42 | W | S | T | | M |
| Missouri | #7 | 30 | W | S | | | M |
| Philadelphia | #8 | 30 | W | S | | P | |
| Texas | #9 | 51 | W | | T | | M |
| Arizona | #10 | 30 | W | S | | | |
| Washington D.C. | #11 | 10 | | | | P | |
| Georgia | #12 | 36 | W | S | T | P | |
| New York | #13 | 43 | | | | P | M |
| Mississippi | #14 | 20 | | S | | | |
| New York | #15 | 31 | | | | | M |
| California | #16 | 10 | | S | | | M |
| North Carolina | #17 | 20 | | S | | P | |
| New York | #18 | 15 | | | | P | M |
| Hawaiian Islands | #19 | 20 | | S | | | M |
| Missouri | #20 | 19 | W | S | | | |
| Mississippi | #21 | 10 | W | S | | | |
| San Francisco Bay | #22 | 15 | | | | P | |
| Missouri | #23 | 38 | | | | P | M |
| Idaho | #24 | 24 | | | | P | |
| Florida | #25 | 17 | W | | | | |
| New Jersey | #26 | 17 | W | | | | |
| Texas | #27 | 15 | | | T | | |
| Number of Invitees | | | 12 | 11 | 6 | 11 | 12 |
| | 320 | | 27.42 | 24.27 | 33.00 | 25.82 | 30.92 |
| Managers who started as Workers = 2 | | | Average # Years Service = | | | 46.50 | |
| Professionals started as Workers = 3 | | | Average # Years Service = | | | 27.33 | |
| Trainers who started as Workers = 4 | | | Average # Years Service = | | | 36.25 | |
| Supervisors started as Workers = 7 | | | Average # Years Service = | | | 28.14 | |
| Workers who started as Workers = 3 | | | Average # Years Service = | | | 21.67 | |
| | | | Average Service (Yrs) | | | 25.22 | |

*Note:* Participant Information

Table 7

| Added Demographic Details (Participants) | Participant |
|---|---|
| Transmission and Distribution construction, maintenance and operation | #1 |
| Transmission Engineer/Manager | #2 |
| Journeyman Lineman/Senior Technical Instructor/Safety Prime | #3 |
| Power Station Electrician | #4 |
| Transmission Manager/Emergency Operations/Safety | #5 |
| Lineman/Line Supervisor/Trainer/Managed bare hand work on Transmission System | #6 |
| Groundman/Apprentice Lineman/Journeyman Lineman/Supervisor/Transmission Superintendent | #7 |
| Design Engineer/Advanced Field Coordinator | #8 |
| Substation Journeyman,Manager of Risk MMGT, Director of HR, Manager of Training, Chief Construction Manager | #9 |
| Lineman/ Foreman (Substations and Overhead Lines) | #10 |
| Operations Consultant and Technical Services | #11 |
| Lineman/ Foreman/Safety Coordinator/Lineman Trainer | #12 |
| Compliance Manager - Regulator Standards/Work Standards | #13 |
| Foreman | #14 |
| Area Manager in charge of 11 high voltage substations/scheduling of planned work, emergency work response, safety, facility maintenance and budget management | #15 |
| Safety/Manage work being done by Contractors on Utility System | #16 |
| Supervisor operations crews / Safety Professional | #17 |
| Environmental Health and Safety (EH&S) Section Manager. Transmission and Substation Operations with over 1,300 employees. | #18 |
| System Operations - grid monitoring Generating unit commitment T&D, Substation and Metering Project management Engineering studies Reliability reporting Risk management | #19 |
| Journeyman Lineman, Foreman, General Foreman. Distribution and Substation work. | #20 |
| General Foreman | #21 |
| Power Engineer, Insturment Engineer, Control Technican | #22 |
| Engineer/Manager: Systems/Operations/Transmission/Distribution/Generation | #23 |
| Senior Generation Engineer | #24 |
| Electrician | #25 |
| Line worker, forester | #26 |
| Technical skills training for workers in energized power lines and substations | #27 |

*Note*: Additional Participant data

## Data Collection

In Round 1, each of the participants had an opportunity to indicate whether the 30 different reasons for workplace accidents, as I developed based on previous studies, were relevant and pertinent in the electric power industry. Participants were also asked to provide other reasons for why accidents occurred not covered in the list developed for Round 1 and what they considered as ways of preventing further accidents in the electric power industry. I used possible solutions to prevent accidents suggested by the participants in Round 1 to develop the questionnaire for Round 2 of the Delphi study. In Round 2, participants considered whether these solutions were desirable and feasible. In Round 3, participants were asked to identify the important items, while in Round 4, they indicated their confidence with the list of overall solutions and preventative methods, derived from the earlier rounds, based on importance, feasibility, and desirability. I provided separate 5-point Likert-type scales for participant response for feasibility and desirability in Round 2; another 5-point Likert-type scale for importance in Round 3, and a final 5-point Likert-type scale for confidence in Round 4. Solutions in this study were only accepted if items were scored as a 3 or more on each Likert-type scale by 70% or more of the participants.

Prior to beginning Round 1, I estimated that the average time to complete each of the four questionnaires was less than 30 minutes. There were 27 participants in Round 1, 25 in Round 2, 24 in Round 3, and 23 participants completing Round 4. The average time taken by participants in Round 1 to complete the questionnaire was approximately three hours. Two participants took more than 24 hours while another participant took more than 17 hours to complete the Round 1 exercise. In Round 2, the average time taken was 30 minutes while they took an average time of 9 minutes in Round 3 and 67 minutes in Round 4.

Participants in Round 1 were asked to provide solutions to accidents for each item on the questionnaire and to indicate the possible challenges. The responses were collated for each question and then analyzed using the NVivo 12 Plus qualitative analysis software. I used the responses to develop a word cloud for each question and followed that with a word tree analysis. These pictorially represented critical words identified by the study participants. That way, I had a good indication of the common terms used by the participants and the context of these words and phrases. I then conducted auto-coding, sentiment coding, and researcher manual coding afterward. The auto-coding was done first to provide me with a view of the participants' responses and for a review to determine how relevant these could be in the data analysis. I then manually conducted sentiment coding (positive and negative). That indicated participants' response perspective, which preceded my manual coding. The manual coding involved the use of industry-relevant terms, the other questions on the Round 1 questionnaire, and themes that I deciphered from the word cloud, word tree, auto-coding, and sentiment coding done before. I then conducted a manual coding in line with the four-frames as offered by Bolman and Deal, which was the conceptual framework adopted in this study. This coding approach occurred for each of the 30 items listed in the Round 1 questionnaire. Appendix I includes all coding done as part of this study and more detailed information.

## Data Analysis

Table 8 above shows the Yes responses, as a percentage, for each issue, from Round 1, to indicate whether these contributed to accidents, serious worker injuries, and fatalities in the electric power industry.  Participants provided solutions to each of the 30 items in Table 8.  Two of these items were not supported with a yes-response by 70% or more of the participants, and I removed them from further consideration in this study.

The deleted items were Poor Regulatory Oversight, with 59.26% participant yes-response support, and Incorrect Labeling with 66.67%.  I also removed the solutions provided in Round 1 for these two items from further consideration in the study.  Each of the issues where more than 70% of the participants provided a yes-response remained for further consideration in Round 2 of the Delphi study.

As an example, Q4 in Round 1 was: List at least one way to prevent accidents that may be caused by "Poor work ethics; history of wrongdoing that went unaddressed."  What are the possible challenges?

There was a 92.59% yes- response to question Q4 with 26 different solutions forwarded by participants for poor work ethics: history of wrongdoing that went unaddressed: This is shown in Appendix J. From the Q4 solutions, a word cloud, word tree, auto-coding, and sentiment coding was done using NVivo 12 Plus before I conducted manual coding in line with the Bolman and Deal four-frames.

Figure 12 shows the word cloud generated for *Poor work ethics; history of wrongdoing that went unaddressed*. The associated word tree was developed by conducting word search queries based on the word cloud. The top words were work, safety, and practices. Figure 13 shows the Word Tree developed for work (the top word from the word cloud). auto-coding of the data followed, as shown in Figure 14. Figure 15 includes sentiments done afterward.

Table 8 Round 1 Causes that participants provided solutions

| % Yes | Question | Remarks |
|---|---|---|
| 70.37 | A: Q1: Poor Design | Move to Next Round |
| 88.89 | B: Q2: Management System Flaw | Move to Next Round |
| 59.26 | ~~Q3: Poor Regulatory Oversight~~ | Drop |
| 92.59 | C: Q4: Poor work ethics; history of wrongdoing that went unaddressed | Move to Next Round |
| 66.67 | ~~Q5: Incorrect labeling~~ | Drop |
| 85.19 | D: Q6: Medical and other personal issues | Move to Next Round |
| 88.89 | E: Q7: Grounding, earthing failures / errors | Move to Next Round |
| 88.89 | F: Q8: Ineffective and inefficient maintenance | Move to Next Round |
| 70.37 | G: Q9: Animals / living organisms | Move to Next Round |
| 92.59 | H: Q10: Hazardous worksite conditions | Move to Next Round |
| 96.30 | I: Q11: Unplanned events | Move to Next Round |
| 96.30 | J: Q12: Inappropriate work methods | Move to Next Round |
| 81.48 | K: Q13: Stakeholder demands | Move to Next Round |
| 96.30 | L: Q14: Poor judgment by individuals or work crews | Move to Next Round |
| 88.89 | M: Q15: Poor attitude and or behavior by individuals or work crews | Move to Next Round |
| 92.59 | N: Q16: Ineffective or no workplace training | Move to Next Round |
| 92.59 | O: Q17: Poor supervision | Move to Next Round |
| 96.30 | P: Q18: Work planning | Move to Next Round |
| 85.19 | Q: Q19: Management priorities | Move to Next Round |
| 92.59 | R: Q20: Poor team communication | Move to Next Round |
| 81.48 | S: Q21: Willful disregard for safety rules | Move to Next Round |
| 81.48 | T: Q22: Permit to work violations | Move to Next Round |
| 96.30 | U: Q23: Lock-out tag-out non-compliance | Move to Next Round |
| 92.59 | V: Q24: Organizational safety culture | Move to Next Round |
| 92.59 | W: Q25: Individual risk taking and negligence | Move to Next Round |
| 92.59 | X: Q26: Equipment failure | Move to Next Round |
| 88.89 | Y: Q27: Procedural error | Move to Next Round |
| 88.89 | Z: Q28: Poor management oversight | Move to Next Round |
| 70.37 | AA: Q29: Poor quality material | Move to Next Round |
| 92.59 | AB: Q30: Non-use or personal protective equipment | Move to Next Round |

*Note*: Data from Round 1 of Delphi study


*Figure 12*: Word Cloud (Poor work ethics; history of wrongdoing that went unaddressed)

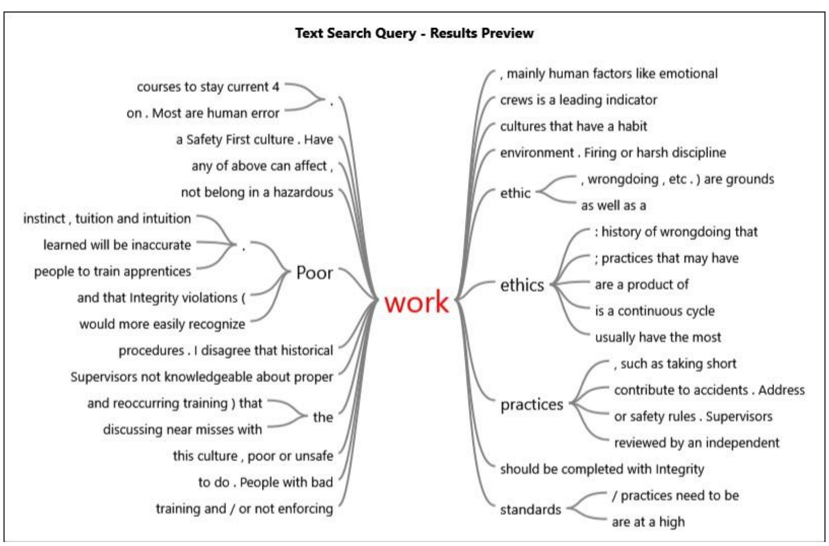


*Figure 13*: Word Tree (Poor work ethics; history of wrongdoing that went unaddressed)

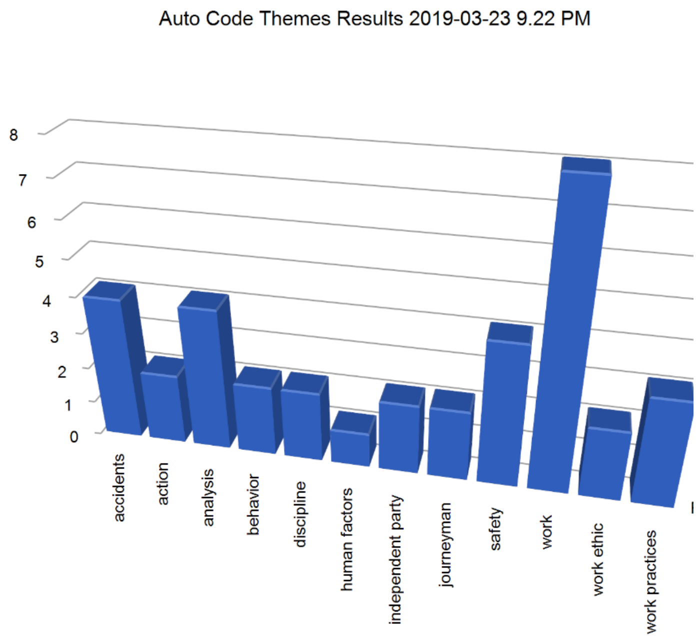


Figure 14 Auto-Coding (Poor work ethics; history of wrongdoing that went unaddressed)

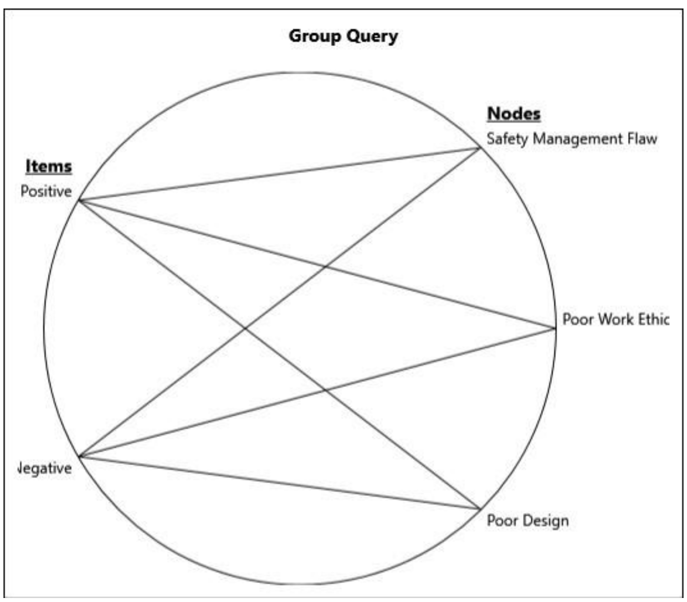


*Figure 15*: Sentiments ((Poor work ethics; history of wrongdoing that went unaddressed)

I then conducted manual coding; shown in Fig 16.

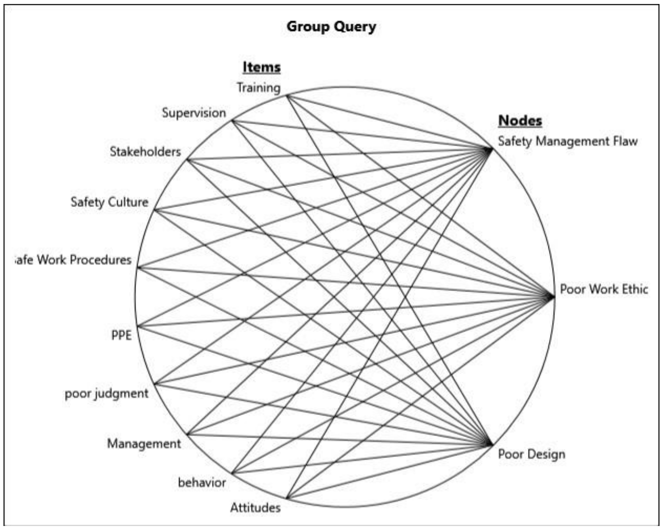


*Figure 16*: Researcher Conducted Manual Coding

Finally, I conducted coding consistent with the four-frames as espoused by Bolman and Deal; shown in Figure 17.

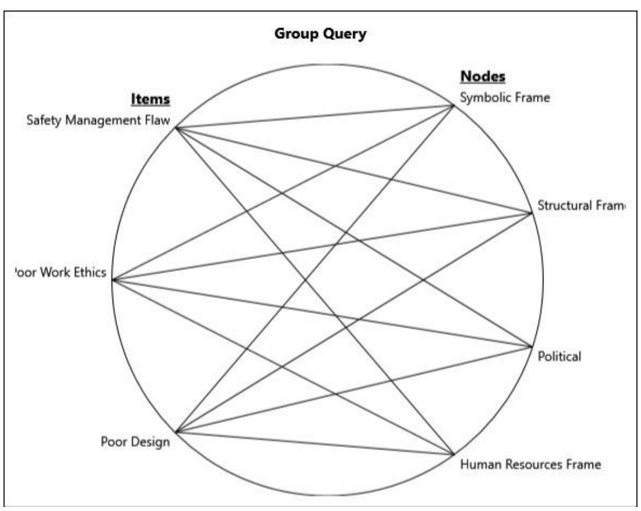


*Figure 17: Group Query*

I conducted a similar analysis for each of the other problem items where participants provided solution responses: shown in Appendix K.

Table 9 contains a summary of the top three solutions for each problem item where more than 70% of participants in Round 1 provided a yes-response to accident causation: Problems listed in Table 8 (with *Poor Regulatory Oversight* and *Incorrect Labeling* removed after Round 1). Solutions shown in Table 9, were Focus on People; S1, Work Standards; S2, Safety Management; S3, Workplace Training; S4, Management; S5, and Supervision; S6.

Solutions to Poor work ethics; History of wrongdoing that went unaddressed emerged from this analysis. These were Management-S5 (31% coding reference), Safety Management -S3 (16%), and Focus on People-S1 (15%). Similarly, the top three solutions for problem A (*Poor Design*) were Work Standards-S2 (28% coding reference), Management-S5 (28%), and Supervision-S6 (17%). The top three solutions for problem AB (*Non-use of Personal Protective Equipment*) were Supervision-S6 (22% coding reference), Work Standards-S2 (19%), and Safety Management -S3 (19%).

A weighted ranking of these top solutions was then done for each problem item in Table 9 and summarized in Table 10. I used a rank multiplier of seven for the top-ranked solution for each problem. The other two solutions had rank multipliers of five and three, respectively. These were arbitrary rankings that were used to separate the solutions derived to identify the top ranked solutions from the other solutions (Lourenço, & Lebensztajn; 2018).

Focus on People, S1, included solution coding regarding qualified personnel; experts and consults; human performance monitoring; regular job visits; management - workers communication and feedback; Individual and group behavior and habits; culture; teamwork; confidence; work planning and review.

Table 9 Top 3 Solutions to Identified Problems (Round 1)

| The Top Three Solution Areas for each question in Round 1 (% Coding) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Problems (From A, B, C,….., AB) / Solutions (S1, S2, S3, S4, S5, & S6) | | | | | | | | | |
| | A | | B | | C | | D | | E |
| S2 | 28 | S1 | 25 | S5 | 31 | S1 | 26 | S2 | 58 |
| S5 | 28 | S5 | 22 | S3 | 16 | S5 | 26 | S4 | 21 |
| S6 | 17 | S3 | 16 | S1 | 15 | S3 | 19 | S6 | 17 |
| | F | | G | | H | | I | | J |
| S2 | 21 | S4 | 22 | S3 | 19 | S5 | 21 | S4 | 19 |
| S3 | 21 | S2 | 20 | S4 | 19 | S4 | 19 | S5 | 17 |
| S4 | 20 | S6 | 18 | S2 | 14 | S6 | 17 | S6 | 16 |
| | K | | L | | M | | N | | O |
| S5 | 27 | S5 | 22 | S6 | 25 | S6 | 23 | S5 | 21 |
| S6 | 22 | S6 | 22 | S5 | 23 | S2 | 18 | S6 | 21 |
| S4 | 18 | S4 | 21 | S2 | 16 | S1 | 18 | S1 | 16 |
| | P | | Q | | R | | S | | T |
| S6 | 29 | S5 | 26 | S6 | 21 | S6 | 22 | S6 | 22 |
| S2 | 22 | S6 | 22 | S2 | 18 | S5 | 22 | S2 | 20 |
| S4 | 15 | S2 | 21 | S3 | 18 | S2 | 19 | S3 | 17 |
| | U | | V | | W | | X | | Y |
| S2 | 23 | S6 | 23 | S6 | 24 | S6 | 21 | S6 | 22 |
| S6 | 22 | S5 | 18 | S5 | 18 | S2 | 19 | S4 | 19 |
| S3 | 16 | S2 | 17 | S3 | 17 | S3 | 18 | S2 | 18 |
| | Z | | AA | | AB | | | | |
| S6 | 24 | S6 | 21 | S6 | 22 | | | | |
| S5 | 20 | S4 | 20 | S2 | 19 | | | | |
| S2 | 17 | S3 | 18 | S3 | 19 | | | | |

*Note*: Top three solution sets

Table 10 Solutions to Accidents

| Solution Areas | | **Rank 1** | PTS | **Rank 2** | PTS | **Rank 3** | PTS | **W/PTS** | PTS |
|---|---|---|---|---|---|---|---|---|---|
| Focus on People | S1 | 2 | 7 | 0 | 5 | 3 | 3 | 23 | 5 |
| Work Standards | S2 | 4 | 7 | 7 | 5 | 7 | 3 | 84 | 18 |
| Safety Management | S3 | 1 | 7 | 2 | 5 | 9 | 3 | 44 | 12 |
| Workplace Training | S4 | 2 | 7 | 5 | 5 | 4 | 3 | 51 | 11 |
| Management | S5 | 6 | 7 | 9 | 5 | 0 | 3 | 87 | 15 |
| Supervision | S6 | 13 | 7 | 5 | 5 | 5 | 3 | 131 | 23 |

*Note*: Top Group Solutions

Work Standards, S2, included solutions coding regarding: maintenance; reliability; inspection; international best practice; compliance; technology use, diagnostic testing, and research; quality management systems; troubleshooting; breakdowns; calibration; construction; operating; performance monitoring; focus on compliance; work methods, documented standard, procedures, implementation of change; work planning; work monitoring and review; qualified and experienced workers; manufacturers instructions; spares, materials, tools, and personal protective equipment; safety culture, barriers, housekeeping; and equipment failure.

Safety Management, S3, included solution coding regarding focus on safety; safety legislation; focus on compliance with approved work methods and procedures; culture of change; organizational culture; safety culture; quality of regulator inspections; distraction; individual obligation to inform; safe work procedures and documented standards; compliance with manufacturers instructions; workplace inspections; work planning, monitoring, and review; spares, materials, tools, and personal protective equipment; safety barriers; housekeeping; lock-out-tag-out, permit to work; and recordkeeping.

Workplace Training, S4, included solution coding regarding training frequency, quality, methods, and location ; company core values; communication and feedback; work processes, rules, and procedures; correcting (flaws); manufacturers instructions; compliance; work planning, monitoring, and review; materials, tools, documented standards, and inspection; personal protective equipment; safety systems; safe work barriers; good housekeeping; prevention of equipment failure.

Management, S5, included solution coding regarding management coaching and support; priorities, focus, and assumptions; response management and arrangements; actions; significance of regulator findings; regulator communication; industry stakeholders; qualitative of intake and recruits; disciplinary action; company-union collaboration; HR services; work planning, monitoring, and review; availability and quality of spares, materials, and tools; procedures and documented standards; organizational safety culture; equipment failure.

Supervision, S6, included solution coding regarding supervisor support and interaction; confidence; knowledge; ability; involvement in job – work; work team selection; compliance demand; reporting; worker involvement in work planning, monitoring, and review; availability of spares, materials, and tools; adherence with work procedures and documented standards; work inspection; personal protective equipment audits and inspection; tools inspection; recordkeeping; Lock-Out-Tag-Out oversight; safety barriers; safety culture; permit to work arrangements; equipment failure.

## Evidence of Trustworthiness

A study is worthy if the research value and process support clarity maintained throughout the study (Cope, 2014). Brady (2015) described the trustworthiness as the integrity of the research process and the results and outcome of the study. I was determined, in this study, to maintain cognizance of these requirements and not to be biased. Houghton, Casey, Shaw, & Murphy (2013) suggested that bias reduction was possible if I deliberately and proactively looked for opportunities to mitigate possible bias situations during the study. Achieving trustworthiness means that research credibility, transferability, dependability, and confirmability have been established.

**Credibility**

The primary attribute for a credible study is how believable it is. Credibility is the first strategy that I used to ensure research quality and to remove bias (Yin, 2013). This strategy, exemplified in the quality of data collected during the study and by the systematic approach to interpret the results derived from the entire process. Data collection in this study occurred from the literature search to the information developed through the four Rounds of the Delphi exercise. Items moved from one Delphi round to another when supported by more than 70% of the participants selecting a 3, 4 or 5 on a 5-point Likert-type scale provided for each item in each round of the Delphi study. Credibility developed from the systematic approach to analyzing qualitative data in this study. Responses were collated for each question and analyzed using NVivo 12 Plus. A word cloud and word tree analysis pictorially represented critical and common words participants used. These were a good reflection of the common terms and the context of these words and phrases. I conducted auto-coding of data before sentiment and manual coding. I also conducted manual coding in line with the Bolman and Deal four-frame conceptual framework adopted in this study. In a Delphi study, consensus promotes that belief. In this study, there was a consensus on 28 items. Achieving saturation from participants' responses also adds to research credibility (McGuinness & Brien, 2007). There was data saturation. Data were consistent and repeated by different participants in the Delphi (Dalkey & Helmer, 1963; Linstone & Turoff, 1975).

**Transferability**

Patton (2015) postulated that transferability was applying the findings from one study to other research in different spheres and disciplines. Transferability surrounds the responsibility I assumed to ensure that results derived can be scrutinized and the process can find relevance in other research areas (Patton, 2015). It is possible that while this study covered the entire United States, the results are relevant in the electric power industry outside the United States; in Canada where I, work, and in the Caribbean where I have extensive experience and knowledge. There are issues considered in this research, including workers working in remote locations, without direct supervision from supervisors and managers. The study findings may, therefore, be relevant to other industries in the United States, such as the telecommunication and other utilities such as water, natural gas, transportation, and high energy industry.

**Dependability**

Dalkey and Helmer (1963) postulated that the maintenance of data consistency in different areas of research is a measure of dependability. In this study, data gathering occurred through participants' responses, which resulted in consensus on a topic that has real-world significance. Data, sourced from an arrangement where questionnaires, were administered via Survey Monkey and research participants were anonymous to one another. Data analysis was done through a systematic approach using NVivo 12 Plus, which involved the automatic generation of word clouds, word trees, and auto-codes. These automatic analyses preceded manual coding in line with the conceptual framework upon which the study occurred.

Additionally, a set criterion of 70% or more participants agreeing to a particular issue by selecting a 3, 4, or 5 on a Likert-type scale before that item went to the next round of the Delphi study. The efficiency with which I recorded the research process, the quality of data and the consistency achieved throughout the study are vital for the dependability and captured in this study (Ravitch & Carl, 2016). Consistent details sent to each Delphi panelist, as approved by the IRB, for a proper understanding of the process and what their roles will be, also supported dependability (Hsu & Sandford, 2007; Yousuf, 2007). I kept a reflective journal which improved research details and management (McGuinness & Brien, 2007). Participant dropouts did occur, but 23 individuals completed the entire four Rounds of the Delphi. Before the exercise, a participant population of 20 was deemed sufficient for this study. There was data saturation. Data were consistent and repeated by different participants in the Delphi (Dalkey & Helmer, 1963; Linstone & Turoff, 1975).

**Confirmability**

Confirmability is a measure of objective corroboration of research results by an independent and unbiased party (Venkatesh, Brown, & Bala, 2013). Paton (2015) postulated that there is a potential for bias in qualitative studies. Yin (2013) supported that limitations and biases exist on data validation, analysis, and result explanation. Mitigation of that bias occurred by me as the researcher adopting a data analysis methodology where the first three assessment of qualitative data were automatic features of and generated using NVivo 12 Plus before the researcher attempted any manual coding. Even then, the conceptual framework I selected for this study guided the coding. I was deliberate in maintaining this strategy to data analysis and management throughout the study. Tufford and Newman (2012) described this as bracketing, a method of improving research quality by removing researcher assumptions and mitigating researcher bias. In this study, the focus on maintaining data that could be reproduced to substantiate research thinking and direction is one that can be reproduced and therefore, lends positively to research confirmability. The conceptual framework, Bolman and Deal four-frame model, was suitable, relevant, and provided research confidence (Bolman & Deal, 2013).

## Study Results

The research question was specific in the search for answers:

What is the consensus of opinion of a panel of experts in the electrical power industry regarding desirable and feasible solutions to fatal and serious workplace accidents occurring in the United States?

The different solution groups, S1 to S7 as in Table 11, were developed from responses provided by participants and further clarified in Table 12 up to and including Table 18. The process followed is shown in Figure 18. As discussed earlier in Chapter 4, the S1 solution group is a composite of the different sub-points about the group shown in Table 12. For the S2 solution group and each of the other solution groups from S3 to S7, the information about the respective sub-points is in Table 13 through to Table 18. The chart shown in Figure 18 is a simple depiction of the study process. That way, the logical sequence of the study can be better understood.

Testing and collation of participant responses on solutions to problems identified in Round 1 in this study occurred and were measured against the study criteria. In Round 2, the seven leading solutions (S1 to S7) was tested to determine whether participants found them desirable and feasible through two separate 5-point Likert-type scales; one for feasibility and another for desirability for each solution item. For S1, Focus on People, each of the sub-items described before was listed, and participant responses noted: as shown in Table 12.

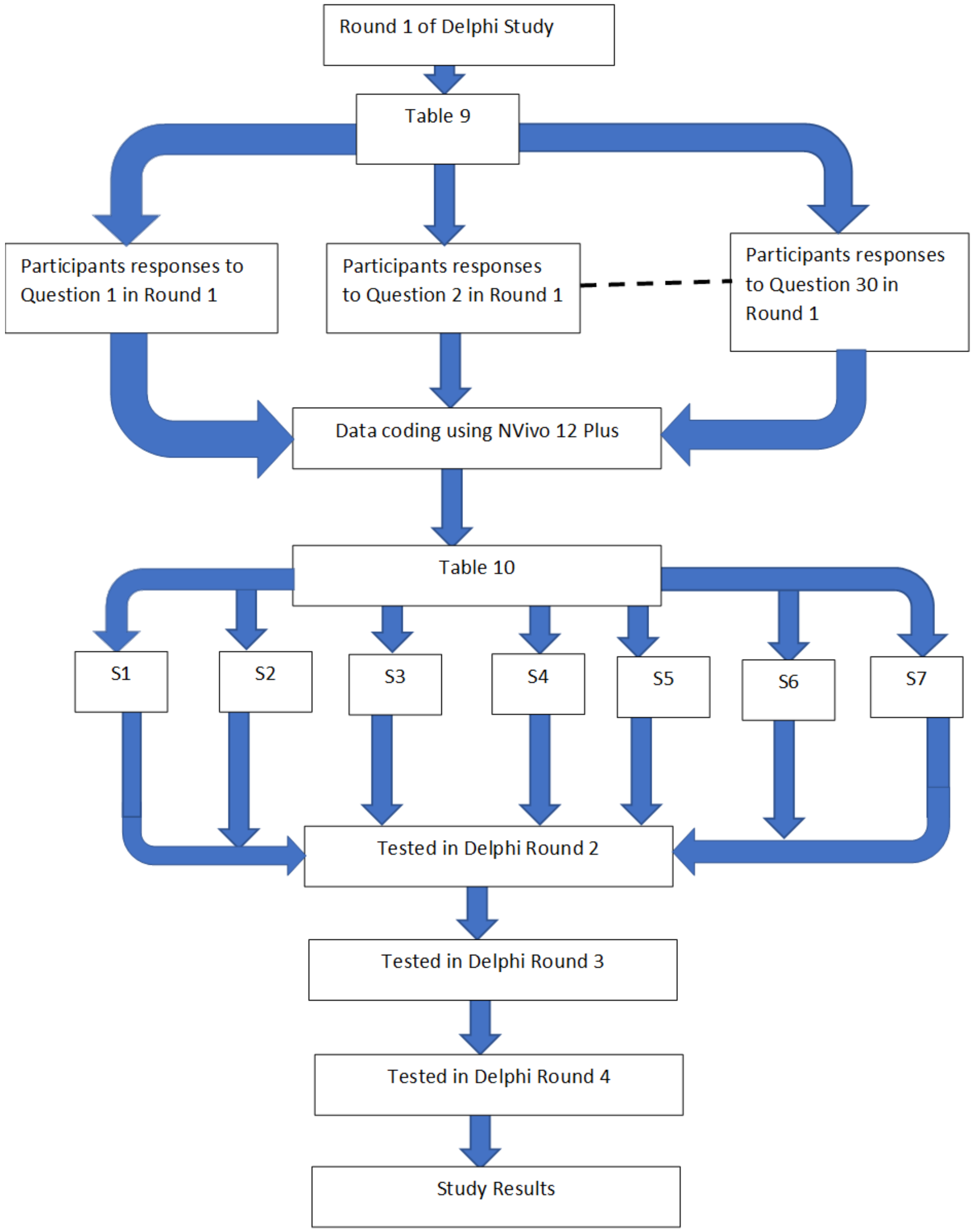


*Figure 18:* Study Process

Table 11 Summary of Solutions (overall rating)

| Rating | | % response | Indicate Desirable | Indicate Feasible | Indicate Importance | Indicate Confidence |
|---|---|---|---|---|---|---|
| 6 | S1: Focus on People | Worker knowledge, training, behavior, attitudes, judgment, communication, and Related solutions | 93 | 92 | 90 | 87 |
| 3 | S2: Work Standards | Work Method and Related solutions | 97 | 98 | 97 | 94 |
| 5 | S3: Safety Management | Safety Management, Regulatory and Related solutions | 95 | 94 | 93 | 88 |
| 4 | S4: Workplace Training | Workplace Training and Related solutions | 96 | 95 | 95 | 92 |
| 2 | S5: Management | Management Related solutions | 98 | 97 | 98 | 98 |
| 1 | S6: Supervision | Supervisor Related solutions | 100 | 100 | 100 | 100 |
| 7 | S7: Audit/Review | Management Audits, Review, and Related solutions | 88 | 92 | 88 | 78 |

***Note*:** Summary of Solutions (overall rating)

From Table 11 The top rated solution group is Supervision. Management, Work Standards are the next two solution groups.

There was consistent support from participants for *Focus on People* type solutions to problems where individuals were becoming accident prone, seriously injured, or killed at work. It was desirable for manager and supervisor attention on behavior and habits, teamwork, and communication type solutions. Participants felt that if qualified personnel, as knowledgeable and experienced practitioners, are involved in work planning, prevention of errors due to work missteps can occur.

Table 12  Focus on People Solutions

| | | response Round 2 Desirable | Feasible | Round 3 Importance | Round 4 Confidence | |
|---|---|---|---|---|---|---|
| Focus on People | S1 | 93% (25) | 92% (25) | 90% (24) | 87% (23) | % response Worker knowledge, training, behavior, attitudes, judgment, communication, and Related solutions |
| # Responses 3, 4, or 5 | | 24 | 23 | 22 | 19 | Involvement of qualified personnel, expert practitioners, and consultants, |
| | | 24 | 22 | 20 | 22 | Monitor human performance |
| | | 24 | 24 | 23 | 21 | Regular supervisor and manager job visits |
| | | 23 | 22 | 20 | 19 | Communication and feedback (management - workers) |
| | | 24 | 23 | 23 | 19 | Focus on people, behavior, habits |
| | | 23 | 22 | 23 | 21 | Work methods, procedures, and management of change, work planning, monitoring, review, procedures, documented standards |
| | | 22 | 25 | 20 | 19 | Culture, Safety Culture, problem identification (the why) |
| | | 24 | 22 | 20 | 19 | Teamwork, communication, confidence, confidential |
| | | 21 | 23 | 23 | 21 | Prevention of equipment failure |

*Note*: Focus on People Solutions

Participants unanimously supported an organizational safety culture which encouraged involvement by all at work as feasible: prompted by managers and supervisors conducting regular job visits.  In Round 3, regular supervisor and manager job visits; focus on people, behavior, habits; and work methods, procedures, and management of change, work planning, monitoring, review, procedures, documented standards were most important to participants as *Focus on People* type solutions. In Round 4, participants were most confident that once managers and supervisors monitored human performance, prevention of workplace accidents, worker injuries and fatalities could occur. Overall, *Focus on People* type solutions were deemed as desirable, feasible, and important by more than 90% of participants and with 87% of them confident that once implemented and managed accidents prevention could occur.

Actual participant *Focus on People* type solutions response: *Feeder processing requires applying grounds. This step is clearly outlined in orders that are provided to the operator. One way to prevent this is to utilize HPI tools such as 3-way communication where the order is repeated back to the district operator to confirm that information was understood.*

A similar analysis, conducted for S2 (Work Standards), was as listed in Table 13. Adopting measures aimed at the prevention of equipment failure, maintenance of safety barriers, an enhanced safety culture, good housekeeping, and constant vigilance of work monitoring and review were the most desirable and feasible Work Standards type solutions highlighted by participants in Round 2.  The availability of personal protective equipment and how employees kept these were also unanimously deemed as desirable and feasible by all of the 25 responses received in Round 2. In Round 3, all participants found performance monitoring, work monitoring and review, personal protective equipment availability and condition, safety and housekeeping and equipment failure prevention-type solutions as important.

Compliance focus, technology in use, work methods change management, work design, and planning type solutions were deemed as important by all participants in Round 3. All participants were confident that this focus was needed to prevent accidents. All participants were also confident that a focus on diagnostic testing of apparatus and manufacturer instructions, together with worker training, knowledge, and experience was necessary to prevent accidents. Overall, *Work Standards* type solutions were deemed as desirable, feasible, and important by more than 90% of participants who were confident that once implemented and managed accidents could be prevented.

Table 13. Work Standards Solutions

| Work Standards | S2 | response Round 2 Desirable 97% (25) | Feasible 98% (25) | Round 3 Importance 97% (24) | Round 4 Confidence 94% (23) | % response Work Method and Related solutions |
|---|---|---|---|---|---|---|
| # Responses 3, 4, or 5 | | 24 | 24 | 24 | 20 | Performance Monitoring |
| | | 23 | 23 | 21 | 20 | Reliability Centered Maintenance, Maintenance scheduling and cycles, Recordkeeping and Recordkeeping procedures |
| | | 24 | 24 | 23 | 22 | inspection methods and arrangements, troubleshooting, breakdown management, equipment and device calibration |
| | | 24 | 24 | 21 | 21 | Construction and Operating practices and procedures, International and Best Practice , Technology, Quality Management System |
| | | 25 | 24 | 24 | 22 | Compliance Focus, Technology in Use, New Technology, Work Methods change-management, Work design and planning |
| | | 24 | 25 | 24 | 23 | Work monitoring, review, , documented, standard, worker training, knowledge and experience |
| | | 23 | 25 | 24 | 23 | Diagnostic testing, Research, and Manufacturers instructions |
| | | 25 | 25 | 24 | 21 | Available and condition of personal protective equipment, tools, and materials |
| | | 25 | 25 | 24 | 22 | Safety Barriers, Safety Culture, and Housekeeping |
| | | 25 | 25 | 24 | 22 | Prevention of equipment failure |

*Note*: Work Standards Solutions

Actual participant *Work Standards* type solutions response: *Proper and effective maintenance can help prevent the failure of equipment, which can cause harm to individuals in the vicinity. Another method is to plan around the potential failure of equipment so that workers have barriers in between where they are working and the hazard.*

An analysis for S3 (Safety Management) yielded results that were similar for S1 and S2 above; as shown in Table 14.

Table 14 Safety Management Solutions

| | | response Round 2 | | Round 3 | Round 4 | |
|---|---|---|---|---|---|---|
| | | Desirable | Feasible | Importance | Confidence | |
| Safety Management | S3 | 95% (25) | 93% (25) | 93% (24) | 88% (23) | % response Safety Management, Regulatory and Related solutions |
| # Responses 3, 4, or 5 | | 24 | 24 | 24 | 20 | Focus on safety and Legislation |
| | | 25 | 25 | 24 | 21 | Focus on compliance, work methods, procedures, change |
| | | 24 | 21 | 20 | 18 | Culture , Organizational Culture, Safety Culture |
| | | 22 | 21 | 19 | 18 | Quality of Regulator Inspection |
| | | 23 | 22 | 24 | 21 | Distraction, individual obligation to inform, procedures, rules and documented standards |
| | | 24 | 24 | 24 | 23 | Manufacturers instructions and other compliance |
| | | 25 | 25 | 24 | 22 | Safety inspection, work planning, monitoring, and review |
| | | 23 | 25 | 23 | 21 | Safety oversight and audits of materials, spares, materials, tools, and personal protective equipment |
| | | 24 | 24 | 21 | 19 | Workplace training, safety Systems, barriers, safety culture, housekeeping, workplace safety arrangements |
| | | 23 | 24 | 18 | 19 | Prevention of equipment failure |

*Note*: Safety Management Solutions

Overall, *Safety Management* type solutions were deemed as desirable, feasible, and important by more than 90% of participants and with 88% of them confident that once implemented and managed accidents prevention could occur. Focus on compliance, work methods, procedures, change, manufacturer instructions, safety inspection, work planning, and review were the top solutions in this analysis: an active, direct, and forward management type approach that participants believed will reduce workplace errors, accidents injuries and fatalities.

Actual participant *Safety Management* type solutions response: *Have a Safety Program with a policy that reflects effective controls for any and all hazards associated with animals/living organisms. The Program should also consist of initial expectations training and periodic retraining. Conduct periodic audits. Periodically update the policy with Continuous Improvement in mind.*

Table 15 Workplace Training Solutions

| Workplace Training | S4 | response Round 2 Desirable 96% (25) | Feasible 94% (25) | Round 3 Importance 95% (24) | Round 4 Confidence 92% (23) | % response Workplace Training and Related solutions |
|---|---|---|---|---|---|---|
| # Responses 3, 4, or 5 | | 24 | 23 | 23 | 20 | Training philosophy, company core values training, and workplace training arrangements (cost, availability, management). |
| | | 24 | 24 | 23 | 23 | Communication, process, procedures, frequency, quality, methods, and location |
| | | 23 | 24 | 23 | 20 | Feedback (management - workers), Correct (Flaws) |
| | | 25 | 22 | 24 | 20 | Manufacturers instructions and other compliance |
| | | 25 | 25 | 24 | 22 | Inspection, work planning, monitoring, and review |
| | | 24 | 25 | 21 | 21 | Material science, use, testing, and maintenance of tools, work procedures, and documented standards |
| | | 23 | 24 | 23 | 20 | Safety rules, procedures, and barriers, Safety Culture |
| | | 24 | 25 | 22 | 21 | Housekeeping |
| | | 24 | 22 | 22 | 23 | Lessons from equipment failure, accident prevention |

*Note*: Workplace Training Solutions

An analysis for S4 (Workplace Training) yielded results that were similar for S1, S2, and S3 above: as shown in Table 15. Overall, *Workplace Training* type solutions were deemed as desirable, feasible, and important by more than 90% of participants who were confident that once implemented and managed, accident prevention could occur. There was a consistent spread of participant support for each of the different aspects of *Workplace Training* type solutions highlighted in Table 15.

Table 16 Management Solutions

| | | response Round 2 | | Round 3 | Round 4 | |
|---|---|---|---|---|---|---|
| | | Desirable | Feasible | Importance | Confidence | |
| Management | S5 | 98% (25) | 97% (25) | 98% (24) | 98% (23) | % response Management Related solutions |
| # Responses 3, 4, or 5 | | 24 | 24 | 24 | 21 | Focus and Assumptions |
| | | 24 | 23 | 24 | 23 | Management Coaching /Support / Priorities / Response Management and Arrangements |
| | | 25 | 24 | 24 | 23 | Actions/Response |
| | | 23 | 25 | 21 | 21 | Response of Regulator Findings / Regulator Communication / Industry Stakeholders |
| | | 25 | 25 | 22 | 23 | Qualitative of intake/ recruit/ / HR Services |
| | | 25 | 24 | 24 | 22 | Disciplinary Action/ Company-Union collaboration |
| | | 25 | 24 | 24 | 23 | Support for work planning/ monitoring/ review |
| | | 25 | 25 | 24 | 23 | Purchase of spares/materials/tools/Equipment Failure |
| | | 25 | 24 | 24 | 23 | Work procedures, documented standards |
| | | 24 | 25 | 24 | 23 | Safety Management and Safety Culture |

*Note*: Management Solutions

Actual participant *Workplace Training* type solutions response: *More training and oversight; structured process. Require lineman to earn continuing education credits annually.*

An analysis for S5 (Management) yielded results that were similar for S1, S2, S3, and S4 above; as shown in Table 16.

Overall, *Management* type solutions were deemed as desirable, feasible, and important by more than 95% of participants who were confident that if implemented and managed, accident prevention could occur. There was a consistent spread of participant support for each of the different aspects of *Management* type solutions highlighted in Table 16.

Actual participant *Management* type solutions response: *Station ground grids need to be tested periodically to ensure that grounds used for worker protection are actually providing the intended protection from inadvertent energization.*

Table 17 Supervision Solutions

| Supervision | S6 | response Round 2 Desirable 100% (25) | Feasible 100% (25) | Round 3 Importance 100% (24) | Round 4 Confidence 100% (23) | % response Supervisor Related solutions |
|---|---|---|---|---|---|---|
| # Responses 3, 4, or 5 | | 25 | 25 | 24 | 23 | Supervisor support, interaction, confidence, knowledge, ability, |
| | | 25 | 25 | 24 | 23 | involvement in job - work selection |
| | | 25 | 25 | 24 | 23 | Demand for compliance, reporting, Inspection, adherence with procedures, and documented standards |
| | | 25 | 25 | 24 | 23 | Worker Involvement |
| | | 25 | 25 | 24 | 23 | Work planning, monitoring, review |
| | | 25 | 25 | 24 | 23 | Arrangements for available spares, materials, and use of tools, personal protective equipment |
| | | 25 | 25 | 24 | 23 | Safety and Safety Culture |
| | | 25 | 25 | 24 | 23 | Permit to Work, Lock-out-tag-out |

*Note*: Supervision Solutions

An analysis for S6 (Supervision) yielded results that were similar for S1, S2, S3, S4, and S5 above; as shown in Table 16. Overall, *Supervision* type solutions were desirable, feasible, and important to 100% of participants who were confident that once implemented and managed, accidents prevention could occur, and as highlighted in Table 17.

Actual participant *Supervision* type solutions response: *We have to teach workers when their "automatic mode" needs to slow down. Practical drift creates a sense that their work methods are fine because, they have gotten away with it for so long.*

An analysis for S7 (Audit/Review) yielded results that were similar for S1, S2, S3, S4, S5, and S6 above; as shown in Table 18.

Table 18 Audit/Review Solutions

| | | response Round 2 Desirable | Feasible | Round 3 Importance | Round 4 Confidence | |
|---|---|---|---|---|---|---|
| Audit/Review | S7 | 88% (25) | 92% (25) | 88% (24) | 78% (23) | % response Management Audits, Review, and Related solutions |
| # Responses 3, 4, or 5 | | 22 | 23 | 21 | 18 | Audits, review, corrective action response, management of inspection, safety culture |

*Note*: Audit/Review Solutions :

There was a consistent spread of participant support for each of the different aspects of *Audit/Review* type solutions highlighted in Table 18.

Actual participant *Audit/Review* type solutions response: *Conduct Field Auditing to ensure that workers are knowledgeable and using proper work procedures.* Another response: *The Program should also consist of initial expectations training and periodic retraining. Conduct periodic audits. Periodically update the policy with Continuous Improvement in mind*.

The responses received from participants in this study on solutions to problems identified in Round 1 were collated, tested against the study criteria for consensus and listed below keeping the alignment of individual problems and the solutions identified for that particular issue. Testing of these solutions occurred against participants'-indication of the solutions being desirable, feasible, important and provided confidence that, if addressed, the suggested ways can prevent further and future accidents where workers in the electric power industry can become seriously injured or even killed while performing work. A summary listing of the solutions proffered for each of the 30 items in Round 1 follows in Appendix J and Appendix K which contain a detailed listing of the actual solutions.

The design of this study was for a selection of a 3, 4, or a 5 on a 5-point Likert-type Scale for each item in each of the Delphi rounds resulted in 28 out of the 30 items originally identified and included in the Round 1 questionnaire remaining relevant throughout the Study. That made the data analysis and study management much more complex and complicated than originally anticipated. In Appendix K, a comparison of the possible results if the acceptance criteria were 4 or 5 only for each item in the different questionnaires in this study. Instead of participants' responses to 28 items moving from Round 1 to Round 2 as actually occurred in this study, solutions to 20 items would have remained relevant for later consideration. The reduction may or may not have impacted on the overall conduct of the study, but this was not assessed in its entirety.

## Summary

In Chapter 4, there was a description of the research setting and the process for receiving approval from the IRB at Walden University before collecting any data in this study. Process description for identifying and eventually selecting the research participants also occurred. Demographic information on the research participants and their industry experience was used to show how suitable they were as experts for the Delphi study. A description of the data collection procedures and data analysis strategy adopted for this study was then detailed and discussed at length. Evidence of the research trustworthiness was then tabled and supported by a rich description of how credibility, transferability, dependability, and confirmability of the study and study results.

In Chapter 5, there is an interpretation of the research findings and how these relate to the research question and conceptual framework. An explanation of the study limitations will precede the study implications and recommendations.

# Chapter 5: Discussion, Conclusions, and Recommendations

The primary motivation for this study was a significant misunderstanding among electric industry practitioners about how to prevent accidents, worker injuries, and fatalities. The purpose of this Delphi study was to rely on experienced and knowledgeable electric industry practitioners to confirm the reasons for accidents and to suggest ways to prevent these from occurring. I used the Bolman and Deal four-frame model to assist in the conceptualization of the issue and to assist in addressing the challenge in an approach not previously adopted. Proposed solutions to accidents identified in this study, were desirable, feasible, and important for participants. Participants concurred that organizational leadership, managers, supervisors, and workers are in different ways responsible for solving problems that can prevent accidents. The solutions to these accidents invariably require concerted and dedicated effort by each group of industry participants to ensure that systems remain safe and by extension, individuals at work will not be injured or killed. System issues can be solved by the dedicated attention of the different working groups. People problems add an entirely different challenge and cannot be easily solved. People issues stem from social dynamics to medical and personal difficulties, interpersonal communication, and trust. Participants in this study believed that it was possible to address and solve these issues.

## Interpretation of Findings

Seven different groups of solutions evolved from this study. Of these, supervision, the role of supervisors, supervisor understanding and supervisor action was the most fundamental and seen by participants as the most influential in accident prevention with no injuries, including fatalities, to workers in the electric power industry in the United States. Management aim and focus was another top-ranked solution that evolved from this study: So too, was work methods and workplace training. The other but slightly less popular accident prevention solutions were safety management, a focus on people, and workplace audits and reviews. While it is possible to isolate each of these and specifically focus on the solution item, the most significant benefit can only occur if the solutions are holistically treated as interdependent. It is therefore not suggested that workplace training alone, for example, be considered as a right solution that if implemented would prevent worker injuries or deaths. It is more likely that workplace training, management focus, together with supervisory understanding and action, would combine to realize a safer workplace where workers will be more inclined to comply with safety rules and work procedures. That way, workplace errors can be reduced and possibly be entirely mitigated. It will, therefore, mean that in workplaces where there is a significant effort to augment safety management systems, workplace audits, and reviews with a focus on people, especially attitudes, behavior, and judgment, with management focus, and supervisory action, the likelihood of workplace accidents occurring will be extremely low, if at all (Murata, 2017; Probst, 2015). It will be challenging for best results to be achieved from an audit exercise, for example, by not following the workplace training on audits and audit review; in line with safety management system requirements, or if not done with a management focus on accident prevention. It is equally not possible for workers to believe that workplace audits can achieve the best possible outcomes if there is a focus on technical and systemic problems and not also on people and people issues for which, if handled, could result in workers' improved performance levels and while remaining safe. As a result, the following must be considered via a combined focus on several different solution strategies and not solely on the particular issue at any point in the discussion.

A design flaw with electrical devices such as transformers and poles are sometimes only realized after being installed for extended periods. To prevent accidents and for organizational success, employee engagement is critically important (Kaliannan & Adjovu, 2015). Design considerations must include construction factors as well as maintenance, operation, worker safety, and working space considerations. The International Electrotechnical Commission and the Institute of Electrical and Electronics Engineers standards for electrical power systems construction can guide design in a safe manner utilizing industry best practice. If changes or retrofitting to the design model occur while the equipment is in-service and with all associated hazards not adequately mitigated, this change can be dangerous. Sometimes work crews can have a false sense of security concerning issues of clearance. If measurements are inaccurate in a work-plan, this can complicate the work tasks.

Safety management flaws can be difficult to identify and challenging to fix once identified. The prevention of accidents depends on how well individuals address the known flaws (Dekker, 2006; Manuele, 2014). Supervisors, managers, and trainers have significant responsibilities in this regard: managers in conducting system reviews and audits; supervisors in managing tailgate meetings or pre-job talks and for enforcing compliance with work requirements; and trainers in teaching workers and individuals at work and ensuring that workers can identify hazards, hazardous conditions, and effectively mitigating the associated danger (McGrory et al., 2017; Mills & Koliba, 2015).

Human issues: Workers not wearing personal protective equipment, bad habits, procedural deviation, poor judgment, willful violations of work rules and procedures, overconfidence, negligence, and inadequate and inconsistent supervision are among the factors that contribute to poor work ethics. Vaughn (1997) suggested that deviation from standard human performance and practices, once allowed to flourish, is extremely difficult to rectify. Mitropoulos et al. (2005) suggested that focusing on compliance reduces hazard exposures and that it is possible that compliance promotes a limited view of accident causality and unnecessary attention on individuals at fault rather than on the system factors that do not address hazards. These hazardous situations eventually lead to and encourage unacceptable worker behaviors. Getting individuals at work to enforce compliance with rules and work procedures will keep individual behavior in check, temper attitudes, and prevent deviation from standard work requirements (Albright, 2017).

Kao et al. (2016) contended that safety behavior was self-regulatory, which could help to prevent injuries and to avoid unsafe actions. Medical conditions and personal issues can impact on workplace activities. Managers, supervisors, and coworkers need to exercise empathy and extend support to individuals who are affected by these issues and conditions. At the same time, individuals must exercise self-control and follow all of the prescribed directions of their health care providers. Workers must communicate medical conditions with their employers. If known, administrative controls can lead to either the retirement of the worker as being medically unfit or for supervisors to designate duties to accommodate the worker. To not do so may result in the worker putting themselves and others at risk when carrying out critical work operations (Uehli et al., 2014). Grounding and earthing failures and errors are human issues much more than technical or systemic problems. There are locations where the installation of grounds or electrical-earths can be challenging and likely impractical, but work tasks can be revised to maintain safe working arrangements. The value of worker training on equipotential earthing must never be underestimated. Supervision and strict compliance with work procedures is critically important (Probst, 2015). Complacency, laziness, and poor judgment by individuals and work teams not grounding systems before work is as much an indication of supervision and training failures (Albright, 2017; Price & Williams, 2018). Managers and supervisors must set the expectation, offer initial and reoccurring training, guide work activities, and strictly enforce compliance with procedures. Violations, reflecting poor work ethic and wrongdoing, are grounds for immediate dismissal of managers, supervisors, and workers who contribute to this procedural deviation (Merlin et al., 2016; Miller et al., 2016).

Spares and parts necessary for effective maintenance are not always available, mainly due to inefficiency and poor planning, so that equipment remains in service for longer than optimum periods. Uncompleted maintenance contributes to poor equipment condition and eventual failure. Maintenance-related failures are many times misdiagnosed as random failures and treated as emergency breakdowns. Park (2015) described how a commercial aircraft was destroyed by fire after landing at an airport as a result of a poorly done maintenance job. All of the passengers were still on board. Maintenance related issues and work practices that deviate from standard methods, represent a willful disregard by workers and work teams. Ineffective training if workers are incompetent afterward; and new technologies introduced without worker-training are opportunities for superior work performance and accident prevention (McCall & Pruchnicki, 2017). The political and symbolic frames are apt for analyzing the effects of vegetation management strategies, stakeholder demands, and technical work standards on electric power system reliability and worker safety (Bolman & Deal, 2013). The human resources and structural frames enable examination of existing industry practices and the workers' abilities, skills, and capabilities (Bolman & Deal, 2013). Invariably, with tree cutting, trimming, and removal optimized both in the distance away from energized power lines and installations, it effectively means that workers are more often than before conducting tree trimming exercises in energized environments where higher risk levels exist. A possible side-effect of this activity is that workers may develop confidence that can prove dangerous in the absence of meticulous hazard mitigation. Park (2015) highlighted two maintenance-related safety recommendations. The first focused on the preparation of instructions for maintenance jobs, and the second involved the planning and implementation of maintenance jobs.

Electrical power lines, equipment, and stations are in places that can be a habitat for wildlife and dangerous plant species and organisms. Workers, at times, have to work in territories where bears, alligators, venomous snakes, bees, and other dangerous animals can be. These present different challenges to workers who already work in some of the most dangerous and challenging working situations and environments. Worker death, by tree contact with electric power lines, is known to have occurred (Casman, 2019). Zhao, Ghiselli, Law, and Ma (2016) believed that intrinsic motivation affects job characteristic so it may be that electrical workers are intrinsically motivated and always aware of the dangers that wildlife and living organisms presented.

Management must set guidelines that will allow for full regulatory and industry compliance while still allowing for unique organizational and actual workplace and locational challenges to be fully covered in the training course content (Wanik, Parent, Anagnostou, & Hartman, 2017). Individuals performing work require the technical knowledge of the work tasks, working environment, and condition. Employees also need program schedules, acceptable performance outcomes, an indication of how these are measured, the work procedures, and the safety rules that guide work activities. All of these require appropriate and adequate supervision by competent and knowledgeable individuals capable of maintaining workers respect and focus on the work tasks to be performed. The working conditions on and around energized power lines and installations where workers have to carry out work activities at heights with high risks of falls will always be dangerous. There are instances where hazardous worksite conditions have led to accidents and where workers died (Fox, 2014; Sinclair, 2017).

Work planning and hazard identification are critical activities to mitigate possible danger and to prevent accidents. One way to avoid unplanned events is to have someone dedicated to looking at others performing work activities. That way, when individuals would be micro-focused on particular items of work, the onlooker will be scanning the work environment for issues that either encroached into the work zone after the work began or for situations possibly missed during the job briefing or tailgate discussions (Kaliannan & Adjovu, 2015). A deviation from the planned work arrangements requires another tailboard before proceeding. The opportunity will exist for the conducting of another thorough site-specific risk analysis and for effective and timely mitigation. Stakeholder demands are many times conveniently overestimated and not treated in the right context. Managers and supervisors are responsible for managing stakeholder demands and for ensuring that work remains fully compliant with standards and procedures (Bedarkar & Pandita, 2014; Ibrahim et al., 2016).

There are special work activities in the electric power industry where individuals may work alone: This may happen for individuals who perform functions that require specialized training and certification. Even in this arrangement, these individuals must employ all of the safety procedures, double check that these arrangements are in place and active, and wear proper personal protective equipment before performing hazardous work operations (Jerie & Baldwin, 2017). At times, following an individual's actions in that way may not be possible as the communication medium is inhibited, absent, or not possible either technically or because of organizational procedures and practices. Workplace training, supervision, management priorities, improper maintenance, or equipment failure each are significant contributors to poor decisions and judgment by workers. Individuals, however, sometimes exercise personal behavior and attitudes that are less than appropriate; they willfully disregard working advice and guidance, sometimes because of overconfidence. Individual self-discipline is critically essential if individuals are to remain safe while at work: this may be a single but most important factor in poor judgment and the prevention of accidents(Albright, 2017; Jerie & Baldwin, 2017).

Workplace training is a core business activity; without it, the business will likely fail; with it, the best opportunities exist for successful organizational outcomes. The right topics not delivered will not derive the practices and procedures perpetuated by the organization but the practices and procedures convenient to other individuals at work (Murata, 2017). Supervisors in organizations are like the chassis of a vehicle. There are wheels which take the vehicle where it goes; the engine to ensure that it can get there, and the driver who coordinates the speed, the actual route, and the time when the journey will commence. The chassis keeps everything together and makes the vehicle work as a vehicle should. In the workplace, the supervisor holds everything together and causes the work operations and organizational outcomes to be what it should.

Work planning, when done well, is an organizational commitment to conducting work in a methodological, strategic manner aimed at safe and productive performance outcomes. Work planning, not well done, is a failure to meet the vision of conducting work in a manner intended at the safe and productive performance. Management actions that are inconsistent or dismissive of worker concerns are anti-supportive and not conducive to a positive work environment where genuine efforts by all occur for organizational success. Ballard, Miller, Piantadosi, Goodman, and McClure (2017) indicated that it was inherent for humans to develop categories determined by membership rules learned implicitly. Humans, however, are generally gifted with the ability to learn (Kuselman, 2015). The implications are that managers and supervisors can learn not to compromise workplace safety, even if it is not intentional when pressured to get things done and to meet organizational goals (Probst, 2015). Individuals who do not work to this end shall be removed or even dismissed; regardless of their job function (Ballard et al., 2017). It is critically important that the person in charge of a job must know and project the importance of good communication. Workers cannot get help from supervisors and managers if they are unable to communicate this need in a clear and appropriate manner. Managers and supervisors cannot expect superior and accident-free outcomes if their intent is effectively not transferred to workers understanding, agreement, and focus (Moffatt-Bruce et al., 2017; Scott et al., 2014; White et al., 2016).

Individuals violating permits to work are either not aware of the provisions of the permit to work or have willfully disregarded one of the most sophisticated work management systems in the electrical power industry. To fix this type of safety breach, one must fully understand why breaches occur on a detailed work arrangement, where workers issuing or receiving permits are specially trained to issue or receive these instruments and where the declarations are deliberate and worded such that the signatories accept legal liabilities for ensuring that work measures are safe (Allen & D'Elia, 2015). It is also critical that the individual issuing the permit to work usually is a supervisor or the supervisor of the work to be performed. Implicit in this arrangement, is the quality of communication between the issuer and the receiver of the permit to work. Also implied, is the job briefing that occurs with all members of the work party for a detailed discussion on the job (Labib, 2015).

If a permit to work violation is an exquisite high-end violation, then lock-out-tag-out-non-compliance is the most significant willful violation of safe work procedures and which is most times carried out by a supervisor or the person receiving the permit. These violations are occurring in the electric power industry. Ideally, the opportunity to learn from accident experiences are the best opportunities to apply new knowledge and to best prepare and to prevent other similar accidents (Murata, 2017). Several things must happen for learning from accident to occur; findings of the accident investigations must guide the lesson. The quality of the investigation should guide the credibility of the report findings, recommendations, and conclusions; organizational leaders, managers, and supervisors must support and facilitate learnings and implement recommendations once known. Non-use of personal protective equipment speaks more to workers and their responsibility and duty of care while at work than anything else. No amount of experience and work knowledge will substitute for workers wearing appropriate and necessary personal protective equipment while performing dangerous work.  Defaulting employees are to be removed and even dismissed; to be saved from their irresponsible behavior.

## Limitations of the Study

The first limitation could be that the study results may prove useful in the electrical power industry only because of the uniqueness that exists in this industry.  Safety Management System as a contributor to accidents, based on the findings of this study, seems not likely to restrict the application of the findings only to the electric power industry.  Deficiencies in Lock-out Tag-out procedures, issues surrounding worksite responsibilities, and understanding of individual roles on job sites; a poor safety culture exists and promoted by management; management, worker unions, and regulators interaction and games; Job Safety Analysis issues and proper use of personal protective equipment are all issues that reflect a poor safety management arrangement in the electric power industry.  These were evident in other industries (Labib, 2015; Moshansky, 1992; Murata, 2017; Probst, 2015; Singh et al., 2010).  The use of the Bolman and Deal four-frame approach to analyzing data proved advantageous as it was easy to apply and sufficiently versatile that the results can extend the findings to industries and workplaces other than the electric power industry (Bolman & Deal, 2013; Moore, 2016).  The research scope was limited to the electric power industry and how to prevent accidents occurring in the United States.  The primary focus was to understand the contributing factors for situations where electricity industry workers become severely injured or even killed while performing work.  The strategy was to employ the Bolman and Deal (2013) four-frame model to analyze participants' responses and to use the data to promote safe working arrangements: It may prove a helpful model for further studies in the electric power as well as other industrial sectors.

The second limitation is that the Delphi panelists as research participants brought very pointed views that may be prevalent only where the individual works. Researcher tact and skill ensured that the research remained on-course (San Su, Wardell, & Thorkildsen, 2013). The number of items, 28 out of 30 possible issues, that the participants supported as factors that contribute to workplace accidents, serious worker injuries, and even fatalities, are indicative of two cogent facts. First, the electric power industry is a dangerous and hazardous industry where accidents can occur if individuals at work are not safe and do not take appropriate steps to mitigate the danger. The second fact is that the issues tested in this study were from previous studies of accidents in other industries; the level of agreement indicate the wide-ranging implications of the findings in this study that the lessons can extend into different work areas (Labib, 2015; Moffatt-Bruce et al., 2017; Murata, 2017; Probst, 2015; Singh et al., 2010).

The third possible limitation was if the best candidates did not participate in this study. The experienced and knowledgeable participants in this study were electric power industry managers, trainers, professionals, supervisors, and workers with an average of 25.2 years service. Their industry background was diverse and a good reflection of the practitioners who are crucially involved in dangerous and hazardous work in the electric power industry (Volberg et al., 2017). Participants were able to describe work arrangements, procedures, environments, and pertinent issues connected to workplace safety management in the electrical power industry. The participants willingly shared information and contributed to new learning and understanding of the challenges in and as contributors to accident prevention efforts in the electric power industry (Volberg et al., 2017).

A fourth limitation can be the personal and professional bias and possible influence on the strategy used to conduct the literature search, data collection, and analysis in this study. More than 20 electric power industry experts contributed to the extension of existing knowledge about the electric power industry. They did this over the four separate rounds of the Delphi study: In the Round 1, I encouraged the participants to suggest other information they considered as pertinent and not covered in the questionnaire (Patton, 2015). The information they provided enhanced the likelihood that the data is correct because of the consensus achieved on 28 different issues while participants remained anonymous to one another. The 28 relevant issues represented a significant effort to improve the research trustworthiness and data derived from the process (Yin, 2013).

The fifth limitation may be researcher management of the Delphi study. The iterative process of the Delphi technique was a possible disadvantage as attrition by participants can affect the research and highlight credibility issues in the overall findings (Annear et al., 2015; Willems, Sutton, & Maybery, 2015). Before the study I accepted that twenty-five (25) participants were acceptable if the attrition rate is less than 25 % over the entire study; to this end, 27 participants started Round 1 and 23 completed Round 4: 85% of the participants in this study remained interested to the end of the Delphi rounds (Brody et al., 2014; Sinclair, Oyebode, & Owens, 2016). I remained meticulous and exercised all available opportunities to keep the research exercise free of administrative delays and inefficiencies (De Loë et al., 2016; Patton, 2015).

A sixth limitation may be possible social desirability bias if participants misrepresented their real views and behaved in socially acceptable ways (Heitner et al., 2013). There is very little likelihood of this occurring as the questions did not require participants to reveal or recount their behavior, contribution, or influence on any particular accident or workplace issue directly related to the study (Kim & Kim, 2016). Also, I ensured strictest control on participant anonymity and research confidentiality (Heitner et al., 2013).

Understanding how accidents occur is preliminary to the deliberate taking of steps toward the prevention of future electric industry workplace accidents and to keep workers safe and uninjured. For this study, a specific delimitation surrounded the use of the Bolman and Deal four-frame model. The different perspectives described in the four-frames allowed for a better review of organizational and people issues and dynamics that contribute to workplace accidents. Since no previous study of this kind was conducted in the electric power industry using this model, the heavy reliance on participants and the detailed data they provided heightens the significance of the selection strategies and process (Brady, 2015). It is possible that individuals with little or limited knowledge and experience made the research less meaningful, even with consensus. That possibility makes participant retention and the integrity of their industry experience and knowledge crucially important. Participants selection were on LinkedIn through invitation. Participation was voluntary and spanned over two months. The fact that 85% of the participants remained interested in the study over the entire four rounds more likely improved the study credibility and trustworthiness.

Other specific issues, considered as a delimitation before the study, surrounded the use of the Normative Delphi technique, what a Delphi expert was, and how that aligned with the actual selection of participants. It is possible that better and more suitable experts did not accept the invitation to participate or that the use of the public social media, LinkedIn, was not the best way to attract participants (Brady, 2015). It is also possible that the participants, even over the vast geographical space, were unhelpful because they were too personally-linked to electric power industry accidents. That realization, as far as I know, did not materialize.

The research question, whether it was too pointed and possibly contentious for experts to admit to issues in the electric power industry freely as a delimitation. That likelihood is low as each of the four questionnaires in this study comprised more than 30 questions which required participants to indicate desirability, feasibility, importance, and confidence. The likelihood of individual bias and coordinated bias among more than 20 anonymous participants in this arrangement is extremely low. It is possible that workers could blame managers and vice versa, but that would more reflect a characteristic of the electric power industry rather than a research design factor. With participant involvement limited to responses to me as the researcher developed questionnaires, participant actions and group politics, research inadequacies, technologies, and techniques that may have factored in this study is insignificant. If during the period over which the study spanned accidents occurred, that experience may influence participant response for the remaining Delphi rounds. The results of this study were consistent through the entire exercise. That showed a consistent pattern of participants' responses.

A delimitation condition set before the study was the geographical area where participants were chosen (United States) and the requirements for research consensus: With the data coding strategy I adopted and the acceptance criteria for research results also delimited before the study. It was possible that all these factors limited the results derived in this research. The fact that 28 out of the 30 issues remained as factors that lead to workplace accidents in the electric power industry makes these assumptions credible. The likelihood of results limitation is, therefore, insignificant.

One possible limitation in this study surrounds the composition in terms of the job functions of the participant pool. It is possible that if the participants came from only one discipline, linemen as an example, the results can be different. Differentiation of the responses from linemen as compared to those from managers was not discernable in this study because of the anonymous manner the four Delphi rounds occurred via Survey Monkey. If the participant pool were only trainers, then the responses using the approach from this study would produce trainers responses while still maintaining individual anonymity. This way, it will likely be possible to identify where particular human performance issues may exist and how best to mitigate these for superior outcomes, including the prevention of accidents and worker injuries.

## Recommendations

Organizations in the electric power industry should use the findings identified in this study to compare their own operating experiences and to appropriate suitable corrective actions for superior performance outcomes. The approach may make it necessary for the recreation of the study and to compare actual organizational results against their desired results. It may be that for particular organizations, the challenges can be different and so too will be the forward approach to addressing and correcting problems they may identify. Organizations adopting this approach should measure the possible benefits against their accident and worker injury experience.

Organizations and individuals in the electric power industry are experiencing a crisis with regards to individual attitudes, behavior, and a problem of willful disregard for work rules, and safe work procedures. Further investigation is necessary to determine if this is isolated or widespread, even extending outside of the industry and into other realms of human endeavor.

The inquiry must include a review and understanding of safety culture in the electric power industry and whether there are elements in this culture that if promoted, can allow for improved organizational outcomes.

Individual investigation, at an organizational level, of the items identified in this study as contributing to accidents in the electric power industry where workers suffer serious and fatal injuries should occur. This aim of that investigation is to glean exact details on how in particular organizations, the work rules, procedures, and practices can be revised and updated, and for workplace changes to prevent further and future accidents.

Further investigation on the items identified in this study where individuals at work either misjudged situations or disregarded safe work arrangements is necessary as that shows a negative pattern of human performance in the hazardous and dangerous industry and working environment. It may be that with a more in-depth and focussed investigation of the human and social issues, significant opportunities and initiatives that would be unique to the region or company where that study occurs will evolve. Organizational leadership, especially where employees suffered fatal and serious injuries in the last five years, should review the safety management systems to focus on and emphasize more on human interactions, the quality of interpersonal communication, and interactive person-to-person activities to augment existing organizational support for work procedures and technical compliance.

A review of workplace training for work in critical functions should occur for opportunities to merge individual focus with organizational direction and if training arrangements can align with employee needs rather than only on organizational processes and procedures. Possible benefits from this approach is an evolving human performance culture which can appropriately address individual attitudes and behavior while discouraging willful violations of safety rules and poor judgment by individuals at work.

Further studies can be conducted with single job functions for better identification and understanding of the human problems and challenges experienced by that homogenous group of participants. It is possible that results from this study were skewed and tempered by the heterogeneous group of participants who represented a full cadre of job functions in the electrical power industry. Participant groups can also be gleaned from Power Stations separately from those in Transmission or Distribution and the other divisions in the electric power industry. It is possible that results can vary depending on the work division.

A lot of the causes of accidents are related. Proper supervision will prevent most of the reasons for accidents to occur. Adequate training for supervisors is imperative for a safe working environment. Specific supervisor-work procedures and oversight activities must grow on support by institutionalized knowledge resident in the organization, possessed by experienced practitioners, and in specialist training to augment the effort.

The safety policies and rules in an organization must keep pace with advancements in technology and industry best practice. Many times workers encounter tools, equipment, and procured material that are available on the market which encourage modes of operation that inherently vary from set work procedures and documented instructions. As such, there must be continuous review and revision to ensure that new items procured are consistent with policy, rules, and procedures.

Recommendations from accident investigations, appropriately reviewed and actioned, to ensure that there is no recurrence. This review may involve revision of work procedures and safety rules. Disseminate information about work issues and work practices from accident investigation so that work teams can, in the future, prevent similar errors and breaches.

Non-use of personal protective equipment is in the same category as poor work ethic, poor attitude, and poor supervision. It is common that personal protective equipment is the last line of defense against hazards behind engineering and administrative controls. However, personal protective equipment is of utmost importance, especially in instances where there is a breakdown of the different lines of defense up to the worker. An example of this would be insulation breakdown when operating a switch. If for whatever reason the bushings of a switch were to crack while in operation, the operator must be wearing insulated gloves if the handle was to become energized as a result. Supervisors and managers must demand full compliance.

**Implications**

Unengaged management and uninterested supervision: complacency is a big contributing factor in accidents. Personnel (including executive leadership), who do not have an understanding of what hazards are faced daily by frontline workers, allowing drift from strict adherence to the process and procedures. Workers when performing the same types of tasks, day after day not being vigilant when the expected task changes or is slightly modified. Workers often perform the customary steps and get themselves into challenging and dangerous situations. An example, provided by a participant in this study, was the preparing equipment for energization; there is a step where high voltage testing is one of the final activities. An individual can perform this process many times in the same week. Then on the Friday-afternoon, the worker gets instructions to prepare equipment for energization, but not with the high voltage testing because of a field task where someone is still at work. The individual making the equipment ready for energization follows the customary practice, without registering that someone is still at work on the system, performs the high voltage testing, electrocuting (killing) the individual in the field. The implication is that whatever the task or work activity and wherever done; the effect can be that an individual at work in the electrical power industry can introduce unsafe conditions into the workplace. If that goes unaddressed, the implications can include worker injuries or death. Organizational leaders, to clerical assistants, can impact on the quality of information upon which a lineman or an electrician may have to act. If all other barriers fail as to err is human, then the frontline worker can be in danger.

Latent organizational weaknesses which can lead to accidents where workers can become injured or killed including any undetected deficiencies in the management control processes (such as strategy, policies, work control, training, and resource allocation), values (shared beliefs, attitudes, norms, and assumptions), and workplace conditions which can cause individual error (precursors) or safety barrier breaches (flawed defenses). Organizational Leadership must recognize the implications of promoting inherently flawed systems: individuals at work will not improve performance and workplace outcomes would suffer. The consequence can also include worker injuries and fatalities.

Potential hazards: If left uncontrolled, can contribute to an accident. These include engineering factors, task demands, human factors and individual capabilities, management issues, work organization, and environmental factors, work pace and personal protective equipment, unexpected equipment conditions and proximity to other utilities. The implications are that with poor work outcomes, electric power service availability, continuity, reliability assurance to customers who depend on electric service to maintain their quality and living standards are no longer guaranteed.

Deficiencies in work organization or planning, specialized equipment operation, the encroachment of minimum approach distances in energized environments all contribute to workplace accidents occurring in the electric power industry. These can happen at any job site. Weather conditions can exacerbate road driving conditions and increase the likelihood of motor vehicle accident or a road mishap occurring at a location where individuals would be working on or near electrical systems. That can exacerbate dangerous conditions, cause inattention and distraction as well as improper equipment operation. The implications are that these accidents are more likely if the work crew installed an inadequate level of work area protection and incorrectly managed the hazards present at that location. It may be that individuals at the worksite were inexperienced, inadequately trained, or willfully disregarded safe work rules and procedures. It can also happen if the individuals exercised poor judgment on the dangers of working at that location. Human nature and habit patterns, their assumptions, and overconfidence can contribute to individuals making a poor judgment at work. These are equally possible if there was mental short-cuts, inaccurate risk assessments due to the erroneous perception of risks.

The above points addressed what can impact the safe performance of a job. One problem is that in the electric power industry, workers frequently have to report to remote locations, and there is no one to oversee how a job is set up and performed. Workers must be trained and must be encouraged to speak up when necessary. Workers must be trained adequately so if there is something out of line, they will maintain control of the worksite and activities, and are capable of deciding on how to do that and keep the safe performance of a job. The implications are that the work can impact members of the public to the extent that there is equipment loss, individuals can become affected by unplanned and unanticipated power outages, or worse.

Managers and supervisors must insist that the crew members understand that the foreman, as the supervisor, is ultimately responsible for completing a safe project, and it is their responsibility to follow the plan. Specific arrangements are necessary for confirmation of worker retention of knowledge: This can be a topic of further research. The implications are that the performance outcomes can improve, worker injuries or deaths prevented, and the lessons apply to other workplaces, in other industries or the electric power industry outside of the United States.

Although this is a low probability scenario, there are instances of trees making contact with energized infrastructure and becoming energized. One participant related that there was a situation where a frog closed a circuit between an energized LV conductor and the pole. It created a high impedance fault, and as such, the fuse for the circuit did not operate. The pole and down-guy-wire in this instance became energized as the bonding conductor burnt out. Where the down-guy-wire entered the ground, there was a puddle of water that started to boil with the dissipated heat. These instances are particularly dangerous as the fault current is low and does not ensure that protective devices operate promptly. The implications are that lessons learned from accident investigations into these and other electric power industry accidents and dangerous conditions can help to prevent accidents throughout the United States and in territories such as Canada and the Caribbean.

Where material procured is substandard and low quality, there can be unexpected failures at critical stages of a job which can result in accidents. One participant related an example where on a pin-type insulator changeout hotline job, the new insulator failed while being installed. This accident investigation revealed that a batch of pin-type insulators received was defective. Even though it passed an insulation resistance test, it was a soft material that was cut easily by the tie wire. In cases like this, both the specifications for future procurement and the acceptance testing of future material received must be reviewed and revised to prevent such occurrences. The review of methods of field testing material must be comprehensive (technical and procurement practices). The implications are that the lessons learned from these incidents and the improvements made to the procurement processes can be used to aide the positive development of similar arrangements in the electric power industry throughout the United States and in territories outside of the United States; such as Canada and the Caribbean.

Equipment failure can be mitigated against on a job by proper inspection and testing of equipment and also using the equipment as intended. In most instances, there are provisions and multiple layers of protection in the event of failure. However, in some critical instances, equipment failure can cause fatal accidents. Employees must be appropriately trained in critical thinking when reacting to such unplanned events. Employees applying the teachings from training courses can impact on the serviceability of electric components and therefore prevent in-service or premature equipment failure. The implications are that customer service quality, availability, and reliability can be guaranteed as possible dangerous occurrences may be averted.

Permitting systems are enforced to ensure the safety of the workforce. It is a method of communication between plant operators and the executing crew to indicate that the portion of the plant on which work occurs is safe. Permits are necessary for instances where the plant has to be made safe by a plant operator before a crew executing work. The switching process is usually the prerequisite to a cold line permit. The permit is also a guide that ensures that the switching process is safe. Violations to the permit to work procedure could mean that work is being carried out by crew/s on a plant that is not made safe for work by the plant operator, which can result in accidents. Permitting is also imperative in instances where there are multiple working parties on the same circuit and coordinating between the working parties and the plant operators to safely re-energize circuits after completing work. The implications are that multi-workgroups working on the same circuit for efficiency gains can continue to occur without issues of miscommunication between workgroups. That way, workers can complete tasks successfully and in an injury-free manner.

The safety rules would have been developed to prevent very particular unsafe situations and for mitigation of hazards. By not adhering to the safety rules and without a proper supervisory assessment and implementation of controls, the result can be accidents. These accidents are due to employees encountering situations and hazards that the safety rule was there to prevent and mitigate. There are instances, however, where the safety rules are lagging behind industry best practice, and there are deviations in safety rules implementation. In such cases, proper work planning and job hazard analysis must be done to ensure the necessary controls to prevent departure from standard practice, and to mitigate against the hazards, consistent with the safety rules. The implications are that for instances where industry best practices are available, electric power industry organizational leaders shall adopt these and upgrade organizational processes, practices, and rules and so benefit from the opportunity of improved performance outcomes and accident prevention.

Poor judgment by individuals or work crews is the human aspect of the job. Skilled workers are trained to make a continuous assessment of the job and adapt accordingly. There have been several instances where wrong decisions taken by foremen and linemen have led to a loss of life or limb. An example would be to attempt a reclosure on a circuit without tracing the entire circuit. There could be a burst-wire on the ground which could become energized when closing the fuse. In a fatality accident, involving a line clearing crew, the workers decided to utilize a porter wrap to cut a large tree-branch without taking a proper assessment. This decision eventually led to an improper technique by a worker for the size of the branch resulting in the branch falling on one of the line clearers killing him instantly (George, 2018). The implications of successful addressing of poor judgment instances and situations are that the lessons learned can be applied elsewhere in the United States and territories such as Canada and the Caribbean.

## Conclusion

Financial pressures on management and time pressures put on crews create conditions where individuals in the electric power industry resort to taking short-cuts, which can inevitably lead to serious worker injuries and fatalities. There are significant social and interpersonal challenges: poor supervision by individuals vested with the responsibility to maintain safe operations; field employees have poor attitudes towards management; and clueless management with no idea what’s going on in the field because they never go out and enforce the organizational expectations for its employees. There is insufficient quality involvement in and an emphasis on job briefings and tailgate meetings by general foremen, foremen, and supervisors.  A poor safety culture that strives on blame and finger-pointing where management seems fully aware but not inclined to repair.  Implementing change, even if poor performance is known, is difficult to accomplish.  Workers disregarding safe work procedures must know and understand that the price includes their becoming injured permanently, killed, or dismissed from the company.  Management issues such as the organizational culture,  leadership matters, inadequate controls, and sub-optimal allocation of resources can lead to worker errors, especially when work procedures, policies, and standards are not well promulgated.  Managers are responsible for ensuring appropriate communication of work procedures, policies, rules, and organizational priorities with employees.  Managers are also responsible for selecting employees with the right qualifications and for the actual placement of employees.  It is, therefore, an indictment on management and supervision if workers lack necessary job experience, knowledge, and were involved in workplace accidents, primarily when there was inadequate supervision of the work activities.

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Appendix A: Emails with Permissions

**From:** Ganesh Narine
**Sent:** Tuesday, July 10, 2018 5:07 PM
**To:** Lanny Floyd
**Subject:** Fw: Request for permission to use information for Doctoral Dissertation

Thank You Sir.

Much appreciated.

Ganesh Narine

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**From:** Lanny Floyd <h.landis.floyd@gmail.com>
**Sent:** Tuesday, July 10, 2018 5:52 AM
**To:** Ganesh Narine
**Subject:** Re: Request for permission to use information for Doctoral Dissertation

Permission granted

Sent from my iPhone

**From:** Ganesh Narine
**Sent:** Monday, July 9, 2018 9:48 PM
**To:** capschell@earthlink.com; danny.ligget@ieee.org; H.L.Floyd@ieee.org
**Cc:** capschell@capschell.com
**Subject:** Request for permission to use information for Doctoral Dissertation

Dear Professors,

I am a doctoral student at Walden University. I am conducting research on why accidents are occurring in the North American power industry. I have your research paper on " How we can better learn from electrical accidents " (cited below). I am interested in using information, including your diagrams on my research dissertation. I will appropriately cite and fully recognize the source of my information. Before doing this, I seek your permission to do so. I assure you that I will attribute full recognition to you for the excellent work that you have done.

I look forward to your positive response. Thank you in advance.

Ganesh Narine
STUDENT ID: A00648285

Capelli-Schellpfeffer, M., Floyd, H. L., Eastwood, K., & Liggett, D. P. (1999). How we can better learn from electrical accidents. *IEEE Industry and Commercial Power Systems Technical Conference (Cat. No. 99CH36371).* doi: 10.1109/icps.1999.787244



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| **Title:** | How we can better learn from electrical accidents |
| **Author:** | M. Capelli-Schellpfeffer |
| **Publication:** | IEEE Industry Applications Magazine |
| **Publisher:** | IEEE |
| **Date:** | May-June 2000 |





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**From:** Ganesh Narine
**Sent:** Monday, July 2, 2018 12:12 PM
**To:** Bolman, Lee G.
**Subject:** Re: Request for Permission

Thank You Dr. Bolman.

---

**From:** Bolman, Lee G. <BolmanL@umkc.edu>
**Sent:** Monday, July 2, 2018 11:48 AM
**To:** Ganesh Narine
**Subject:** RE: Request for Permission

Dear Ganesh Narine,

Permission is granted.

Good luck on your dissertation.

Lee G. Bolman, Ph.D.
Professor and Marion Bloch/Missouri Chair in Leadership
Bloch School of Management
University of Missouri-Kansas City
5110 Cherry Street
Kansas City, MO 64110

Tel: (816) 235-5407

**From:** Ganesh Narine <ganesh.narine@waldenu.edu>
**Sent:** Monday, July 02, 2018 10:55 AM
**To:** lee@leebolman.com
**Subject:** Request for Permission

Good Day to You Mr. Bolman,

I am a doctoral Student at Walden University. My research in on workplace accidents in the US Electric Power Industry. I have selected the Bolman and Deal Four-Frame Model as my Contextual Framework for this research.

My request, Sir, Is for permission to reproduce your
**Exhibit 1.1. Overview of the Four-Frame Model.**
**Exhibit 1.2. Expanding Managerial Thinking.**

in my Dissertation. I assure you that all formal and necessary citations and recognition will be afforded.

I look forward to your positive response.

Ganesh Narine

STUDENT ID: A00648285

Source Document:
Bolman, L. G., & Deal, T. E. (2013). *Reframing Organizations: Artistry, Choice, and Leadership* (5th ed.). San Francisco, CA: Jossey-Bass

**From:** Atsuo Murata <murata@iims.sys.okayama-u.ac.jp>
**Sent:** Tuesday, July 10, 2018 12:09:36 AM
**To:** Ganesh Narine
**Subject:** RE: Request for use of diagrams and informaton

Hi Ganesh Narine

I think that there is no problem, and can give you a permission.

Best
Atsuo Murata

**From:** Ganesh Narine
**Sent:** Monday, July 9, 2018 10:34 PM
**To:** customer@scirp.org; murata@iims.sys.okayama-u.ac.jp
**Subject:** Fw: Request for use of diagrams and informaton

Good Day to you.

Please help me. I am hopeful of gaining permission to reuse a diagram contained in the article cited below in this email thread. I am a doctoral student at the dissertation stage of my study. This Atsuo Murata article is relevant to my research. I therefore seek your assistance so that I can have permission to include "Figure 4 Model on safety culture that takes cross-cultural differences into account" on page 411 in my doctoral dissertation. I assure you that all appropriate recognition will be afforded for this use.

Thank you in advance

Ganesh Narine
STUDENT ID: A00648285
Walden University

Article

Murata, A. (2017) Cultural Difference and Cognitive Biases as a Trigger of Critical Crashes or Disasters. Journal of Behavioral and Brain Science, 7, 399-415.
https://doi.org/10.4236/jbbs.2017.79029

**From:** Ganesh Narine
**Sent:** Monday, July 2, 2018 9:35 AM
**To:** murata@iims.sys.okayama-u.ac.jp
**Subject:** Re: Request for use of diagrams and informaton

Good Morning Sir,

I am following-up on my April 01, 2018 request (email thread below). This is a very interesting article and relevant to my study.

I look forward to your permission to include your work (including diagrams) in my Doctoral Dissertation. All required recognition and source identification will be assured.

Ganesh Narine
STUDENT ID: A00648285

---

**From:** Ganesh Narine
**Sent:** Sunday, April 1, 2018 4:33 PM
**To:** murata@iims.sys.okayama-u.ac.jp
**Subject:** Request for use of diagrams and informaton

Dear  Atsuo Murata,

I am a doctoral student at Walden University in the U.S.A. I am conducting research on why serious and fatal accidents occur in the North American electric power industry. I have your research paper on "Cultural Difference and Cognitive Biases as a Trigger of Critical Crashes or Disasters" (cited below). I am interested in using information, including your diagrams on my research dissertation. I will appropriately cite and fully recognize the source of my information. Before doing this, I seek your permission to do so. I assure you that I will attribute full recognition to you for the excellent work that you have done.

I look forward to your positive response. Thank you in advance.

Ganesh Narine
STUDENT ID: A00648285

Murata, A. (2017) Cultural Difference and Cognitive Biases as a Trigger of Critical Crashes or Disasters. Journal of Behavioral and Brain Science, 7, 399-415. https://doi.org/10.4236/jbbs.2017.79029

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**From:** Ganesh Narine
**Sent:** June 2, 2018 7:06 PM
**Subject:** Fw: Request for permission to reproduce your Table 1. on page 1697 of "Enhancing rigour in the Delphi technique research"

---

**From:** Ganesh Narine
**Sent:** Saturday, June 2, 2018 7:04 PM
**To:** Hasson, Felicity; Keeney, Sinead
**Subject:** Re: Request for permission to reproduce your Table 1. on page 1697 of "Enhancing rigour in the Delphi technique research"

Hi Felicity,

Thank you very much.

GN

---

**From:** Hasson, Felicity <f.hasson@ulster.ac.uk>
**Sent:** Saturday, June 2, 2018 4:36:14 PM
**To:** Ganesh Narine; Keeney, Sinead
**Subject:** Re: Request for permission to reproduce your Table 1. on page 1697 of "Enhancing rigour in the Delphi technique research"

Granesh

Yes of course, best wishes with your study.
Felicity

---

**From:** Ganesh Narine <ganesh.narine@waldenu.edu>
**Sent:** 02 June 2018 16:52:42

**To:** Hasson, Felicity; Keeney, Sinead
**Subject:** Request for permission to reproduce your Table 1. on page 1697 of "Enhancing rigour in the Delphi technique research"

Hi,

I am a doctoral research student at Walden University. I am conducting my research and using the Delphi Method. I found your document (*Enhancing rigour in the Delphi technique research*), relevant to my study.

My request is for permission to reproduce your Table 1 Types of Delphi designs on page 1697. I assure you that all necessary recognition will be afforded your work as the data source if permission is granted.

I look forward to your response and I thank you in advance.

Ganesh Narine

STUDENT ID: A00648285

Source Doc:
Hasson, F., & Keeney, S. (2011). Enhancing rigour in the Delphi technique research. *Technological Forecasting and Social Change, 78*(9), 1695-1704. doi:10.1016/j.techfore. 2011.04.005

**From:** Ganesh Narine
**Sent:** June 6, 2018 8:41 PM
**Subject:** Fw: Request for use of your Flowchart in my doctoral dissertation

---

**From:** Ganesh Narine
**Sent:** Wednesday, June 6, 2018 7:39 PM
**To:** Barry Wellar
**Subject:** Re: Request for use of your Flowchart in my doctoral dissertation

Thank You Professor Wellar,

I am sorry about the passing of Dr. Novakowski. I also apologize for incorrectly spelling your name before.

I will update you when my Dissertation becomes available online.

Ganesh

---

**From:** Barry Wellar <wellarb@uottawa.ca>
**Sent:** Wednesday, June 6, 2018 9:07:13 AM
**To:** Ganesh Narine
**Subject:** RE: Request for use of your Flowchart in my doctoral dissertation

You are most welcome. Since Erin/Nick has passed away it seems that only my permission is needed in terms of authorship. Regarding the journal, to my knowledge it appears that as a rule journals only require what you are doing in terms of sourcing, so please consider permission granted to proceed as you propose.

Dr. Barry Wellar, MCIP
Professor Emeritus
Department of Geography
University of Ottawa
Ottawa ON  K1N 6N5

**From:** Ganesh Narine [mailto:ganesh.narine@waldenu.edu]
**Sent:** Tuesday, June 5, 2018 10:38 PM
**To:** Barry Wellar; nnovakowski@swgc.mun.ca
**Subject:** Re: Request for use of your Flowchart in my doctoral dissertation

Thank You Dr. Weller,

I truly appreciate your positive response.

I most certainly will let you know when it can be accessed online.

Ganesh

---

**From:** Barry Wellar <wellarb@uottawa.ca>
**Sent:** Tuesday, June 5, 2018 10:02:27 PM
**To:** Ganesh Narine; nnovakowski@swgc.mun.ca
**Subject:** RE: Request for use of your Flowchart in my doctoral dissertation

Permission granted on my part, best wishes for a successful dissertation outcome.
Please inform me when the dissertation can be viewed online.

Dr. Barry Wellar, GISP
President, Information Research Board Inc.
133 Ridgefield Crescent
Ottawa, ON K2H 6T4
CANADA

**From:** Ganesh Narine [mailto:ganesh.narine@waldenu.edu]
**Sent:** Tuesday, June 5, 2018 9:43 PM
**To:** wellarb@uottawa.ca; nnovakowski@swgc.mun.ca
**Subject:** Request for use of your Flowchart in my doctoral dissertation

Hi,

I am a doctoral research student at Walden University. I am conducting my research and using the Delphi Method. I found your document (*Using the Delphi technique in normative planning research: methodological design considerations*), relevant to my study.

My request is for permission to reproduce your Figure 1 Flowchart for a normative Delphi on page 1488. I assure you that all necessary recognition will be afforded your work as the data source if permission is granted.

I look forward to your response and I thank you in advance.

Ganesh Narine

STUDENT ID: A00648285

Novakowski, N., & Wellar, B. (2008). Using the Delphi technique in normative planning research: methodological design considerations. *Environment and Planning A*, *40*(6), 1485-1500. doi:10.1068/a39267

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**From:** Ganesh Narine
**Sent:** Tuesday, July 10, 2018 4:55 PM
**To:** Icek Aizen
**Subject:** Re: Request to reuse your diagram in my research

Thank You Professor.

GN

**From:** Icek Aizen <aizen@psych.umass.edu>
**Sent:** Tuesday, July 10, 2018 2:16 PM
**To:** Ganesh Narine
**Subject:** Re: Request to reuse your diagram in my research

Dear Ganesh Narine,

No permission is needed to include an ORIGINAL drawing of the TPB model in a thesis, dissertation, presentation, poster, article, or book. If you would like to reproduce a published drawing of the model (such as the one in the White et al. article, you need to get permission from the publisher who holds the copyright. You may use the drawings on my website ("https://people.umass.edu/aizen/tpb.diag.html" or "https://people.umass.edu/aizen/tpb.background.html") for non-commercial purposes, including publication in a journal article, so long as you retain the copyright notice.

Best regards,

Icek Ajzen
Professor Emeritus
University of Massachusetts - Amherst
https://people.umass.edu/aizen

On Jul 10, 2018, at 12:20, Ganesh Narine <ganesh.narine@waldenu.edu> wrote:

Good Day to You Sir,

I am a doctoral student at Walden University. I am at the dissertation stage of my research. Your research on the Theory of Planned Behaviour is relevant to my study on why accidents are occurring in the US Electric Power Industry. Your diagram on this theory was captured by White et al. (2016). My request is for permission to reuse this diagram in my doctoral dissertation. I assure you that all appropriate recognition will be afforded.

I thank you in anticipation of a positive response.

Ganesh Narine
Student ID: A00648285
Walden University

**From:** Ganesh Narine
**Sent:** Tuesday, July 10, 2018 11:51 AM
**To:** Katherine White
**Subject:** Re: Request for copy of your paper to further my research (further request)

Thank you for your kind response. I will contact the Azjen website as you suggested. Appreciate much.

Ganesh

---

**From:** Katherine White <km.white@qut.edu.au>
**Sent:** Tuesday, July 10, 2018 5:48:45 AM
**To:** Ganesh Narine
**Cc:** Nerina Jimmieson
**Subject:** RE: Request for copy of your paper to further my research (further request)

Dear Ganesh,

Thanks for your email. It is ok to use the idea of the Figure from this paper but it might be an idea for you to consult also Ajzen's website for Figure suggestions.

http://people.umass.edu/aizen/

Kind regards,
Katy White

**From:** Ganesh Narine
**Sent:** Tuesday, July 10, 2018 5:24 AM
**To:** km.white@qut.edu.au
**Subject:** Fw: Request for copy of your paper to further my research (further request)

Hi Ms White,

I found your article very much relevant to my study and I want to reuse your Figure on "The Theory of Planned Behavior (Ajzen, 1991, p.182)" as captured Section 1.2.2 of your paper. I again assure you that all appropriate recognition will be afforded you and your colleagues as the source of this data. I believe that it compliments my research literature and makes my doctoral dissertation all the better.

I look forward to your response.

Ganesh Narine
STUDENT ID: A00648285
WALDEN UNIVERSITY

Your paper:

White, K. M., Jimmieson, N. L., Obst, P. L., Gee, P., Haneman, L., O'Brien-McInally, B., & Cockshaw, W. (2016). Identifying safety beliefs among Australian electrical workers. *Safety science*, *82*, 164-173. doi: 10.1016/j.ssci.2015.09.008

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**From:** Ganesh Narine
**Sent:** Friday, May 4, 2018 6:05 AM

**To:** Katherine White
**Cc:** Nerina Jimmieson
**Subject:** Re: Request for copy of your paper to further my research

Thank You very much for your positive and kind response.

GN

**From:** Katherine White <km.white@qut.edu.au>
**Sent:** Friday, May 4, 2018 12:21:57 AM
**To:** Ganesh Narine
**Cc:** Nerina Jimmieson
**Subject:** RE: Request for copy of your paper to further my research

Hi Ganesh,

Thanks for your email. Please find the paper attached.

All the best with your research.

Kind regards,
Katy White

**From:** Ganesh Narine [mailto:ganesh.narine@waldenu.edu]
**Sent:** Friday, 4 May 2018 11:24 AM
**To:** Katherine White <km.white@qut.edu.au>
**Subject:** Request for copy of your paper to further my research

Good Evening Ms. White,

I am a student at Walden University (USA) and I am conducting my doctoral research on accidents in the electric power industry in North Eastern USA. I found your paper on one of my literature search. This is relevant to my study. I therefore request that you allow me a copy. I assure you that all proper citations and source identification will be afforded to you and your colleagues. Thank you in advance.

Your paper:

White, K. M., Jimmieson, N. L., Obst, P. L., Gee, P., Haneman, L., O'Brien-McInally, B., & Cockshaw, W. (2016). Identifying safety beliefs among Australian electrical workers. *Safety science*, *82*, 164-173. doi: 10.1016/j.ssci.2015.09.008

Ganesh Narine
STUDENT ID: A00648285
WALDEN UNIVERSITY

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**From:** Ganesh Narine
**Sent:** Sunday, April 29, 2018 11:41 AM
**To:** Matt Brearley
**Subject:** Re: Request for a copy of your paper to further my research

Thank You Dr. Brearly,

I will provide you with details of my study progress and with any interesting studies that I unearth during this journey. I have not done any work on electrical safety but I am open to that possibility. I did an article in 2004 for the West Indian Engineering Forum. I will look for that and share it with you as soon as I can.

Ganesh

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**From:** Matt Brearley <matt@thermalhyperformance.com.au>
**Sent:** Thursday, April 26, 2018 6:59:59 AM
**To:** Ganesh Narine
**Subject:** Re: Request for a copy of your paper to further my research

No Problem Ganesh, will send through within the next 7 days. Your research area is of great interest to me as I work with a variety of electrical utility organisations here in Australia – please let me know of any publications/documents you produce as I'd like to read them.

Apologies for the typo in the previous email.

Regards,

Matt

**From:** Ganesh Narine <ganesh.narine@waldenu.edu>
**Date:** Thursday, 26 April 2018 at 7:47 pm
**To:** Matt Brearley <matt@thermalhyperformance.com.au>
**Subject:** Re: Request for a copy of your paper to further my research

Good Morning Sir,

Thank You so much. I will very much be interested in your latest article as well. I assure you that appropriate recognition and citations for your work will be maintained.

I look forward to your new article.
Ganesh

**From:** Matt Brearley <matt@thermalhyperformance.com.au>
**Sent:** Wednesday, April 25, 2018 11:08:54 PM
**To:** Ganesh Narine
**Subject:** Re: Request for a copy of your paper to further my research

Hi Garesh,

Please find attached the requested paper. We are close to submitting another paper regarding heat stress in the electrical utility industry, I can send that to you once submitted if you are interested.

Regards,

Matt

**Matt Brearley** PhD
Managing Director
Thermal Hyperformance Pty Ltd
+61420889399
**www.thermalhyperformance.com.au**

**From:** Ganesh Narine <ganesh.narine@waldenu.edu>
**Date:** Thursday, 26 April 2018 at 12:56 pm
**To:** "matt@thermalhyperformance.com.au" <matt@thermalhyperformance.com.au>
**Subject:** Request for a copy of your paper to further my research

Good Evening Sir,

I am a doctoral research student at Walden University in the USA. My research is on why serious and fatal accidents are happening in the electric power industry.
My request is for a copy of your work (below). This is a paper that may prove very helpful to my research. Thank you in advance of a positive response. I assure you that all required citations and recognition will be afforded your work, if I include it in my research.
Ganesh Narine
STUDENT ID: A00648285

Your Document:
Working in Hot Conditions—A Study of Electrical Utility Workers in the Northern Territory of Australia
Matt Brearley, Phillip Harrington, Doug Lee & Raymond Taylor
Pages 156-162 | Accepted author version posted online: 29 Sep 2014, Published online: 29 Sep 2014
Download citation https://doi.org/10.1080/15459624.2014.957831

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**From:** Glen Kenny <gkenny@uottawa.ca>
**Sent:** Wednesday, April 25, 2018 10:28 PM
**To:** Ganesh Narine
**Subject:** Automatic reply: Request for a copy of your paper to further my research

Hello, thank you for your message. I am currently away from the office. I will respond to your email on my return April 26.

Regards,
Glen P. Kenny, PhD (Med), FCAHS
Professor and University Research Chair (Exercise and Environmental Physiology)
Director, Human and Environmental Physiology Research Unit

Fellow of the Canadian Academy of Health Sciences
Faculty of Health Sciences
University of Ottawa
Ottawa, Ontario, K1N 6N5
(613) 562-5800 ext. 4282 (office)
(613) 562-5497 (fax)

**From:** Ganesh Narine
**Sent:** Wednesday, April 25, 2018 10:28 PM
**To:** gkenny@uottawa.ca
**Subject:** Request for a copy of your paper to further my research

Good Evening Sir,

I am a doctoral research student at Walden University in the USA. My research is on why serious and fatal accidents are happening in the electric power industry.
My request is for a copy of your work (below). This is a paper that may prove very helpful to my research. Thank you in advance of a positive response. I assure you that all required citations and recognition will be afforded your work, if I include it in my research.
Ganesh Narine
STUDENT ID: A00648285

Your Document:
An Evaluation of the Physiological Strain Experienced by Electrical Utility Workers in North America
Robert D. Meade, Martin Lauzon, Martin P. Poirier, Andreas D. Flouris & Glen P. Kenny
Pages 708-720 | Accepted author version posted online: 26 May 2015, Published online: 02 Sep 2015
Download citation  https://doi.org/10.1080/15459624.2015.1043054

---

**From:** Takis Mitropoulos <takism2009@gmail.com>
**Sent:** Tuesday, April 3, 2018 3:37 PM
**To:** Ganesh Narine

**Cc:** tabdelha@msu.edu; takism@asu.edu; gah2343@mac.com
**Subject:** Re: Fw: Request for use of information

HI Ganesh,
yes you have permission to use the figures from the paper.

Best

P. Mitropoulos

On Mon, Apr 2, 2018 at 6:26 AM, Ganesh Narine <ganesh.narine@waldenu.edu> wrote:
Dear Professors, Director

I hope that you are enjoying great health and happiness. I am a doctoral student at Walden University. I am conducting research on why accidents are occurring in the North American power industry. I have your research paper on " Accident prevention strategies: Causation model and research directions" (cited below). I am interested in using information, including your diagrams on my research dissertation. I will appropriately cite and fully recognize the source of my information. Before doing this, I seek your permission to do so. I assure you that I will attribute full recognition to you for the excellent work that you have done.

I look forward to your positive response. Thank you in advance.

Ganesh Narine
STUDENT ID: A00648285

Mitropoulos, P., Howell, G. A., & Abdelhamid, T. S. (2005). Accident prevention strategies: Causation model and research directions. In *Construction Research Congress 2005: Broadening Perspectives* (pp. 1-10). doi: 10.1061/40754(183)8

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**From:** Greg Howell <GHowell@Leanconstruction.org>
**Sent:** Monday, April 2, 2018 9:18 AM
**To:** Ganesh Narine
**Subject:** Automatic reply: Request for use of unformation

Thank you for your email. To reach Greg Howell, please contact gah2343@mac.com.

Greg

**From:** Takis Mitropoulos <takism2009@gmail.com>
**Sent:** Sunday, April 8, 2018 4:38 PM
**To:** Ganesh Narine
**Cc:** gah2343@mac.com
**Subject:** Re: Fw: Request for use of unformation

Ganesh, I already emailed you permission several days ago.
Best

On Sun, Apr 8, 2018, 6:19 AM Ganesh Narine <ganesh.narine@waldenu.edu> wrote:
Good Morning Professor,

Please assist me with regards to my request in the email thread below.

Thank you in advance.

GN

---

**From:** Gregory Howell <gah2343@mac.com>
**Sent:** Saturday, April 7, 2018 1:59 PM
**To:** Ganesh Narine
**Cc:** Takis Mitropoulos
**Subject:** Re: Request for use of unformation

Suggest you contact Takis Mitropoulos

Takis Mitropoulos <takism2009@gmail.com

Gregory A. Howell
Box 1003
Ketchum, ID 83340-1003

***Connecting people and ideas***

C - 208/726-9989

Skype GregHowell

On Apr 2, 2018, at 11:50, Ganesh Narine <ganesh.narine@waldenu.edu> wrote:

Hello Mr. Howell,

The drawing that I am interested in is attached. Thank you for responding

GN

---

**From:** Gregory Howell <gah2343@mac.com>
**Sent:** Monday, April 2, 2018 10:23 AM
**To:** Ganesh Narine
**Subject:** Re: Request for use of unformation

I suggest you send me the diagrams from the paper - I am not where I can find the paper. I'll read it and then suggest a time for you to call and we can figure out where to go from there. Best regards, GAH

Greg Howell

On Apr 2, 2018, at 7:26 AM, Ganesh Narine <ganesh.narine@waldenu.edu> wrote:

Dear Professors, Director

I hope that you are enjoying great health and happiness. I am a doctoral student at Walden University. I am conducting research on why accidents are occurring in the North American power industry. I have your research paper on " Accident prevention strategies: Causation model and research directions" (cited below). I am interested in using information, including your diagrams on my research dissertation. I will appropriately cite and fully recognize the source of my information. Before doing this, I seek your permission to do so. I assure you that I will attribute full recognition to you for the excellent work that you have done.

I look forward to your positive response. Thank you in advance.

Ganesh Narine
STUDENT ID: A00648285

Mitropoulos, P., Howell, G. A., & Abdelhamid, T. S. (2005). Accident prevention strategies: Causation model and research directions. In *Construction Research Congress 2005: Broadening Perspectives* (pp. 1-10). doi: 10.1061/40754(183)8

---

**From:** Greg Howell <GHowell@Leanconstruction.org>
**Sent:** Monday, April 2, 2018 9:18 AM
**To:** Ganesh Narine
**Subject:** Automatic reply: Request for use of unformation

Thank you for your email. To reach Greg Howell, please contact gah2343@mac.com.

Greg
<accident causation model  a.jpg>

---

**From:** Ganesh Narine
**Sent:** Sunday, April 1, 2018 9:27 PM
**To:** Ashraf Labib
**Subject:** Re: Request for use of information

Thank You Professor.

I will proudly share my work with you afterwards.

Ganesh

---

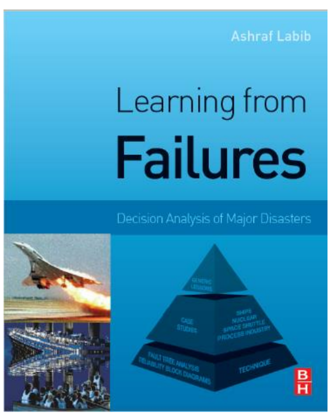
**From:** Ashraf Labib <ashraf.labib@port.ac.uk>
**Sent:** Sunday, April 1, 2018 5:07 PM
**To:** Ganesh Narine
**Subject:** Re: Request for use of information

Dear Ganesh,

With pleasure. Good luck.

Best wishes,
Ashraf

-----8<--------------------------------
Professor Ashraf Labib
University of Portsmouth
Faculty of Business and Law,
Operations & Systems Management.
Portsmouth PO1 3DE
United Kingdom
Tel: 0044(0)23 9284 4729
Email: ashraf.labib@port.ac.uk
-----8<--------------------------------




On 1 April 2018 at 21:46, Ganesh Narine <ganesh.narine@waldenu.edu> wrote:
Dear Professor Labib,

I hope that you are enjoying great health and happiness. I have your research paper on " Learning (and unlearning) from failures: 30 years on from Bhopal to Fukushima an analysis through reliability engineering techniques" (cited below). I am interested in using information, including your diagrams on my research dissertation. I will appropriately cite and fully recognize the source of my information. Before doing this, I seek your permission to do so. I assure you that I will attribute full recognition to you for the excellent work that you have done.

I look forward to your positive response. Thank you in advance.

Ganesh Narine
STUDENT ID: A00648285

Labib, A. (2015). Learning (and unlearning) from failures: 30 years on from Bhopal to Fukushima an analysis through reliability engineering techniques. *Process Safety and Environmental Protection*, *97*, 80-90. doi: 10.1016/j.psep.2015.03.008

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**From:** Ashraf Labib <ashraf.labib@port.ac.uk>
**Sent:** Tuesday, January 9, 2018 4:05 AM
**To:** Ganesh Narine
**Subject:** Re: Request for your permission and a copy

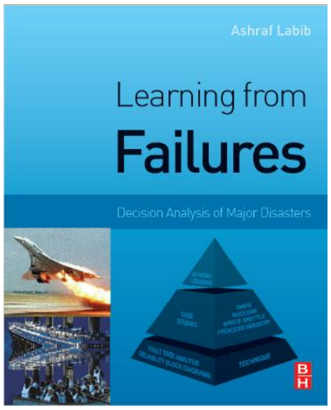
Dear Ganesh,

Thank you for your kind email.  I am sorry that at the moment, I am very busy in supervising 12 doctoral students plus working on a large grant with strict deadlines, and many teaching responsibilities. So my availability will be very limited. Hope you do well in your research which is quite interesting.

Best wishes,
Ashraf

-----8<---------------------------------
Professor Ashraf Labib
University of Portsmouth
Faculty of Business and Law,

Operations & Systems Management.
Portsmouth PO1 3DE
United Kingdom
Tel: 0044(0)23 9284 4729
Email: ashraf.labib@port.ac.uk
-----8<--------------------------------




TEF Gold Teaching Excellence Framework   THE WORLD UNIVERSITY RANKINGS   Athena SWAN Bronze Award

On 8 January 2018 at 21:37, Ganesh Narine <ganesh.narine@waldenu.edu> wrote:
Dear Professor Labib,

Thank you for your kind gesture. Sir, your study is one that is very revealing. My study is focused on why accidents happen in the electric power industry and the prevention of future accidents. This is in line with the disasters you have succinctly studied. Your work is one that extended knowledge in a way that I hope to do in my industry. Would you be willing to give me guidance if that becomes necessary? I am grateful for your response. Thank you in advance.

Ganesh

---

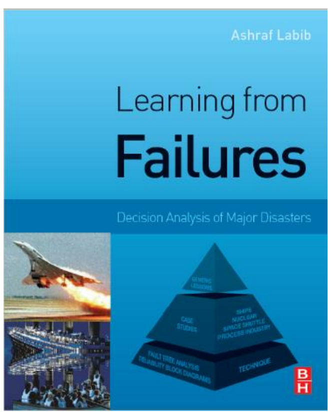
**From:** Ashraf Labib <ashraf.labib@port.ac.uk>
**Sent:** Monday, January 8, 2018 9:21 AM
**To:** Ganesh Narine
**Subject:** Re: Request for your permission and a copy

Dear Ganesh,

Please find attached as requested. Good luck in your studies.

Best wishes,
Ashraf

-----8<---------------------------------
Professor Ashraf Labib
University of Portsmouth
Faculty of Business and Law,
Operations & Systems Management.
Portsmouth PO1 3DE
United Kingdom
Tel: 0044(0)23 9284 4729
Email: ashraf.labib@port.ac.uk
-----8<---------------------------------




TEF Gold Teaching Excellence Framework   THE WORLD UNIVERSITY RANKINGS   Athena SWAN Bronze Award

On 7 January 2018 at 14:43, Ganesh Narine <ganesh.narine@waldenu.edu> wrote:
Hello,

I am a doctoral student at Walden University conducting research on why workplace accidents happen. I am interested in your article (below).
Is it possible for you to share a copy with me? I want to study this and to include the lessons in my own study. I will ensure full recognition of the high quality work that you have done. I may also communicate further with you as I progress with my research. I am sure that I will learn from you.

Thank you for a great and positive response.

Ganesh

## Learning (and unlearning) from failures: 30 years on from Bhopal to Fukushima an analysis through reliability engineering techniques

https://doi.org/10.1016/j.psep.2015.03.008

## Appendix B: Disaster Comparison in Bhopal and Fukushima Daiichi

Comparison of the 1984 Chemical Disaster in Bhopal and the 2011 Fukushima Daiichi Nuclear Power Station Meltdown.

| | Bhopal | Fukushima Daiichi |
|---|---|---|
| When | midnight of December 2, 1984 | March 11th, 2011, |
| What (happened) | Water leak into methyl isocyanate (MIC) tank 610. | Japan earthquake (9.0 Richter scale) followed by a tsunami. AC electrical power lost at Fukushima Daiichi site. |
| How significant was the problem | water leak bypassed safety systems and barriers. Other control systems unavailable due to maintenance. | cooling capability of the four nuclear reactors lost |
| Other issues | Operational errors lead to further escalation of problem. | Tsunami breached designed systems and barriers originally considered as adequate for this facility |
| Disaster/ Accident/Event | leads to an uncontrolled chemical reaction and deadly gas leak. | nuclear melt-down |
| Consequence | >3400 persons died<br>> ~200 000 injured | Level 7 disaster (the highest severity level ) International |

| | | |
|---|---|---|
| | >300 cows died<br>>40sqkm of vegetation and eco-systems damaged. | Nuclear and Radiological Event Scale (INES), |
| Unique (learning/un-learning) | “Storm” waiting to happen | Unexpected and not designed for this level of water from tsunami event |
| What went wrong | 1. safety devices not designed for major gas leak like this one.<br>2. Safety devices not enabled, bypassed and unavailable<br>3. The plant was losing money<br>4. staff and maintenance cutbacks<br>5. questionable safety culture<br>6. worker/management problems. Plant was due to be closed.<br>7. Ineffective emergency response and inability to treat injured victims<br>8. Communities were uninformed resulting in thousands of victims being injured or killed.<br>9. Environmental disaster. | |

| | | |
|---|---|---|
| After the Accident | Led to organizations keeping less volume (storage) of volatile chemicals | Global regulation, new licencing arrangements for nuclear power plants. |

*Note:* Learning (and unlearning) from failures: 30 years on from Bhopal to Fukushima an analysis through reliability engineering techniques. Adapted from A. Labib (2015). Reprinted with permission.

Appendix C: Delphi Design Types

| Design type | Aim | Target panellists | Administration | Number of rounds | Round 1 design |
|---|---|---|---|---|---|
| Classical | To elicit opinion and gain consensus | Experts selected based on aims of research | Traditionally postal | Employs three or more rounds | Open qualitative first round, to allow panellists to record responses |
| Modified | Aim varies according to project design, from predicting future events to achieving consensus | Experts selected based on aims of research | Varies, postal, online etc. | May employ fewer than 3 rounds | Panellists provided with pre-selected items, drawn from various sources, within which they are asked to consider their responses |
| Decision | To structure decision-making and create the future in reality rather than predicting it | Decision makers, selected according to hierarchical position and level of expertise | Varies | Varies | Can adopt similar process to classical Delphi |
| Policy | To generate opposing views on policy and potential resolutions. | Policy makers selected to obtain divergent opinions | Can adopt a number of formats including bringing participants together in a group meeting | Varies | Can adopt similar process to classical Delphi |

| | | | | | |
|---|---|---|---|---|---|
| Real time/consensus conference | To elicit opinion and gain consensus | Experts selected based on aims of research | Use of computer technology that panellists use in the same room to achieve consensus in real time rather than post | Varies | Can adopt similar process to classical Delphi |
| e-Delphi | Aim can vary depending on the nature of the research | Expert selection can vary depending on the aim of the research | Administration of Delphi via email or online web survey | Varies | Can adopt similar process to classical Delphi |
| Technological | Aim varies according to project design, from predicting future events to achieving consensus | Experts selected based on aims of research | Use of hand-held keypads allowing responses to be recorded and instant feedback provided | | Can adopt similar process to classical Delphi |
| Online | Aim varies according to project design, from predicting future events to achieving consensus | Experts selected based on aims of research | Implementation of the technique on any online instrument such as a chat room, or forum. | Varies | Can adopt similar process to classical Delph |
| Argument | To develop relevant arguments and expose underlying reasons for different opinions on a specific single issue | Panellists should represent the research issue from different perspectives | Varies | Varies | Can adopt similar process to modified Delphi i.e. first round involves expert interviews |

| | | | | | |
|---|---|---|---|---|---|
| Disaggregative policy | Constructs future scenarios in which panellists are asked about their probable and the preferable future | Expert selection can vary depending on the aim of the research | Varies | Varies | Adoption of modified format using cluster analysis |

*Note*. Enhancing rigour in the Delphi technique research. Adapted from F. Hasson & S. Keeney (2011). Reprinted with permission.

# Appendix D: Normative Delphi

Figure 2.12 Flowchart for a Normative Delphi.

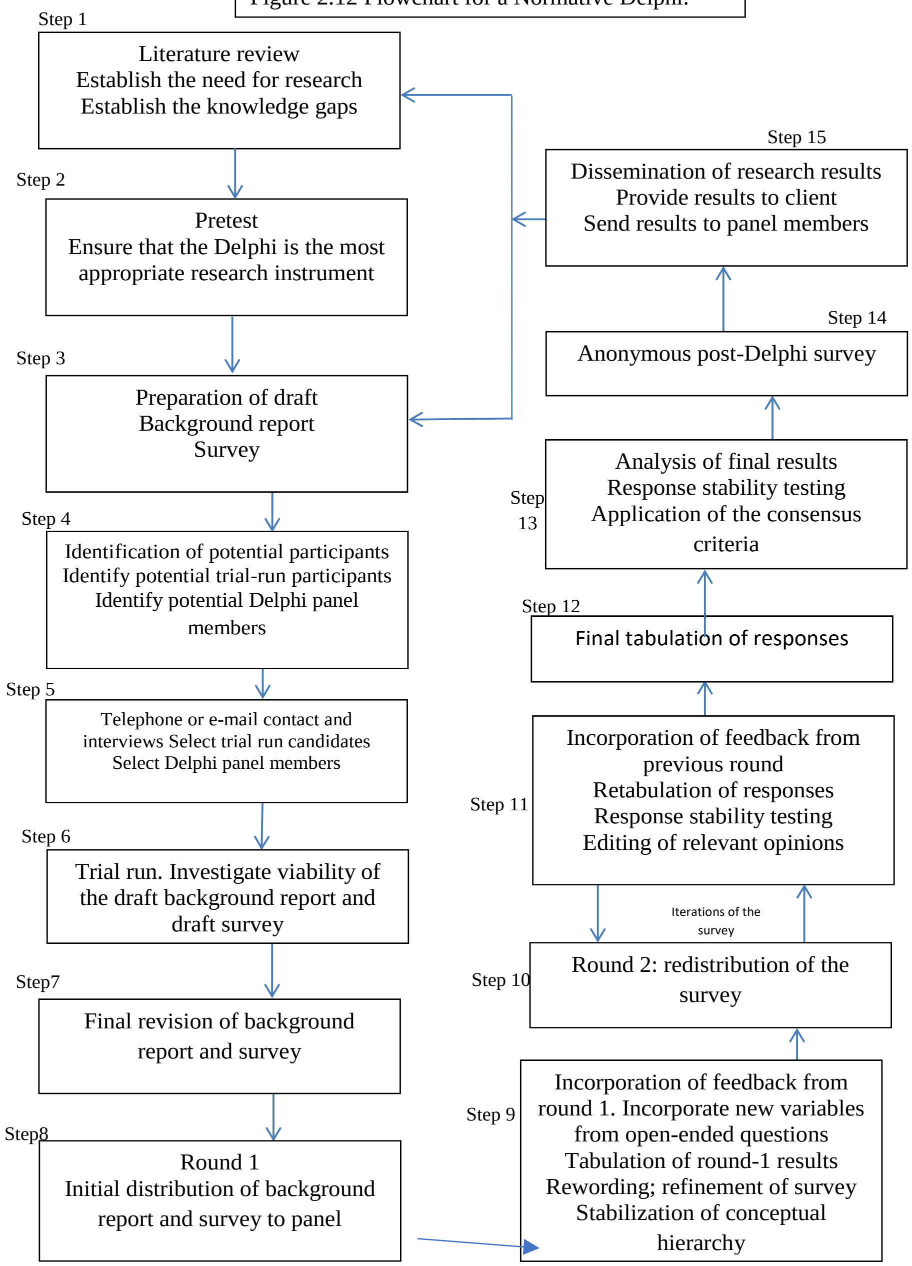



Figure 18: Using the Delphi technique in normative planning research: Methodological design considerations. Adapted from N. Novakowski & B. Wellar. (2008). Reprinted with permission.

Appendix E: Round 1 Questions

# Round 1 Questions

1. The following are reasons why serious and fatal accidents occur in the electric power industry. For each of the listed items, indicate whether you agree and comment on why you selected your option.

| **Accident Cause** | **Agree (Yes/No)** | **Comment -** Potential solution |
|---|---|---|
| Poor design | | |
| Safety management system flaw | | |
| Poor regulatory oversight | | |
| Poor workplace ethics, history of wrongdoing that went unaddressed | | |
| Incorrect labeling | | |
| Medical and other personal issues | | |
| Grounding, earthing failures/errors | | |
| Ineffective and inefficient Maintenance | | |
| Animals/ living organisms | | |
| Hazardous Worksite conditions | | |
| Unplanned events | | |
| Inappropriate work methods | | |
| Stakeholder demands | | |
| Poor judgment by individuals or work crews | | |
| Poor attitudes and or behavior by individuals or work crews | | |
| Ineffective or no workplace Training | | |
| Poor Supervision | | |
| Work planning | | |

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|---|---|---|
| Management priorities | | |
| Poor team communication | | |
| Willful disregard for safety rules | | |
| Permit to work violations | | |
| Lock out tag out non-compliance | | |
| Organizational safety culture | | |
| Individual Risk taking and negligence | | |
| Equipment failure | | |
| Procedural error | | |
| Poor management oversight | | |
| Poor quality material | | |
| Non-use of personal protective equipment | | |

2 What other contributing factors, either organizational and/or individual, that impact on safe work and how do these affect accidents events where individuals are killed or injured at work?

3. What can be done to prevent further and future accidents caused by the items identified in questions 1 and 2 above?

**Appendix F – Round 2 Questions**

# Round 2 Questions

1. Each of the following are solutions to accidents as suggested by >70% participants in Round 1. With Desirability in Round 2, rated as 5 for highly desirable to 1 for highly undesirable and feasibility rated from 5 for definitely feasible to 1 for definitely unfeasible. Please indicate your response to each item.

| **Solution to Prevent Accident** | | **Desirable** Indicate on the scale provided (1 to 5) on how desirable it is to address, and if this may lead to the prevention of accidents, serious worker injuries, and death. | **Feasible** Indicate on the scale provided (1 to 5) on how desirable it is to address, and if this may lead to the prevention of accidents, serious worker injuries, and death. |
|---|---|---|---|
| In Round 1 > 70% of participants believed that Focus on People Solutions was a solution to accidents in the electric power industry where workers are seriously injured or killed while doing work. | Involvement of Qualified Personnel, Expert Practitioners, and Consultants; | | |
| Focus on People Solutions | Human Performance Monitoring; | | |
| Focus on People Solutions | Regular Supervisor and Manager Job Visits | | |
| Focus on People Solutions | Management - Workers Communication and Feedback | | |

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| | | | |
| Focus on People Solutions | Individual and Group Behavior and Habits; Teamwork; Confidence, Confidential | | |
| Focus on People Solutions | Work Methods, Procedures, and Management of Change, Work Planning, Monitoring, Review, Procedures, Documented Standard | | |
| Focus on People Solutions | Culture, Safety Culture, Problem Identification | | |
| Focus on People Solutions | Prevention of Equipment Failure | | |
| In Round 1 > 70% of participants believed that Work Standards Solutions was a solution to accidents in the electric power industry where workers are seriously injured or killed while doing work. | Performance Monitoring | | |
| Work Standards Solutions | Reliability Centered Maintenance, Maintenance Scheduling and Cycles, Recordkeeping and Recordkeeping Procedures | | |
| Work Standards Solutions | Inspection Methods and Arrangements, Troubleshooting, Breakdown Management, Equipment and Device Calibration | | |
| Work Standards Solutions | Construction and Operating Practices and Procedures, International and Best Practice , Technology, Quality Management System | | |

| | | | |
|---|---|---|---|
| Work Standards Solutions | Compliance Focus, Technology in Use, New Technology, Work Methods Change-Management | | |
| Work Standards Solutions | Work Design and Planning; Work Performance Monitoring and Review; Recordkeeping; Documented, Standard, Worker Training, Knowledge and Experience | | |
| Work Standards Solutions | Diagnostic Testing, Research, and Manufacturers' Instructions | | |
| Work Standards Solutions | Available and Condition of Personal Protective Equipment, Tools, and Materials | | |
| Work Standards Solutions | Safety Barriers, Safety Culture, and Housekeeping | | |
| Work Standards Solutions | Equipment Failure | | |
| In Round 1 > 70% of participants believed that Safety Management Solutions was a solution to accidents in the electric power industry where workers are seriously injured or killed while doing work. | Focus on Safety Legislation | | |
| Safety Management Solutions | Focus on Compliance, Work Methods, Procedures, Change | | |
| Safety Management Solutions | Culture; Organizational Culture; Safety Culture | | |
| Safety Management Solutions | Quality of Regulator Inspections | | |
| Safety Management Solutions | Distraction, Individual Obligation to Inform, Procedures, Rules and Documented Standards | | |
| Safety Management Solutions | Compliance with Manufacturers Instructions | | |

| | | | |
|---|---|---|---|
| Safety Management Solutions | Safety Inspection, Workplace Inspections; Work Planning, Monitoring, and Review | | |
| Safety Management Solutions | Safety Oversight and Audits of Materials, Spares, Materials, Tools, and Personal Protective Equipment | | |
| Safety Management Solutions | Workplace Training; Safety Barriers; Housekeeping; Lock-Out-Tag-Out, Permit to Work; Recordkeeping | | |
| Safety Management Solutions | Equipment Failure | | |
| In Round 1 > 70% of participants believed that Workplace Training Solutions was a solution to accidents in the electric power industry where workers are seriously injured or killed while doing work. | Training Philosophy, Company Core Values Training, and Workplace Training Arrangements (Cost, Availability, Management). | | |
| Workplace Training Solutions | Communication, Process, Procedures, Frequency, Quality, Methods, and Location | | |
| Workplace Training Solutions | Feedback (Management - Workers), Correct (Flaws) | | |
| Workplace Training Solutions | Manufacturers Instructions; Compliance | | |
| Workplace Training Solutions | Work Planning, Monitoring, and Review | | |
| Workplace Training Solutions | Material Science, Use, Testing, and Maintenance of Tools, Work Procedures, and Documented Standards | | |
| Workplace Training Solutions | Safety Rules, Procedures, and Barriers, Safety Culture | | |
| Workplace Training Solutions | Good Housekeeping | | |

| | | | |
|---|---|---|---|
| Workplace Training Solutions | Prevention of Equipment Failure | | |
| In Round 1 > 70% of participants believed that Management Solutions was a solution to accidents in the electric power industry where workers are seriously injured or killed while doing work. | Focus and Assumptions | | |
| Management Solutions | Management Coaching /Support / Priorities / Response Management and Arrangements | | |
| Management Solutions | Actions/Response | | |
| Management Solutions | Response of Regulator Findings / Regulator Communication / Industry Stakeholders | | |
| Management Solutions | Quality of intake/ recruit/ / HR Services | | |
| Management Solutions | Disciplinary Action/ Company-Union collaboration | | |
| Management Solutions | Support for work planning/ monitoring/ review | | |
| Management Solutions | Purchase of spares/materials/tools/Equipment Failure | | |
| Management Solutions | Work procedures, documented standards | | |
| Management Solutions | Safety Management and Safety Culture | | |
| In Round 1 > 70% of participants believed that Supervision Solutions was a solution to accidents in the | Supervisor support, interaction, confidence, knowledge, ability | | |

| | | | |
|---|---|---|---|
| electric power industry where workers are seriously injured or killed while doing work. | | | |
| Supervision | Involvement in job – work; work team selection | | |
| Supervision | Compliance demand; reporting | | |
| Supervision | Inspection, adherence with procedures, and documented standards | | |
| Supervision | Worker involvement | | |
| Supervision | Work planning, monitoring, review | | |
| Supervision | Arrangements for available spares, materials, and use of tools, personal protective equipment | | |
| Supervision | Safety and Safety Culture | | |
| Supervision | Permit to Work, Lock-out-tag-out | | |
| Audit/Review solutions are desirable in the prevention of accidents where workers can become seriously injured or killed | Audit/Review solutions are feasible | | |
| Solutions to Poor design | | | |
| Solutions to Safety management system flaw | | | |
| Solutions to Poor regulatory oversight | | | |
| Solutions to Poor workplace ethics, history of wrongdoing that went unaddressed | | | |
| Solutions to Incorrect labeling | | | |
| Solutions to Medical and other personal issues | | | |
| Solutions to Grounding, earthing failures/errors | | | |
| Solutions to Ineffective and inefficient Maintenance | | | |
| Solutions to Animals/ living organisms | | | |

| | | |
|---|---|---|
| Solutions to Hazardous Worksite conditions | | |
| Solutions to Unplanned events | | |
| Solutions to Inappropriate work methods | | |
| Solutions to Stakeholder demands | | |
| Solutions to Poor judgment by individuals or work crews | | |
| Solutions to Poor attitudes and or behavior by individuals or work crews | | |
| Solutions to Ineffective or no workplace Training | | |
| Solutions to Poor Supervision | | |
| Solutions to Work planning | | |
| Solutions to Management priorities | | |
| Solutions to Poor team communication | | |
| Solutions to Willful disregard for safety rules | | |
| Solutions to Permit to work violations | | |
| Solutions to Lock out tag out non-compliance | | |
| Solutions to Organizational safety culture | | |
| Solutions to Individual Risk taking and negligence | | |
| Solutions to Equipment failure | | |
| Solutions to Procedural error | | |
| Solutions to Poor management oversight | | |
| Solutions to Poor quality material | | |
| Solutions to Non-use of personal protective equipment | | |

**Appendix G – Round 3 Questions**

# Round 3 Questions

1. The following are solutions to accidents as suggested by participants in Round 2. Rating in Round 3 ranges from 5 for extremely important to 1 for not at all important. Please indicate your response

| **Solutions to Prevent Accident** | | **Importance** Indicate on the scale provided (1 to 5) the importance of addressing this issue to realize the prevention of accidents, serious worker injuries, and death. |
|---|---|---|
| Focus on People Solutions | Involvement of Qualified Personnel, Expert Practitioners, and Consultants; | |
| Focus on People Solutions | Human Performance Monitoring; | |
| Focus on People Solutions | Regular Supervisor and Manager Job Visits | |
| Focus on People Solutions | Management - Workers Communication and Feedback | |
| Focus on People Solutions | Individual and Group Behavior and Habits; Teamwork; Confidence, Confidential | |
| Focus on People Solutions | Work Methods, Procedures, and Management of Change, Work Planning, Monitoring, Review, Procedures, Documented Standard | |
| Focus on People Solutions | Culture, Safety Culture, Problem Identification | |
| Focus on People Solutions | Prevention of Equipment Failure | |

| | | |
|---|---|---|
| Work Standards Solutions | Performance Monitoring | |
| Work Standards Solutions | Reliability Centered Maintenance, Maintenance Scheduling and Cycles, Recordkeeping and Recordkeeping Procedures | |
| Work Standards Solutions | Inspection Methods and Arrangements, Troubleshooting, Breakdown Management, Equipment and Device Calibration | |
| Work Standards Solutions | Construction and Operating Practices and Procedures, International and Best Practice , Technology, Quality Management System | |
| Work Standards Solutions | Compliance Focus, Technology in Use, New Technology, Work Methods Change-Management | |
| Work Standards Solutions | Work Design and Planning; Work Performance Monitoring and Review; Recordkeeping; Documented, Standard, Worker Training, Knowledge and Experience | |
| Work Standards Solutions | Diagnostic Testing, Research, and Manufacturers' Instructions | |
| Work Standards Solutions | Available and Condition of Personal Protective Equipment, Tools, and Materials | |
| Work Standards Solutions | Safety Barriers, Safety Culture, and Housekeeping | |
| Work Standards Solutions | Equipment failure | |
| Safety Management Solutions | Focus on Safety Legislation | |
| Safety Management Solutions | Focus on Compliance, Work Methods, Procedures, Change | |
| Safety Management Solutions | Culture; Organizational Culture; Safety Culture | |
| Safety Management Solutions | Quality of Regulator Inspections | |

| | | |
|---|---|---|
| Safety Management Solutions | Distraction, Individual Obligation to Inform, Procedures, Rules and Documented Standards | |
| Safety Management Solutions | Compliance with Manufacturers Instructions | |
| Safety Management Solutions | Safety Inspection, Workplace Inspections; Work Planning, Monitoring, and Review | |
| Safety Management Solutions | Safety Oversight and Audits of Materials, Spares, Materials, Tools, and Personal Protective Equipment | |
| Safety Management Solutions | Workplace Training; Safety Barriers; Housekeeping; Lock-Out-Tag-Out, Permit to Work; Recordkeeping | |
| Safety Management Solutions | Equipment Failure | |
| Workplace Training Solutions | Training Philosophy, Company Core Values Training, and Workplace Training Arrangements (Cost, Availability, Management). | |
| Workplace Training Solutions | Communication, Process, Procedures, Frequency, Quality, Methods, and Location | |
| Workplace Training Solutions | Feedback (Management - Workers), Correct (Flaws) | |
| Workplace Training Solutions | Manufacturers Instructions; Compliance | |
| Workplace Training Solutions | Work Planning, Monitoring, and Review | |
| Workplace Training Solutions | Material Science, Use, Testing, and Maintenance of Tools, Work Procedures, and Documented Standards | |
| Workplace Training Solutions | Safety Rules, Procedures, and Barriers, Safety Culture | |
| Workplace Training Solutions | Good Housekeeping | |
| Workplace Training Solutions | Prevention of Equipment Failure | |
| Management Solutions | Focus and Assumptions | |

| | | |
|---|---|---|
| Management Solutions | Management Coaching /Support / Priorities / Response Management and Arrangements | |
| Management Solutions | Actions/Response | |
| Management Solutions | Response of Regulator Findings / Regulator Communication / Industry Stakeholders | |
| Management Solutions | Quality of intake/ recruit/ HR Services | |
| Management Solutions | Disciplinary Action/ Company-Union collaboration | |
| Management Solutions | Support for work planning/ monitoring/ review | |
| Management Solutions | Support for work planning/ monitoring/ review | |
| Management Solutions | Purchase of spares/materials/tools/Equipment Failure | |
| Management Solutions | Work procedures, documented standards | |
| Management Solutions | Safety Management and Safety Culture | |
| Supervision | Supervisor support, interaction, confidence, knowledge, ability | |
| Supervision | Involvement in job – work; work team selection | |
| Supervision | Compliance demand; reporting | |
| Supervision | Inspection, adherence with procedures, and documented standards | |
| Supervision | Worker involvement | |
| Supervision | Work planning, monitoring, review | |
| Supervision | Arrangements for available spares, materials, and use of tools, personal protective equipment | |
| Supervision | Safety and Safety Culture | |
| Supervision | Permit to Work, Lock-out-tag-out | |
| Audit/Review solutions are important in the prevention of accidents where workers can become seriously injured or killed | | |

| | |
|---|---|
| Solutions to Poor design | |
| Solutions to Safety management system flaw | |
| Solutions to Poor regulatory oversight | |
| Solutions to Poor workplace ethics, history of wrongdoing that went unaddressed | |
| Solutions to Incorrect labeling | |
| Solutions to Medical and other personal issues | |
| Solutions to Grounding, earthing failures/errors | |
| Solutions to Ineffective and inefficient Maintenance | |
| Solutions to Animals/ living organisms | |
| Solutions to Hazardous Worksite conditions | |
| Solutions to Unplanned events | |
| Solutions to Inappropriate work methods | |
| Solutions to Stakeholder demands | |
| Solutions to Poor judgment by individuals or work crews | |
| Solutions to Poor attitudes and or behavior by individuals or work crews | |
| Solutions to Ineffective or no workplace Training | |
| Solutions to Poor Supervision | |
| Solutions to Work planning | |
| Solutions to Management priorities | |
| Solutions to Poor team communication | |
| Solutions to Willful disregard for safety rules | |
| Solutions to Permit to work violations | |
| Solutions to Lock out tag out non-compliance | |
| Solutions to Organizational safety culture | |
| Solutions to Individual Risk taking and negligence | |
| Solutions to Equipment failure | |
| Solutions to Procedural error | |
| Solutions to Poor management oversight | |
| Solutions to Poor quality material | |
| Solutions to Non-use of personal protective equipment | |

**Appendix H – Round 4 Questions**

# Round 4 Questions

1. The following are solutions to accidents as suggested by participants through Round 1, 2, and 3. With the rating in Round 4 ranging from 5 to 1 for definitely certain to unreliable respectively, please indicate your response.

| **Solutions to Prevent Accident** | | **Confidence**<br>Indicate on the scale provided (1 to 5) your confidence in the solutions to accidents in the electric power industry where workers are seriously injured or killed while doing work, derived in this study. |
|---|---|---|
| Focus on People Solutions | Involvement of Qualified Personnel, Expert Practitioners, and Consultants; | |
| Focus on People Solutions | Human Performance Monitoring; | |
| Focus on People Solutions | Regular Supervisor and Manager Job Visits | |
| Focus on People Solutions | Management - Workers Communication and Feedback | |
| Focus on People Solutions | Individual and Group Behavior and Habits; Teamwork; Confidence, Confidential | |
| Focus on People Solutions | Work Methods, Procedures, and Management of Change, Work Planning, Monitoring, Review, Procedures, Documented Standard | |
| Focus on People Solutions | Culture, Safety Culture, Problem Identification | |

| | | |
|---|---|---|
| Focus on People Solutions | Prevention of Equipment Failure | |
| Work Standards Solutions | Performance Monitoring | |
| Work Standards Solutions | Reliability Centered Maintenance, Maintenance Scheduling and Cycles, Recordkeeping and Recordkeeping Procedures | |
| Work Standards Solutions | Inspection Methods and Arrangements, Troubleshooting, Breakdown Management, Equipment and Device Calibration | |
| Work Standards Solutions | Construction and Operating Practices and Procedures, International and Best Practice , Technology, Quality Management System | |
| Work Standards Solutions | Compliance Focus, Technology in Use, New Technology, Work Methods Change-Management | |
| Work Standards Solutions | Work Design and Planning; Work Performance Monitoring and Review; Recordkeeping; Documented, Standard, Worker Training, Knowledge and Experience | |
| Work Standards Solutions | Diagnostic Testing, Research, and Manufacturers' Instructions | |
| Work Standards Solutions | Available and Condition of Personal Protective Equipment, Tools, and Materials | |
| Work Standards Solutions | Safety Barriers, Safety Culture, and Housekeeping | |
| Work Standards Solutions | Equipment failure | |
| Safety Management Solutions | Focus on Safety Legislation | |
| Safety Management Solutions | Focus on Compliance, Work Methods, Procedures, Change | |
| Safety Management Solutions | Culture; Organizational Culture; Safety Culture | |

| | | |
|---|---|---|
| Safety Management Solutions | Quality of Regulator Inspections | |
| Safety Management Solutions | Distraction, Individual Obligation to Inform, Procedures, Rules and Documented Standards | |
| Safety Management Solutions | Compliance with Manufacturers Instructions | |
| Safety Management Solutions | Safety Inspection, Workplace Inspections; Work Planning, Monitoring, and Review | |
| Safety Management Solutions | Safety Oversight and Audits of Materials, Spares, Materials, Tools, and Personal Protective Equipment | |
| Safety Management Solutions | Workplace Training; Safety Barriers; Housekeeping; Lock-Out-Tag-Out, Permit to Work; Recordkeeping | |
| Safety Management Solutions | Equipment Failure | |
| Workplace Training Solutions | Training Philosophy, Company Core Values Training, and Workplace Training Arrangements (Cost, Availability, Management). | |
| Workplace Training Solutions | Communication, Process, Procedures, Frequency, Quality, Methods, and Location | |
| Workplace Training Solutions | Feedback (Management - Workers), Correct (Flaws) | |
| Workplace Training Solutions | Manufacturers Instructions; Compliance | |
| Workplace Training Solutions | Work Planning, Monitoring, and Review | |
| Workplace Training Solutions | Material Science, Use, Testing, and Maintenance of Tools, Work Procedures, and Documented Standards | |
| Workplace Training Solutions | Safety Rules, Procedures, and Barriers, Safety Culture | |
| Workplace Training Solutions | Good Housekeeping | |

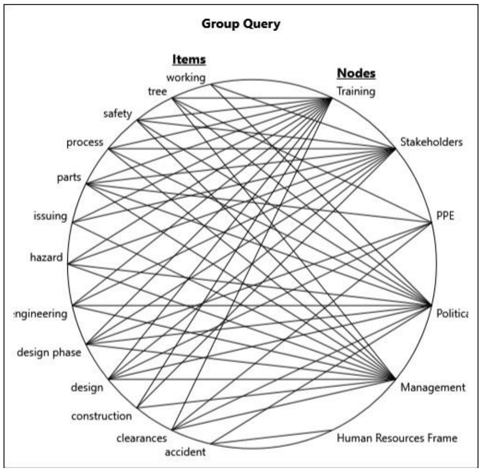
| | | |
|---|---|---|
| Workplace Training Solutions | Prevention of Equipment Failure | |
| Management Solutions | Focus and Assumptions | |
| Management Solutions | Management Coaching /Support / Priorities / Response Management and Arrangements | |
| Management Solutions | Actions/Response | |
| Management Solutions | Response of Regulator Findings / Regulator Communication / Industry Stakeholders | |
| Management Solutions | Quality of intake/ recruit/ HR Services | |
| Management Solutions | Disciplinary Action/ Company-Union collaboration | |
| Management Solutions | Support for work planning/ monitoring/ review | |
| Management Solutions | Support for work planning/ monitoring/ review | |
| Management Solutions | Purchase of spares/materials/tools/Equipment Failure | |
| Management Solutions | Work procedures, documented standards | |
| Management Solutions | Safety Management and Safety Culture | |
| Supervision | Supervisor support, interaction, confidence, knowledge, ability | |
| Supervision | Involvement in job – work; work team selection | |
| Supervision | Compliance demand; reporting | |
| Supervision | Inspection, adherence with procedures, and documented standards | |
| Supervision | Worker involvement | |
| Supervision | Work planning, monitoring, review | |
| Supervision | Arrangements for available spares, materials, and use of tools, personal protective equipment | |
| Supervision | Safety and Safety Culture | |
| Supervision | Permit to Work, Lock-out-tag-out | |

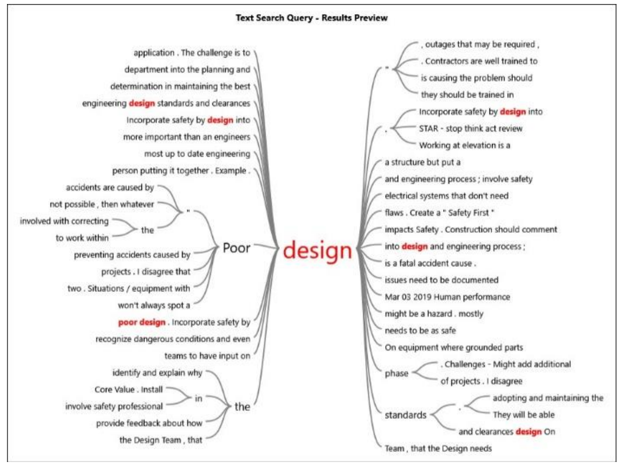
| | |
|---|---|
| Audit/Review solutions to prevent accidents where workers can become seriously injured or killed | |
| Solutions to Poor design | |
| Solutions to Safety management system flaw | |
| Solutions to Poor regulatory oversight | |
| Solutions to Poor workplace ethics, history of wrongdoing that went unaddressed | |
| Solutions to Incorrect labeling | |
| Solutions to Medical and other personal issues | |
| Solutions to Grounding, earthing failures/errors | |
| Solutions to Ineffective and inefficient Maintenance | |
| Solutions to Animals/ living organisms | |
| Solutions to Hazardous Worksite conditions | |
| Solutions to Unplanned events | |
| Solutions to Inappropriate work methods | |
| Solutions to Stakeholder demands | |
| Solutions to Poor judgment by individuals or work crews | |
| Solutions to Poor attitudes and or behavior by individuals or work crews | |
| Solutions to Ineffective or no workplace Training | |
| Solutions to Poor Supervision | |
| Solutions to Work planning | |
| Solutions to Management priorities | |
| Solutions to Poor team communication | |
| Solutions to Willful disregard for safety rules | |
| Solutions to Permit to work violations | |
| Solutions to Lock out tag out non-compliance | |
| Solutions to Organizational safety culture | |
| Solutions to Individual Risk taking and negligence | |
| Solutions to Equipment failure | |
| Solutions to Procedural error | |
| Solutions to Poor management oversight | |
| Solutions to Poor quality material | |
| Solutions to Non-use of personal protective equipment | |

# **Appendix I:** Results of Qualitative Analysis

Using NVivo 12 Plus Software

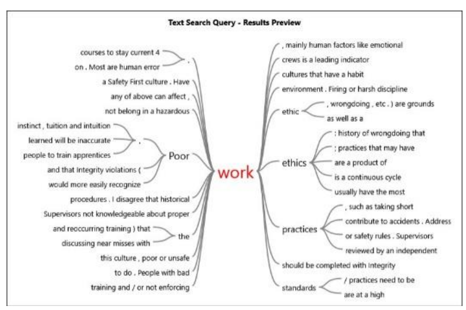
## Poor Design



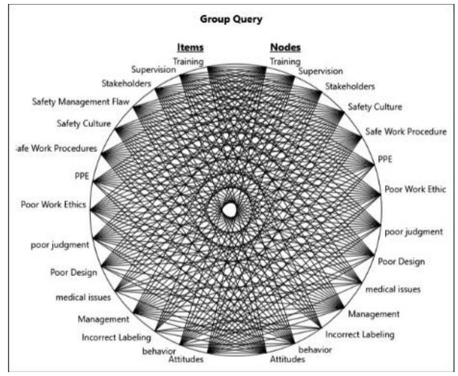

Query: Poor DesignAutocodes vs Manual codes   Text Search Query: Poor Design Word Tree

## Poor Work Ethics

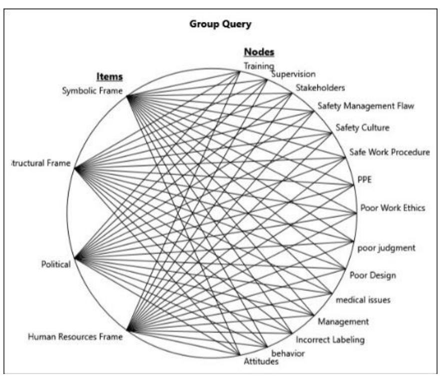

Poor Work Ethics Word Cloud   Text Search Query: Poor Work Ethics Word Tree

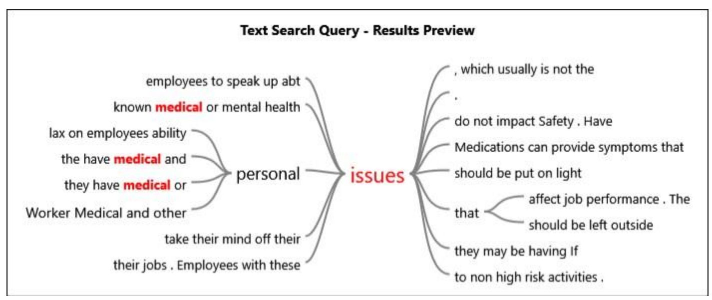
**Medical Issues**


Medical Issues Word Cloud

Group Query Vs all (including Medical)

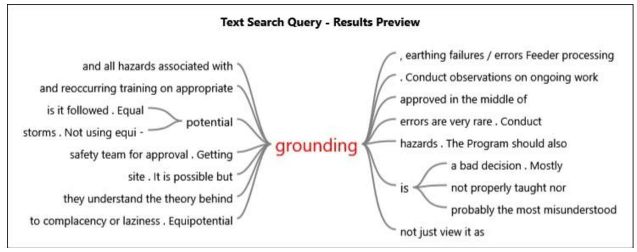



Group Query Frames Vs all (including Medical)

Text Query (Personal Issues & Medical)

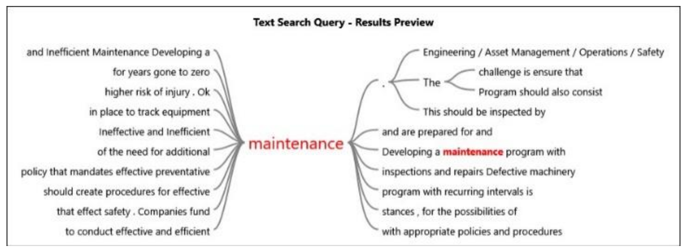
**Grounding**


Grounding Word Cloud

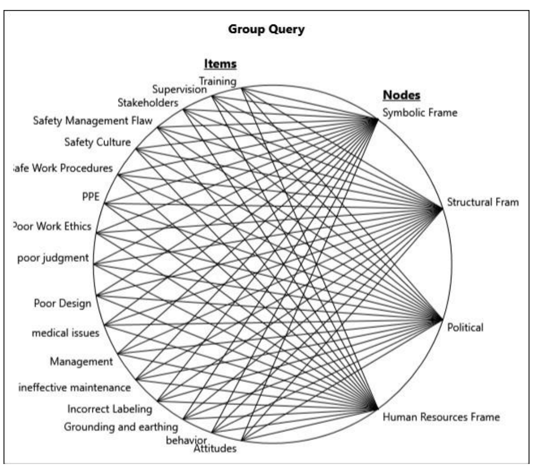
Text Query (Grounding)

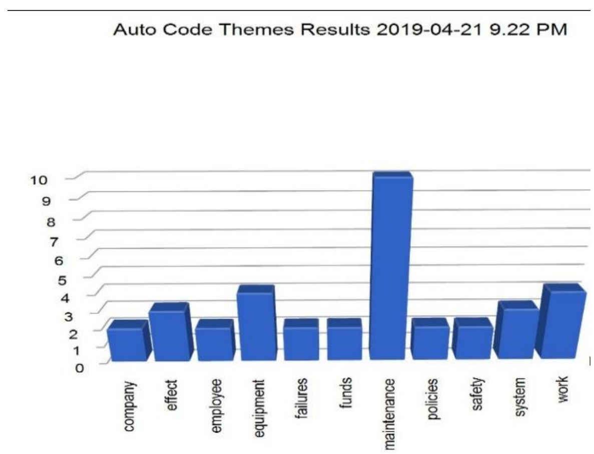
**Ineffective & Inefficient Maintenance (I&IM)**


I&IM Word Cloud

Text Query (Maintenance)

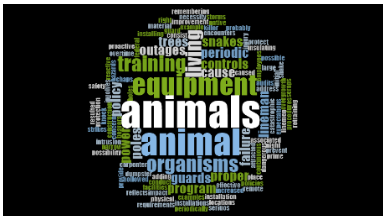


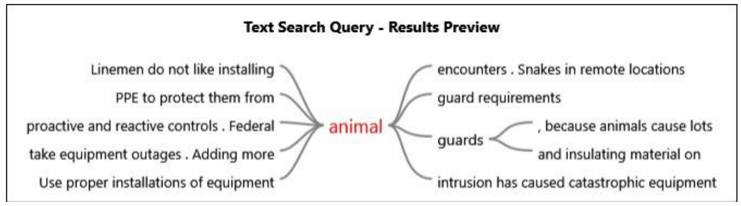




Group Query I&IM vs all (Frames)

Autocodes (I&IM)

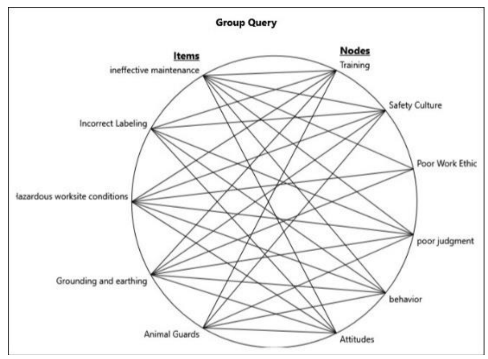
**Animals & Living Organisms**



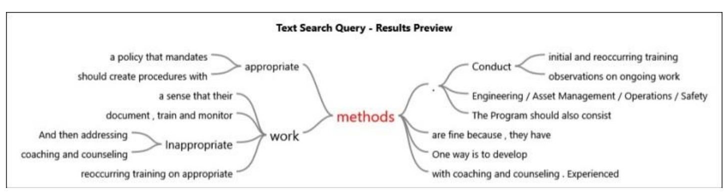

Animals & Living Organisms Word Cloud Text Query (Animals)

## Hazardous work-site conditions

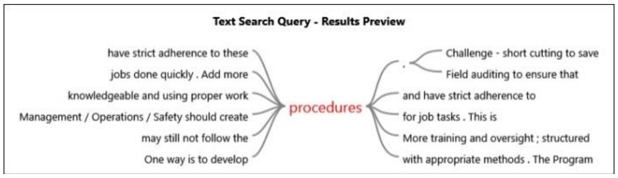



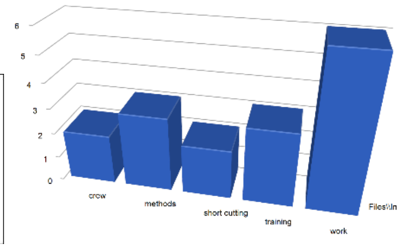

Hazardous work-site conditions Word Cloud Group Query Hazardous work-site conditions vs People Issues

## Inappropriate Work Methods

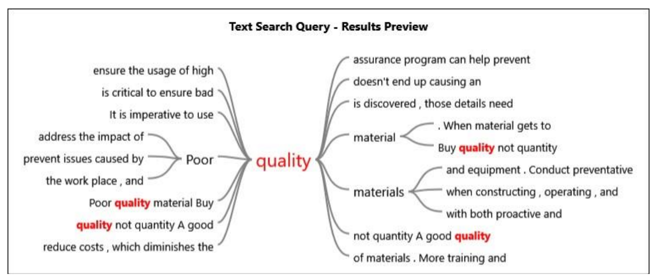

**Inappropriate Work Methods** Word Cloud Text Query (**Inappropriate Work Methods**)

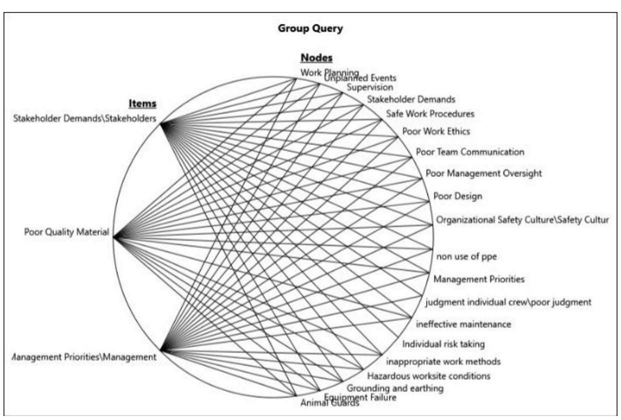


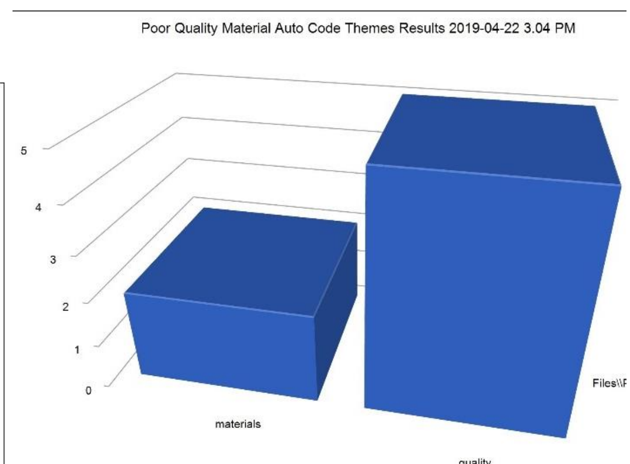




Text Query (**Inappropriate Work Methods**) Autocodes (**Inappropriate Work Methods**)

**Poor Quality Material**


Group Queries (vs all) Poor Quality Material Autocodes

The word cloud developed for the question on non-use of personal protective equipment is shown in Fig 12.  The word cloud showed that the top five words used in the responses by participants to the Q30: Non-use of Personal Protective Equipment on the Round 1 questionnaire were *ppe, non, use, expectations, and culture*.  These words were used to generate the associated Word Trees from NVivo 12 Plus as the researcher used the text search query option available with on this software.

Fig 12 Word Cloud: Q30: **Non-use of Personal Protective Equipment**


Fig 13 shows that associated Word Tree: Q30: Non-use of Personal Protective Equipment (*ppe, non, use, expectations, & culture*).

Fig 13

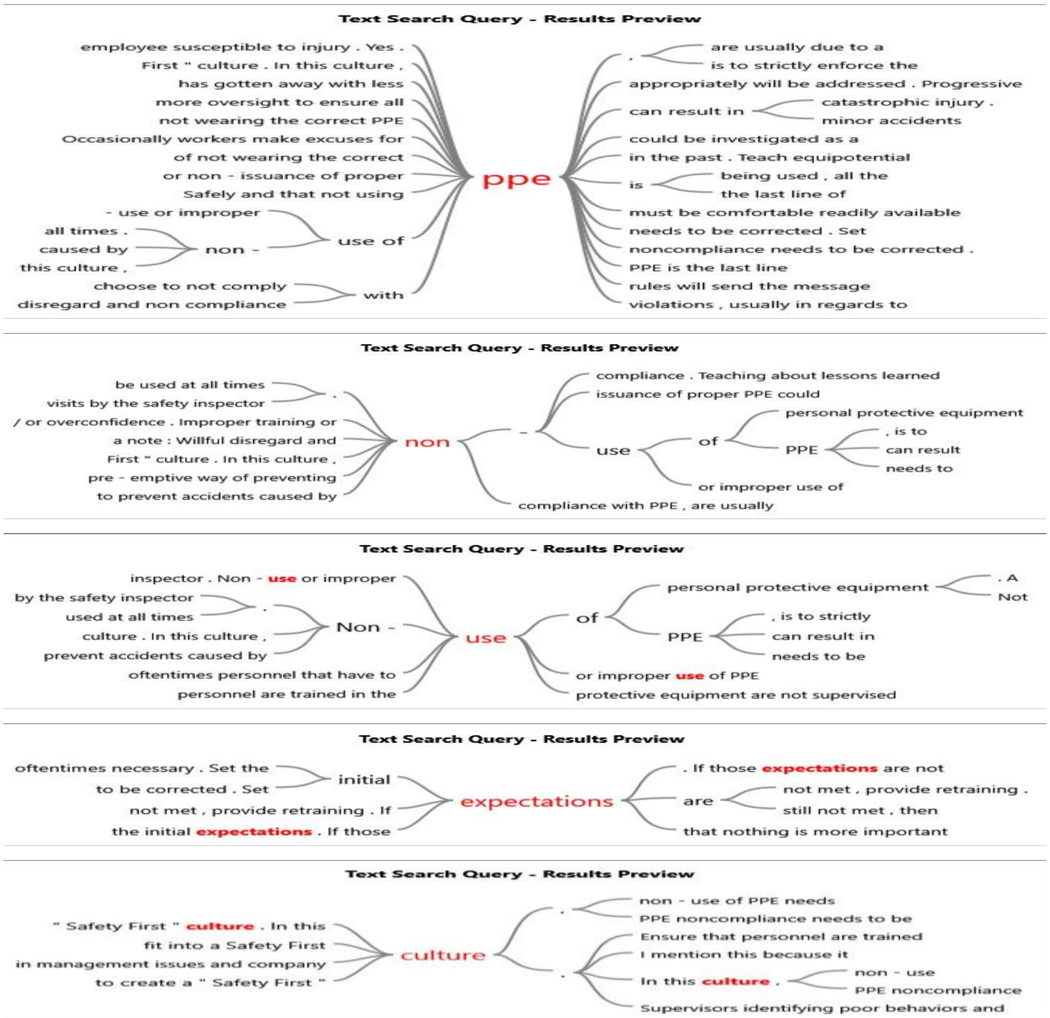
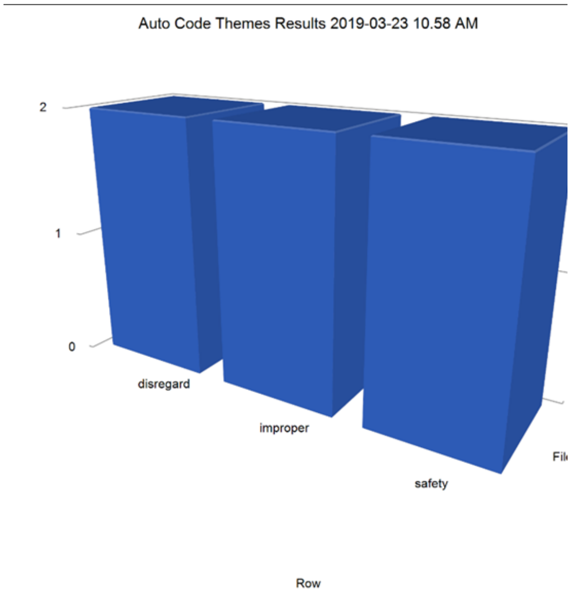



Fig 14 shows that associated Auto-Coding : Q30: Non-use of Personal Protective Equipment

Fig. 14




The automatic coding resulted from the selection of the auto-code option on NVivo 12 Plus. It exacts improper use of personal protective equipment, a disregard for the personal protective equipment, and also safety issues that required further investigations. The codes generated were from participants responses to Q30: Non-use of Personal Protective Equipment on the Round 1 questionnaire. Table 10 shows the Researcher Manual Coding: Q30: Non-use of Personal Protective Equipment.

The matrix entries represent the number of different links I identified as the researcher between the factors listed and based participants responses to the Round 1 questions. For non-use of personal protective equipment, there were participant responses that linked this item with equipment failure, poor design, work planning, ineffective or no workplace training among other factors. This link-spread was almost even across the elements included in this table. Table 11 shows Researcher Manual Coding (Four-Frames): Q30: Non-use of Personal Protective Equipment.

Table 10 The Researcher Manual Coding: Q30

| | A : inappropriate work methods | B : judgment individual crew | C : non use of ppe | D : Poor attitude and behavior | E : Poor Team Communication | F : Poor Work Ethics | G : Wilful Disregard For Safety Rules |
|---|---|---|---|---|---|---|---|
| 1 : Animal Guards | 31 | 31 | 29 | 32 | 29 | 30 | 24 |
| 2 : Equipment Failure | 22 | 18 | 11 | 15 | 11 | 11 | 13 |
| 3 : Grounding and earthing | 42 | 49 | 30 | 43 | 30 | 32 | 25 |
| 4 : Hazardous worksite conditions | 48 | 54 | 30 | 48 | 31 | 35 | 25 |
| 5 : Incorrect Labeling | 41 | 40 | 28 | 37 | 28 | 29 | 24 |
| 6 : ineffective maintenance | 45 | 57 | 30 | 47 | 30 | 38 | 26 |
| 7 : ineffective or no workplace training | 49 | 70 | 39 | 58 | 38 | 41 | 33 |
| 8 : Organizational Safety Culture | 48 | 82 | 43 | 80 | 50 | 59 | 47 |
| 9 : Permit to Work | 20 | 21 | 16 | 19 | 18 | 17 | 18 |
| 10 : Poor Design | 26 | 45 | 36 | 45 | 30 | 39 | 27 |
| 11 : Work Planning | 34 | 47 | 34 | 46 | 47 | 42 | 54 |
| 12 : Positive | 69 | 88 | 59 | 84 | 59 | 65 | 60 |
| 13 : Negative | 83 | 118 | 60 | 104 | 64 | 90 | 62 |

Table 11 Researcher Manual Coding (Four-Frames): Q30

| | **A : Human Resources Frame** | **C : Political** | **F : Structural Frame** | **H : Symbolic Frame** | **B : Management Priorities** | **D : Poor Management Oversight** | **E : Safety Management Flaw** | **G : Supervision** |
|---|---|---|---|---|---|---|---|---|
| 1 : inappropriate work methods | 49 | 49 | 44 | 36 | 54 | 10 | 45 | 50 |
| 2 : judgment individual crew | 67 | 82 | 74 | 62 | 107 | 20 | 75 | 89 |
| 3 : non use of ppe | 38 | 43 | 41 | 37 | 49 | 8 | 44 | 46 |
| 4 : Organizational Safety Culture | 66 | 93 | 85 | 76 | 117 | 18 | 104 | 103 |
| 5 : Poor attitude and behavior | 60 | 75 | 67 | 56 | 87 | 19 | 66 | 78 |
| 6 : Poor Team Communication | 34 | 48 | 45 | 41 | 51 | 14 | 45 | 47 |
| 7 : Poor Work Ethics | 41 | 56 | 50 | 44 | 63 | 15 | 47 | 54 |
| 9 : Wilful Disregard For Safety Rules | 34 | 38 | 47 | 41 | 44 | 16 | 42 | 46 |

The entries represent the number of different links identified by me as the researcher between the factors listed; the four-frame conceptual framework in this study, and based participants responses to the Round 1 questions. The Bolman and Deal four-frames were as relevant as the other factors highlighted in this analysis. Links existed between non-use of personal protective equipment at work, management priorities, management oversight, supervision, and each of the four frames as espoused in the Bolman and Deal model.

# Appendix J: Actual Responses

Actual Participants responses to question Q4 for poor work ethics: history of wrongdoing that went unaddressed:

*One way is to identify individuals who are prone to take safety risks. Coaching these individuals can improve their attitude towards risky behavior.*

*Supervisors not knowledgeable about proper work practices or safety rules. Supervisors not wanting to get their guys in trouble*

*The brother in law positions. Just moving trouble along instead of dealing with it*

*Workers in the electric utility are expected to always check dead before touching conductor. Sometimes we've witnessed people getting lax and bypassing this step,which could be disasterous.*

*Organizations need to create a "Safety First" culture. In this culture, poor or unsafe work ethic as well as a history of wrongdoing needs to be corrected. Set initial expectations that nothing is more important than getting the job done Safely and that unsatisfactory behavior will be addressed. Progressive discipline is oftentimes necessary. Set the initial expectations. If those expectations are not met, provide retraining. If expectations are still not met, then it is fair to remove personnel from the team if they cannot or are not willing to fit into a Safety First culture.*

*Have work practices reviewed by an independent party. An independent party would more easily recognize poor work ethics; practices that may have been done for years.*

*Stop allowing these people to train apprentices. Poor work ethics is a continuous cycle until it it broken. A bad foreman creates bad journeyman, that creates bad apprentices and the cycle continues, because people do what they are taught to do. People with bad work ethics usually have the most experience which is why the issues go unaddressed.*

*More training and oversight; structured process*

*Workers not Trained in areas that the projects needs. I.E. apprentices working without Journeyman supervision.,*

*As previously stated, there is not enough disciplinary action for noncompliance at the company level.*

*Tap root analysis and incident analysis of serious accidents are supposed to produce "lessons learned" to help prevent future accidents. If the analysis conclusions are incorrect, the lessons learned will be inaccurate. Poor work ethics are a product of poor accident investigation. Areas not investigated are in- attentional blindness, practical drift, the anatomy of "good judgement" including instinct, tuition and intuition.*

*Poor work practices, such as taking short cuts, can result in serous injury. Supervision must constantly reinforce the importance of strictly adhering to procedures.*

*I disagree that historical work practices contribute to accidents.*

*Address wrong doing with firm and fair action*

*Not reporting and discussing near misses with the work crews is a leading indicator that an accident will happen sooner or later.*

*Implement controls, I.e., knowledgable observers.*

*Make "Integrity" one of your organization's core values. Set the expectation (both initial and reoccurring training) that the Work should be completed with Integrity and that Integrity violations (poor work ethic, wrongdoing, etc.) are grounds for immediate dismissal.*

*Sometimes in this industry people who are found doing wrong do not belong in a hazardous work environment. Firing or harsh discipline sometimes is doing the offender a favor and may save their life.*

*Training Safety awareness human factors PPE Job safety analysis equipment safety environment condition if any of above can affect , work , mainly human factors like emotional health , mood balance should be assessed as a part of Job safety analysis*

*If a someone does something wrong and no one tells them it is wrong they can't learn. In the same way if you tell them it is wrong and they don't fix it and nothing happens to that person they will keep doing the same things.*

*Can't get away from this. Only a certain pool of people and s transient workforce. Bad workers are around and you inherit on occasions. You learn from experience but the next guy has too*

*Dismissing all parties (management and workers) who contribute to this unacceptable situation*

*Management and Worker Unions must not allow internal organizational politics and games to cloud their responsibility for keeping a safe operation and to positively reinforce full safety compliance.*

*This is probably the number one reason for workplace accidents. Going up in the air without harness properly worn. Working hot secondary without gloves. One guy grabbing a phase and something else that is at a different potential even with gloves on. Most are human error.*

*Work cultures that have a habit of taking "shortcuts", not providing proper training and/or not enforcing work standards are at a high risk for accidents. Workers need to: 1. Safety needs to be #1 priority and everyone needs to understand what that means 2. Workers need the right tools and PPEs to do the job 3. Get the right training and get refresher courses to stay current 4. Work standards/practices need to be enforced Challenge: Changing the way workers think about doing their job. Many think that "this is the way I was taught and it's good enough"*

# Appendix K: Frame Responses

## Solutions Provided by Participants

For the problem of *Poor Design* include: 70.37% of participants believed that *Poor Design* issues could be solved. In Round 2, 92% of participants indicated that the solutions to *Poor Design* were desirable; 100 % found them feasible. In Round 3, 100% indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3% expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Design* include:

> Monitoring of individual performances to stop the action, review assumptions and strategies, and to change work plans if that is necessary: participants agreed that sometimes it was not always possible to spot poor design problems, but skilled and knowledgeable individuals can help to prevent accident-causing situations. Knowledgeable individuals know when to stop work activities to avoid accidents due to *Poor Design*.
>
> Incorporate safety by design into the engineering processes; involve safety professionals in the design phase of projects. Engineering designers should gather feedback from all parties before final approvals. Construction personnel should comment as to how to build the equipment, and Operations personnel should enlighten on how to operate the equipment safely. Likewise, Maintenance practitioners can offer advice on maintenance challenges expected with the design.
>
> Situations/equipment with *Poor Design* issues must be documented and readily available to those who need it regardless of how difficult an exercise that may be.

Data saturation (solutions to *Poor Design*) occurred. These surrounded possible conflicts, assumptions, inspections, practices, maintenance, construction, procedures, training, consultation, work methods, managers, and supervisors.

Table: Poor Design Participant Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *The challenge is to design electrical systems that don't need "tree wire." Better tree clearances mean a lighter wire with no insulation to skin* | *Integrate the Environmental, Health, and Safety department into the planning and design phase of projects.* |
| **Political Frame** | **Symbolic Frame** |
| *If personnel have to work within the "poor design", they should be trained in how to do it safely. If that is not possible, then whatever "poor design" is causing the problem should be taken out of service*<br><br>*I disagree that poor design is a fatal accident cause.* | *Accidents caused by poor design are prevented by correcting poor design.* |

For the problem of *Safety Management Flaw*: 88.89% of participants believed that *Safety Management Flaw* issues could be solved. In Round 2, 100% of participants indicated that the solutions to *Safety Management Flaw* were desirable; 100 % found them feasible. In Round 3, 100% indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3% expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Safety Management Flaw* include:

> Periodic review of the Safety Management System can allow for the identification of flaws. Existing flaws should be addressed and corrected with alacrity and purpose. If there is a flaw in the Safety Management System processes, then some risks can be overlooked.

> A renewed emphasis on tailgate meetings, and job hazard analysis that is fully supported and facilitated by supervisors, general foremen, or foremen, is necessary. Their involvement is critical for full compliance. Management, worker unions, and regulators must support periodic and jointly conduct Safety Management System reviews.

Data saturation (solutions to *Safety Management Flaw*) occurred. These surrounded Safety Management System links with deficiencies in Lock-out Tag-out procedures, working knowledge and understanding of work activities. Issues surrounding worksite responsibilities and understanding of individual roles on job sites where different working parties are engaged. Inadequate and poor quality supervision. Workplace training and refresher training. Job safety analysis and proper personal protective equipment.

Table: Participant Safety Management Flaw Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *(1) Management failure to enforce rules and to demand compliance.*<br>*(2) Improper work procedures.* | *(1) Individuals and work teams deliberately not adopting safety work measures because of a false thinking that the rules do not apply or are relevant to the work activities.*<br>*(2) Have qualified people in the jobs who have hands on knowledge.* |
| **Political Frame** | **Symbolic Frame** |
| *(1) I disagree that accidents are caused by safety management flaws*<br>*(2) Time pressure given by management can be a cause.* | *(1) leadership should always be evaluating management systems and making improvements.*<br>*(2) Typical Safety Management Systems follow OHSAS 18001, OSHA, and State requirements* |

For the problem of *Poor Regulatory Oversight* include: 59.26% of participants believed that *Poor Regulatory Oversight* issues could be solved. This item was not taken further than Round 1.

For the problem of *Poor Work Ethics: History of wrongdoing that went unaddressed*: 92.59% of participants believed that *Poor Work Ethics* issues could be solved. In Round 2, 96% of participants indicated that the solutions to *Poor Work Ethics* were desirable; 96 % found them feasible. In Round 3, 100% indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3% expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Work Ethics: History of wrongdoing that went unaddressed* include:

> Managers and supervisors must deliberately look for and identify individuals who are prone to take safety risks; coaching these individuals for improved attitudes towards the removal of risky behavior. Managers and supervisors must set initial expectations that nothing is more important than for workers to complete job tasks safely.
>
> Management and Workers Unions must not allow internal organizational politics and games to cloud their responsibility for keeping a safe operation and to positively reinforce full safety compliance.
>
> Human (individual and personal) factors assessment like emotional health and mood balance must be part of job safety briefing and analysis. Train supervisors and managers so that they can be proven competent at doing this.
>
> Managers, supervisors, and workers must undergo workplace training to bolster organizational work cultures where individuals will not take shortcuts" in preference to work procedures and standards. A review of these standards and procedures must be done to determine practical difficulties in implementing. Any identified challenge must be effectively addressed and removed as a work challenge.

> Managers and supervisors must set the expectation that integrity must guide work activities and that violations (poor work ethic, wrongdoing, etc.) are grounds for immediate dismissal. Dismissing all parties (management, supervisors, and workers) who contribute to this unacceptable situation will address procedural deviation.

Data saturation (solutions to *Poor Work Ethics: History of wrongdoing that went unaddressed*) occurred. These surrounded the need for leaders in the electric power industry organizations to create a safety first culture. Progressive discipline and its frequency. Managers and supervisors roles and responsibilities for setting initial expectations and providing training. Removal of errant individuals, including dismissal, if expectations are still not or if they cannot or are not willing to fit into a safety first culture. Work standards/practices enforcement are necessary: near misses, reporting and investigations must be a positive paradigm and actively promoted.

Table: Participant Poor Work Ethics: History of Wrongdoing that went Unaddressed Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Workers in the electric utility are expected to always check dead before touching conductor. Sometimes we've witnessed people getting lax and bypassing this step, which could be disastrous.* | *Poor work ethics is a continuous cycle until it is broken. A bad foreman creates bad journeyman, that creates bad apprentices and the cycle continues, because people do what they are taught to do.* |
| **Political Frame** | **Symbolic Frame** |
| *The brother in law positions. Just moving trouble along instead of dealing with it*<br><br>*I disagree that historical work practices contribute to accidents.* | *Have work practices reviewed by an independent party. An independent party would more easily recognize poor work ethics; practices that may have been done for years.*<br><br>*Address wrong doing with firm and fair action* |

For the problem of *Incorrect Labeling* include: 66.67% of participants believed that *Incorrect Labeling* issues could be solved. This item was not taken further than Round 1.

For the problem of *Medical and Other Personal Issues*: 85.19% of participants believed that *Medical and Other Personal Issues* could be solved. In Round 2, 96% of participants indicated that the solutions to *Medical and Other Personal Issues* were desirable; 92 % found them feasible. In Round 3, 91.67% indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3% expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Medical and Other Personal Issues* include:

> Medications can lead to symptoms such as drowsiness which can pose a safety risk in dangerous work as exists in the electric power industry. If a worker is on medication that can cause inattention to detail, or worse (passing out or drowsiness), they should not perform hazardous tasks. Supervisors must explore all possible ways to assign workers with known medical or other health issues to non-high-risk activities.
>
> When non-high-risk work is not available, getting employees to speak up about issues they may be having can prove vital. Specialist medical officers can provide employees with sufficient confidential guidance so that the employee and other co-workers will not be at risk of becoming injured as a result of this issue.
>
> Organizational leadership must support safety policies and programs that mandate fit-for-duty-testing for safety-sensitive roles.
>
> Managers and supervisors must encourage workers to indicate when they have medical or personal issues that can affect job performance. Employees with these issues should not do hazardous work. Organizational leadership should ensure that organizational policies and procedures are sufficient for supervisors and managers to handle workers' medical and other personal issues appropriately.
>
> Train supervisors and managers for this role, have a medical advisor to assist and can screen workers (especially those in safety-sensitive functions, and aging or previously injured workers) as fit for duty (mental, physical, emotional, drug and alcohol testing).

Train volunteer employees, with guaranteed periodic refresher training, on CPR and First Aid Techniques.

Data saturation (solutions to *Medical and Other Personal Issues*) occurred. These surrounded medications, individual privacy, assumptions, procedures, training, consultation, work, managers, and supervisors.

Table: Medical and Other Personal Issues Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Supervisors can recognize unfit workers during the tailboard meeting.* | *Allowing more sick time and mental health days will help employees be able to stay home when they have medical and personal issues.* |
| **Political Frame** | **Symbolic Frame** |
| *Health has no bearing on safety.*<br><br>*Personal issues should be left outside of the work environment.* | *Encourage a culture of self reporting* |

For the problem of *Grounding, Earthing Failures/Errors*: 88.89% of participants believed that *Grounding, Earthing Failures/Errors* could be solved. In Round 2, 100% of participants indicated that the solutions to *Grounding, Earthing Failures/Errors* were desirable; 100 % found them feasible. In Round 3, 95.83% indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3% expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Grounding, Earthing Failures/Errors* include:

Work procedures and arrangements for proper *Grounding and Earthing* must be outlined, clear, and detailed in every work-plan as work on de-energized overhead power lines or electrical systems can be done safely if electrical grounds are applied.

Managers and supervisors must demand non-compliance to this requirement by utilizing human performance improvement tools such as 3-way communication. In grounding and earthing exercises, work procedures must be for workers to repeat the instruction is back to the supervisor to confirm that information was understood. Electrical switching operations, involving the application or removal of grounds, shall be double checked if not more frequently. When preparing energized power lines or equipment for work, the process of making the lines or equipment safe will involve the grounding and earthing. A competent worker must confirm and approve the earthing and grounding of electrical systems before workers can begin work tasks.

Managers and supervisors must train workers on these requirements and procedures so that the workers can understand the electrical theory and reasons for grounding and for them to not just view it as a work requirement. Not using equipotential grounding is a bad and incorrect decision: equipotential grounding is not always correctly taught, and many times it is not followed. Equipotential grounding is one of the most misunderstood and hazardous situation linemen, and electrical workers can encounter. Getting individuals at work to follow the rules rather than opt for short cuts is paramount in maintaining safe work conditions.

Managers and supervisors must ensure that, in electrical substations, electrical ground grids are to be periodically tested to ensure that electrical grounds used for worker protection remain sufficient and capable providing the intended protection from inadvertent energization.

Data saturation (solutions to *Grounding, Earthing Failures/Errors*) occurred. These surrounded equipotential grounding, poor judgment, managers and supervisors, workers, application or removal of grounds, worker training, communication, teamwork, competent worker, work procedures, discipline, and short-cuts.

Table: Grounding, Earthing Failures/Errors Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Conduct initial and reoccurring training on appropriate grounding. Conduct observations on ongoing work to make on the spot corrections and retraining. Apply progressive discipline up to and including removal from the team.* | *Training! I have been aware of two serious injuries from improperly grounded lines: The employees were sure they had grounded correctly.* |
| **Political Frame** | **Symbolic Frame** |
| *It is possible, but grounding errors are infrequent.* | *Managers and supervisors shall manage the Organizational Safety Program and uphold the safety policy for effective controls of grounding and earthing hazards. The Program shall include provisions for worker training and periodic retraining, the conduct of periodic audits and management overview and review.* |

For the problem of *Ineffective and Inefficient Maintenance*: 88.89% of participants believed that *Ineffective and Inefficient Maintenance* could be solved. In Round 2, 100% of participants indicated that the solutions to *Ineffective and Inefficient Maintenance* were desirable; 100 % found them feasible. In Round 3, 95.83% indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3% expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Ineffective and Inefficient Maintenance* include:

> Managers, supervisors, and workers must keep electrical equipment maintained to prevent an accident by avoiding catastrophic failures of high energy equipment. Defective and faulty equipment and machinery are significant unsafe work conditions. Developing and keeping, as a top priority, a maintenance program with recurring intervals, in line with actual performance cycles, equipment manufacturers recommendation, industry standards, best practices, and other arrangements for

equipment and specialized tools maintenance will prevent premature equipment failure. If maintenance on the electrical system is inefficient and ineffectively managed, rotted poles, failing insulators, all with increasing amperage load, will lead to unsafe conditions and opportunities for the next employee tasked with repairing or operating that equipment with hazardous conditions and a higher risk of injury.

Managers and supervisors must focus on workers' needs and organizational requirements. Managers and supervisors must support a safety program that mandates effective preventative maintenance. Engineering/Asset Management/Operations/Safety should enforce effective maintenance procedures. The program should also consist of organizational-set initial expectations, worker training, and periodic retraining. Managers and supervisors shall conduct regular inspections and audits and periodically update and improve work rules and procedures.

Organizations must adopt and implement a maintenance management system for managers and supervisors to track equipment maintenance. The challenge is to ensure that any maintenance management system adopted is simple and sufficiently well organized enough for personnel to be able to use.

Workers must maintain all tools in safe conditions, especially tools required for electrical work, for either live or de-energized environments, and grounding exercises. Supervisors shall audit these arrangements and practices. Supervisors shall conduct random and periodic inspections of tools used by workers. All defective tools shall be removed from use and destroyed according to organizational approved procedures.

Data saturation (solutions to *Ineffective and Inefficient Maintenance*) occurred. These surrounded worker training, oversight, structured process, maintenance management system, management priorities, inspection, repairs, maintenance procedures, customer inconvenience, operating costs, discipline, and short-cuts.

Table: Ineffective and Inefficient Maintenance Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *Careful inspection of tools and equipment prior to use can prevent such an accident.* | *In my experience, workers are trained and fully aware of the need for additional maintenance and are prepared for and trained to perform proper assessments before working.* |
| **Political Frame** | **Symbolic Frame** |
| *Lack of funding or placing funds in other places* | *Managers and supervisors shall manage the Organizational Safety Program and uphold the safety policy for effective controls of grounding and earthing hazards. The Program shall include provisions for worker training and periodic retraining, the conduct of periodic audits and management overview and review.* |

For the problem of *Animals/Living Organisms*: 70.37% of participants believed that *Animals/Living Organisms* could be solved. In Round 2, 80% of participants indicated that the solutions to *Animals/Living Organisms* were desirable; 92 % found them feasible. In Round 3, 79.17% indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 86.96% expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Animals/Living Organisms* include:

> The organizational safety policy and program shall reflect effective and adequate controls for any hazards associated with animals/living organisms. The plan should also consist of initial expectations training and periodic retraining. Managers and supervisors must conduct regular audits. Animal intrusion has caused catastrophic equipment failure, which can cause serious injury if workers are in the vicinity at the time of the failure event: This can also be true for the overgrowth of vegetation: Right-of-ways that are too narrow for the native trees is an example of increased risk of electrical contact.

Employees shall undergo proper training and have personal protective equipment to protect themselves from animal encounters. Bears and snakes in remote locations or underground facilities are a prime example of a dangerous animal encounter. Snake chaps can prevent strikes below the knee. Poles hollowed out by carpenter ants. Beavers cut trees; birds build nests that can knock out power, alligators, snakes in hand holes, and killer bees are a real concern.

Management must ensure the installation of physical protection or guards to keep animals away from electrical equipment: This involves cost and the electrical outages that may be necessary for installation of the protective guards and physical protection devices. Adding more animal guards and insulating material on poles will help save animals and workers.

Data saturation (solutions to *Animals/Living Organisms*) occurred. These surrounded animal guards, prevention measures, assumptions, procedures, training, consultation, work, personal protective equipment, managers, and supervisors.

Table: Animals/Living Organisms Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Federal animal guard requirements.* | *Employ both proactive and reactive controls to address the problem.* |
| **Political Frame** | **Symbolic Frame** |
| *Linemen do not like installing animal guards, because animals cause lots of power outages, which give linemen lots of overtime pay.* | *institute procedures to mitigate the impact of animals/living organisms on electric plant and systems* |

For the problem of *Hazardous Worksite Conditions*: 92.59 % of participants believed that *Hazardous Worksite Conditions* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Hazardous Worksite Conditions* were desirable; 92 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Hazardous Worksite Conditions* include:

Managers and supervisors must continually enforce procedures to identify and control hazardous and dangerous worksite conditions both proactively and otherwise. Conduct pre-job briefing training. Promote that as the job commences, the first activity will always be a job-briefing involving all workers at the job site. Treat job briefings as a compliance activity before moving into the work.

The organizational safety policy and program must reflect effective and adequate controls for any hazards associated with dangerous worksite conditions. If this is not so, then organizational leadership must fix urgently. The plan should also consist of initial expectations training and periodic retraining. Managers and supervisors must conduct regular audits.

Employees shall undergo proper training and have personal protective equipment to protect themselves from *hazardous worksite conditions*. Situational awareness is key to identifying and rectifying hazardous situations before commencing and during work exercises.

Better project management arrangements, managing work programming to lessen multiple crafts working the same job site, with high consequence work, can mitigate dangerous worksite conditions. The allowance of sufficient time in project schedules and a budget for hazard mitigation before construction commencement would prevent accidents and worker injuries.

Workers must monitor and maintain good housekeeping so that the work site does not become cluttered with trip hazards: commonly identified as a cause in accident investigations. These can sometimes be serious or fatal, depending on where the poor housekeeping is with high energy equipment, or if at an elevation.

Data saturation(solutions to *Hazardous Worksite Conditions*) occurred. These surrounded job briefing, project management, unplanned events, work programming, animal guards, prevention measures, assumptions, procedures, training, consultation, proactive work, personal protective equipment, high energy equipment, managers, and supervisors.

Table: Hazardous Worksite Conditions Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *Individuals are to make sure the area is safe before attempting to restore power.* | *Managers must ensure workplace training on hazard recognition and hazard mitigation.* |
| **Political Frame** | **Symbolic Frame** |
| *Employees know the hazards, but do not remove the hazard from the worksite — laziness and time constants.* | *For weather related to ice/snow - issue non-slip footwear* |

For the problem of *Unplanned Events*: 96.3 % of participants believed that *Unplanned Events* could be solved. In Round 2, 92 % of participants indicated that the solutions to *Unplanned Events* were desirable; 88 % found them feasible. In Round 3, 95.83 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Unplanned Events* include:

> Conduct thorough job briefings and consider the worst case scenario in pre-job planning. Workers must receive training skills in situation awareness, better hazard assessment skills, and to understand that a deviation from the planned work requires another tailboard discussion before proceeding further. Supervisors must demand full compliance with this requirement.
>
> Workers must conduct a thorough site-specific risk analysis. Through that arrangement and practice, workers will develop a culture of hazard identification and mitigation. Workers must anticipate that unexpected events can occur and cover these assumptions in the pre-job briefing. Improper pre-job assessments and reviews can contribute to crews and individuals not adequately prepared for tasks to be completed.
>
> Workers and supervisors must check and confirm switching orders and update future switching plans as switching operations to accomplish switching exercises as expected.
>
> Organizational safety policies and procedures must sufficiently allow for workers to address the impact of unplanned events proactively and otherwise. Workers must realize

that *unplanned events* frequently occur due to an uncontrolled hazard and they must update the program to control these possible hazards. Controlling the dangers are not possible (acts of God and natural disasters are examples), but workers updating the work program to reduce the effects of these hazards are necessary. Work teams must have contingency plans in place for *unplanned events*, should that occur. Not all unanticipated events can be recognized. Workers shall contact the person in charge or the shift control personnel in the event of unplanned issues that can impact on the planned job. Communication is essential during unexpected events. The supervisor or shift control personnel must expect that individuals experiencing the *unplanned event* may require immediate and active support.

Data saturation (solutions to *Unplanned Events* ) occurred. These surrounded job briefing, mitigation, work programming, guards, prevention measures, assumptions, procedures, training, consultation, proactive work, personal protective equipment, high energy equipment, contingency, situation awareness, managers, and supervisors.

Table: Unplanned Events Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *Seat of the pants decisions by workers.* | *Unplanned events require a regrouped new specific job brief and hazard assessment. Often this is not done.* |
| **Political Frame** | **Symbolic Frame** |
| *The unexpected, if not identified and a plan developed to rectify, is a leading cause of injuries.* | *Safeguard against the same type of failure if future or subsequent relocation of the work area is not possible.* |

For the problem of *Inappropriate Work Methods*: 96.3 % of participants believed that *Inappropriate Work Methods* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Inappropriate Work Methods* were desirable; 100 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Inappropriate Work Methods* include:

> It is almost natural for humans to gravitate towards taking short-cuts. It is akin to an "automatic" mode. Teach workers to slow down when in their "automatic mode." Practical drift creates a sense that work methods are okay because individuals are lucky and have gotten away for a long time. The program should involve initial training and periodic retraining of all relevant workers and work teams including supervisors and managers. It must be impossible for untrained workers to operate sophisticated and to use specialized tools.
>
> Managers and supervisors must conduct periodic audits to confirm compliance, periodically update the work procedures, and support continuous improvement. Ensure that procedures for job tasks are optimal and simple to follow. It may be very time consuming, and employees may still not follow the procedures, especially when supervisors and managers do not demand and enforce strict compliance. Remove errant supervisors and managers as well as defaulting workers.
>
> Work teams must always be adequately staffed — with no instances of inexperienced individuals leading work-teams and supervising work: That may be an opportunity for supervisors to mentor, coach, and counsel other employees on inappropriate work methods.

Data saturation (solutions to *Inappropriate Work Methods*) occurred. These surrounded untrained workers, worker training, expectation, knowledgeable employees, inappropriate work methods, inspection, inexperienced, maintenance procedures, supervisors, periodic audits, compliance, and short-cuts.

Table: Inappropriate Work Methods Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Standardize work methods and activities, document procedures, train workers, and monitor work methods.* | *Field auditing to ensure that workers are knowledgeable and using proper work procedures. Challenge - short cutting to save time, make job easier.* |
| **Political Frame** | **Symbolic Frame** |
| *Avoid putting people in places of leadership that lets this type of behavior go on* | *Ensure that personnel is trained in how to do a job; emphasize the importance of not taking "shortcuts." The challenge is to overcome the desire of people to get jobs done quickly.* |

For the problem of *Stakeholder Demands*: 81.48 % of participants believed that *Stakeholder Demands* could be solved. In Round 2, 80 % of participants indicated that the solutions to *Stakeholder Demands* were desirable; 84 % found them feasible. In Round 3, 75 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 82.61 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Stakeholder Demands* include:

> Managers must actively keep individuals, including supervisors with responsibility for productivity, answerable and accountable for non-compliance with workplace safety provisions, worker protection, and decision making to preventing accidents: for production to occur only under safe conditions and when supervisors are actively monitoring work operations. Success means meeting *stakeholder demands*, but only if the job is safe. If by meeting *stakeholder demands*, bypassing of safety practices and procedures occurred, then the individuals involved in doing the work and the organization has failed. Safely doing work takes precedence over *stakeholder demands*; It is, however, no excuse to disregard *stakeholder concerns* and to perform work tasks in an inefficient and untimely fashion. Sometimes a job scope is changed because of demanding stakeholders, but even this compromised work scope and arrangement must happen while maintaining the safety arrangements. Managers and supervisors must explain to stakeholders the importance of maintenance, the prevention of equipment failure and unplanned outages.

Data saturation (solutions to *Stakeholder Demands*) occurred. These surrounded work programming, equipment failure, prevention measures, assumptions, consultation, proactive work, high energy equipment, situation awareness, managers, and supervisors.

Table: Stakeholder Demands Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Facilities not being updated or tree trimming being done properly to save money to keep stakeholders happy.* | *Ensure that stakeholders know that their demands are secondary to Safety.* |
| **Political Frame** | **Symbolic Frame** |
| *Have buy-in from stakeholders. The challenge is that "time is money."* | *Have discussions with stakeholders about setting realistic and attainable goals to ensure that they can be met safely. It is the responsibility of the highest level of leadership to ensure this happens.* |

For the problem of *Poor Judgment by Individuals or Work Crews*: 96.30 % of participants believed that *Poor Judgment by Individuals or Work Crews* could be solved. In Round 2, 96 % of participants indicated that the solutions to *Poor Judgment by Individuals or Work Crews* were desirable; 92 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Judgment by Individuals or Work Crews* include:

> Organizations must actively promote a safety-first culture that is intolerant to poor judgment and which supports its correction. Managers and Supervisors must develop work procedures and ensure strict adherence by individuals at work. Strict adherence to well-written procedures can avoid workers having to rely on their judgment. Managing and enforcing these rules helps workers to focus and guide their actions based on work procedures and not by individual judgment and analysis. Progressive discipline may often-times be necessary. Managers and supervisors must set initial expectations if those

expectations are unmet; defaulters should undergo retraining. If, after that intervention, expectations are still not met, then it is fair to remove personnel from the team if they are not willing or able to provide good judgment.

Organizational leaders will encourage superior work performance by instituting a peer checking arrangement on all jobs with as many workers as possible. For individuals working alone and an unwillingness of peers to correct each other may be difficult to manage but managers and supervisors must brainstorm how best to negotiate that challenge successfully. In a trusting work environment, self-check and peer-check will result in safe work practice and an absence of accidents. Managers and supervisors must set initial expectations that nothing is more important than getting the job done safely, that poor individual judgment is discouraged, and it will result in appropriate actions. Group decisions are to be encouraged once platformed on job briefing and full understanding of work tasks and sequence of activities. Organizational leadership should require managers and supervisors to facilitate this work arrangement. It must be that once any worker raises an issue and supervisors and management address it, work shall be in line with the revised arrangements.

Managers and supervisors must do more competency testing of workers. Years of experience as the primary factor promoting individuals must not be a criterion that augments proven competence, skills, knowledge, and consistency in decision making.

Managers and supervisors must ensure that individuals at work do not become complacent in their work, or overconfident in their abilities. These individuals must undergo retraining to prevent the tendency to disregard safety rules, policies, and procedures. Managers must support supervisors doing crew audits identifying poor judgment and addressing it with coaching or counseling. Mentoring programs can be suitable for this effort.

Data saturation (solutions to *Poor Judgment by Individuals or Work Crews*) occurred. These surrounded self-check, peer-check, enforcing rules, written procedures, supervisors, coaching, overconfident, experienced, inexperienced, untrained workers, worker training, expectation, culture, attitudes, behavior, skilled, knowledgeable, inappropriate work methods, and employee unions.

Table: Poor Judgment by Individuals or Work Crews Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *Conduct initial and reoccurring training on appropriate work methods. Conduct observations on ongoing work to make on the spot corrections and retraining. Apply progressive discipline up to and including removal from the team.* | *Have a human performance improvement program to address human errors both proactively and reactively.* |
| **Political Frame** | **Symbolic Frame** |
| *Recognize that humans are fallible and prone to error.* | *You ever had a class in "good judgment". If you were to cite three qualities of good leadership, they would all be soft skills. We train our electrical workers in all hard skills and then make them supervisors and managers. We need to train our leaders of the industry in leadership skills and the mechanics of good judgment..* |

For the problem of *Poor Attitude and Behavior by Individuals or Work Crews*: 88.89 % of participants believed that *Poor Attitude and Behavior by Individuals or Work Crews* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Poor Attitude and Behavior by Individuals or Work Crews* were desirable; 96 % found them feasible. In Round 3, 95.83 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Attitude and Behavior by Individuals or Work Crews* include:

> Managers and supervisors must have support from organizational leadership to improve morale and to address worker dissatisfaction. Organizational leadership and management can encourage performance improvement techniques and tools such as situational awareness to promote positive working arrangements. Close oversight and supervisor presence can help mitigate poor attitude and behavior. More egregious examples would need to be handled using different methods to avoid these individuals affecting or influencing other workers.
>
> Organizational leadership must promote a safety first culture where poor attitude and behavior correction is unaccepted. Managers and supervisors must set initial expectations that nothing is more important than getting the job done safely and that poor attitude and behavior are intolerable and can result in dismissal. Progressive discipline may be necessary. If initial expectations are unachieved, provide retraining. If expectations are still not met, then remove personnel from the team if they cannot or are not willing to fit into a safety-first culture.
>
> Management and supervisors must recognize a poor attitude and not allow work to proceed until that attitude is corrected: despite other work-related pressures to get a certain amount of work done in a particular time to meet a goal.
>
> Proper management is key to good employee attitudes and behaviors: Make employees feel appreciated. Manager and supervisor training must include segments to cover this need.

Data saturation (solutions to *Poor Attitude and Behavior by Individuals or Work Crews*) occurred. These surrounded individuals working together, training, progressive discipline, enforcing rules, written procedures, managers, supervisors, coaching, initial expectations, inexperienced, untrained workers, worker training, expectation, culture, situational awareness, inappropriate work methods, and employee unions.

Table: Poor Attitude and Behavior by Individuals or Work Crews Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *More training and oversight; structured process; Workers hours Workers dissatisfaction* | *Supervisors identifying and addressing poor attitudes must be management supported. Poor supervision breeds poor crew attitudes* |
| **Political Frame** | **Symbolic Frame** |
| *If the promotion of individuals is not from within the organization, they are Engineers and studies show that engineers do not have the best people skills.* | *Our brain uses 1 liter of blood per minute. 20 % of the air we create and 25% of the food we eat is required to operate our brain. When we are distracted by poor behaviors and poor attitude we make mistakes.* |

For the problem of *Ineffective or no Workplace Training*: 92.59 % of participants believed that *Ineffective or no Workplace Training* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Ineffective or no Workplace Training* were desirable; 96 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Ineffective or no Workplace Training* include:

> Employees must receive training on how to execute tasks safely to prevent work induced failures such as accidents, injuries, and death. Despite training costs, organizational leadership and management must communicate and champion the fact that well-trained employees are more productive and safer. Management must support organizational policies, procedures, and resources (budget, time, materials, and staffing) while maintaining priority on worker training.
>
> Accurate training records and ease of access to those records is a way to ensure that only trained workers are assigned specific tasks. Engineering/Asset Management/Operations/Safety should create training programs. Conduct periodic audits of training effectiveness. Management must periodically review, continuously improve, and update the safety training program. If hazard assessment conducted by work teams are not comprehensive, it is easy to miss dangerous conditions and situations, especially when not thought of or factored as likely to be present or to occur during the work exercise.

> Trainers must be knowledgeable in the work function; the better the training program, the better the worker. Training should be ever changing for effectiveness, worker enlightenment, and where individuals will fully comply with work procedures and rules. Ineffective training programs can contribute to the workers becoming overconfident and complacent, and ultimately to possible injury or death.

Data saturation (solutions to *Ineffective or no Workplace Training*) occurred. These surrounded hazard assessment, mentoring, knowledge, records, written procedures, managers, supervisors, overconfidence, initial expectations, inexperienced, untrained workers, culture, policies, procedures, and resources.

Table: Ineffective or no Workplace Training Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Train workers and evaluate the effectiveness of training programs.*<br><br>*How do we mitigate hazards involving the inherent risk humans bring to the table, if we don't teach it?* | *Ensuring robust training and also refresher training can prevent accidents.*<br>*Challenges - Lack of funding for training* |
| **Political Frame** | **Symbolic Frame** |
| *Help train the people around you in a manner that will keep them safe. Training comes from your experienced people not from a book.*<br><br>*Most training for lineman stops after their apprenticeship is completed. Training is costly and utilities are not willing to pay.* | *Avoid assigning work to an individual who is not trained or familiar with a piece of equipment if it has a high energy hazard associated with it.* |

For the problem of *Poor Supervision*: 92.59 % of participants believed that *Poor Supervision* could be solved. In Round 2, 92 % of participants indicated that the solutions to *Poor Supervision* were desirable; 92 % found them feasible. In Round 3, 95.83 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Supervision* include:

> The way that supervisors conduct job site safety exchanges with and how often they witness employees performing a task can help in preventing accidents. The more often a supervisor oversees workers' performing tasks, the less likelihood of errors and accidents.
>
> Organizational leadership must support a supervisor training program that emphasizes, technical and supervisory skills competence regardless of sizeable cost and time commitment. Supervisors are organizational representatives who have important opportunities to recognize if or when workers encroach into dangerous work zones and arrangements. Supervisors can, therefore, identify instances and situations where the possibility of preventing accidents, worker injuries or death is real and active.
>
> Management must set initial expectations with supervisors, emphasizing that nothing is more important than getting the job done safely and that they need to set the same expectations with their teams. If those expectations are unmet, management should provide retraining to the supervisor. If expectations are still not achieved, then remove supervisors from leading workers and work-teams: especially if they cannot or are not willing to fit into a safety-first culture.
>
> Supervisors must be empowered to act and to correct violations with impunity, and without fear of reprisal: especially if disciplinary action is necessary and immediately administered: A safety-serious management should be willing to support a supervisor who makes tough decisions against defaulting employees on workplace safety issues and violations.
>
> Supervisors must master the human relations skills necessary to convince others to do work in an accident-free environment and without worker injuries or death. Supervisors are champions of organizational core-values and future leaders; leadership training is an essential investment. Front line supervisors must to have field experience: It is necessary for the electric power industry.

Data saturation (solutions to *Poor Supervision*) occurred. This surrounded leadership, core values, champions, field experience, certification, knowledge, understanding, maturity, work together, progressive discipline, enforcing rules, written procedures, coaching, worker training, expectation, culture, situational awareness, and work methods.

Table: Poor Supervision Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *Supervisors need to be technically proficient in work tasks and receive appropriate training.*<br><br>*Supervisors must be well qualified and experienced in work at hand.* | *Supervisors also need to practice good leadership and need to receive appropriate training.*<br><br>*Managers must set and detail expectations for supervisors.*<br><br>*Supervisors must be well qualified and experienced in work at hand.* |
| **Political Frame** | **Symbolic Frame** |
| *Keeping poor supervisors under scrutiny by management individuals, and providing frequent feedback, can help guide these individuals from creating an environment where accidents can occur.*<br><br>*Most training for lineman stops after their apprenticeship is completed. Training is costly and utilities are not willing to pay.* | *Promote integrity.*<br>*Organizations need to create a "Safety First" culture. Supervisors play an integral role in creating/maintaining that culture.* |

For the problem of *Work Planning*: 96.3 % of participants believed that *Work Planning* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Work Planning* were desirable; 100 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Work Planning* include:

> Managers and supervisors must ensure robust job planning and job briefing to prevent accidents. Job packages must include job aids such as procedures, job safety analysis identifying hazards, and information on prior incidents, if available, can help avoid accidents. A properly planned job includes safety consideration such as correct fall protection, personal protective equipment, proper isolation, and grounding. Often, these

items are left to the workers to arrange and decide when they arrive on site. It is imperative to consider safety when creating a work plan. All parties should provide feedback about how to best organize the project safely and carefully, given their areas of expertise. Front line supervision and workers must recognize bad work planning and provide effective, practical, and useful feedback to supervisors and managers. Managers and supervisors must then take appropriate action to prevent recurrence of sub-standard work planning.

Managers, supervisors, and workers must coordinate work planning with work going on concurrently and which might have an impact on the job activities. Personnel must be aware when conditions and situations change and require work reassessment strategies due to the unplanned changes. These must be a deliberate, proactive pre-disposition: Improper pre-work assessments and reviews contribute to crews and individuals being improperly prepared for tasks and accident events.

Data saturation (solutions to *Work Planning*) occurred. This surrounded job planning, job briefing, safety consideration, actively involve, coordinate, worker training, expectation, culture, situational awareness, work methods, recognize, field experience, certification, knowledge, understanding, enforcing rules, written procedures, coaching, managers, and supervisors.

Table: Work Planning Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *OSHA required pre-job briefings.*<br><br>*Knowing the hazards is one thing, but removing the hazard from the worksite should be part of the work planning.* | *Involve crew leader in work planning. Challenge - time commitment and working logistics.* |
| **Political Frame** | **Symbolic Frame** |
| *I never allowed a lousy plan to affect my work as a lineman. I just would not do it until there was a better idea. That said, I became a foreman after 14 years as a lineman. Now lineman becomes foreman after 3 years because of the worker shortage. Less likely to stand up to or even recognize a bad plan.* | *None at the start and none on time*<br><br>*Rushing, budget and bonus money.*<br><br>*Profit over safety* |

For the problem of *Management Priorities*: 85.19 % of participants believed that *Management Priorities* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Management Priorities* were desirable; 100 % found them feasible. In Round 2, 95.83 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 2, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Management Priorities* include:

> Management must create and encourage a safety first culture where nothing is more important than getting the job done safely: Management must make safety the number one priority of the organization. Management must genuinely, actively, and repeatedly communicate this so that workers do not lose focus. Managers must recognize the challenge of keeping safety as a top priority even in situations where the acute pressure to get things done is overwhelming, and not to feel pressured to meet other work-related goals and to compromise safety.
>
> Supervisors must demand strict adherence to procedures to prevent accidents: It is a point of hypocrisy when supervisors and managers preach that safety practices are foremost, but then blatantly disregard safety to meet scheduling, production quotas, or alleviate budgetary concerns.
>
> Managers must be exposed to the fieldwork regularly so they will have a detailed idea about what they are managing and the individuals doing that work. They must be up-to-date or aware of the work activities on projects or jobs, have a full understanding of the actual work plan, the strategy for getting it done, and HOW best to do it.

Data saturation (solutions to *Management Priorities*) occurred. This surrounded culture, priority, safe work, cost, coordinate, customers, stakeholders, situational awareness, work methods, field experience, knowledge, understanding, enforcing rules, written procedures, coaching, managers, and supervisors.

Table: Management Priorities Responses: Four-Frames

| Structural Frame | Human Resources Frame |
| --- | --- |
| *When a Manager steps into a process and wants to accelerate a job, or change priorities, a worker can ensure his safety by strictly adhering to work procedures, with no "fade."* | *Being rushed.*<br>*Get rid of managers that are not on board with the company's safety culture.* |
| **Political Frame** | **Symbolic Frame** |
| *Production is rewarded more than safety and workers know that as a fact. Some workers even choose shortcuts just to get ahead of the competition and for promotion.* | *Slow down and keep employees motivated*<br>*Adopt a true safety first value* |

For the problem of *Poor Team Communication*: 92.59 % of participants believed that *Poor Team Communication* could be solved. In Round 2, 96 % of participants indicated that the solutions to *Poor Team Communication* were desirable; 96 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Team Communication* include:

The person in charge of a job must be trained in good communication and know the importance of excellent interpersonal and group communication. Before a job starts, and while a job is in progress, arrange planned meetings where everyone can be aware of the actual work progress and planned changes. These meetings must be factored as part of the job and time must be added to overall job times.

Managers and supervisors must recognize the benefits of and use strategies aimed at improving human performances by genuinely and meaningfully communicating with workers on accident prevention efforts. Implement thorough and complete job briefings before and during the work processes and exercises. Recognize that a common challenge is that job briefings are not always well conducted: Use effective communication to prevent misunderstandings.

Workers mindful of what other workers are doing will help prevent accidents: Managers and supervisors must facilitate this. By precisely knowing what coworkers are doing, and when, can avoid an accident caused by actions that interfere with other groups. Sometimes this can be best handled by having one person/entity in charge of all tasks on a particular job.

It is imperative that individuals at work and work teams practice effective communication to drive safe, superior team performance, and work outcomes. Managers and supervisors must set expectations on effective communication and provide appropriate training to individuals at work. Managers must also ensure that supervisors are fostering a culture that supports good communication.

Supervisors must be mindful that by forming work teams, individuals who work well together is extremely important. If interpersonal issues exist among team members, managers and supervisors must diagnose and address this issue decisively, even if it means removing an individual or individuals from the employ altogether or in showing workers where they may be contributing to the problem or problems. Managers and employee unions must work together to alleviate possible accidents and worker injuries that can result from sub-standard conditions due primarily to poor interpersonal communication.

Data saturation (solutions to *Poor Team Communication*) occurred. This surrounded strategies, culture, human performances, tailgate meetings, sub-standard conditions, complacency, confusion, job briefings, situational awareness, work methods, recognize, performance, understanding, misunderstandings, written procedures, coaching, managers, and supervisors.

Table: Poor Team Communication Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Communication deficiencies have been identified to be a potential cause of injuries, especially during the administration of operating orders* | *Good pre-job briefings: Sometimes a challenge is language barriers can exist.* |
| **Political Frame** | **Symbolic Frame** |
| If there is bad chemistry on the crew, there will be poor communication. | *Communication is a training topic for all persons at work.* <br> *Establish communication protocols* |

For the problem of *Willful Disregard for Safety Rules*: 81.48 % of participants believed that *Willful Disregard for Safety Rules* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Willful Disregard for Safety Rules* were desirable; 96 % found them feasible. In Round 3, 95.83 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Willful Disregard for Safety Rules* include:

> Managers and supervisors must recognize possible individual or individuals who may exhibit a tendency to disregard workplace rules, and get appropriate counseling, or to keep the errant individual off the job: despite possibly but not deliberately invading the person's right to privacy.
>
> Managers and supervisors must follow a firm, consistent approach to handing willful violations – discipline: It is prudent to train supervisors and workers before the working arrangements get to that point where individuals will *willfully disregard safety rules*.
>
> Managers must discipline individuals who *willfully disregard safety rules*. If the defaulting individual cannot recover, then the only recourse would be that the manager must remove the person from that job function and all hazardous work tasks. This removal can mean dismissal from the company.
>
> Supervisors must remain vigilant and seek out workers who take short cuts when performing work; mostly the result of overconfidence and complacency. Individuals who are affected by either or both, have a higher tendency to disregard safety in the belief that nothing will occur since they may have done the same or similar work tasks before without implementing safety procedures. This removal will save errant individuals from making mistakes and possibly injuring themselves or others at work.
>
> One reason for willful disregard for safety rules is the quality of accident investigations where the main focus usually is on determining errors committed by the last individual before the accident event. To prevent this, organizational leaders must require full compliance with accident investigation guidelines where *human-error* would be just one aspect of the investigation.

Data saturation (solutions to *Willful Disregard for Safety Rules*) occurred. This surrounded focus, strategies, culture, errors, human performances, counseling, tailgate meetings, sub-standard conditions, complacency, overconfidence, job briefings, situational awareness, work methods, recognize, performance, understanding, misunderstandings, written procedures, coaching, managers, and supervisors.

Table: Willful Disregard for Safety Rules Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Willful disregard for safety rules needs to be corrected.*<br><br>*Set initial expectations that nothing is more important than getting the job done Safely and that unsatisfactory behavior will be addressed.* | *Progressive discipline is often necessary. Set the initial expectations. If those expectations are not met, provide retraining. If expectations are still not met, then it is fair to remove personnel from the team if they cannot or are not willing to fit into a Safety First culture.* |
| **Political Frame** | **Symbolic Frame** |
| *Linemen have big egos and enjoy living on the edge. This ego makes them willingly disregard safety rule.* | *Investigations often produce phrases like, "total disregard for safety rules, ignoring PPE requirements etc". Last year in the United States 45 children died after being forgotten in the back seat on a hot day. It's easy to blame the worker by saying "Willful disregard." The truth is there is always something more complex at work. If we don't ask the right questions, we won't find the answer. Worse we can't change outcomes. Culture change is needed to develop a workforce that resists the urge to make willful violations of safety rules* |

For the problem of *Permit to Work Violations*: 81.48 % of participants believed that *Permit to Work Violations* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Permit to Work Violations* were desirable; 92 % found them feasible. In Round 3, 91.67 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Permit to Work Violations* include:

> Managers and supervisors must frequently remind all individuals at work that proper job briefings at the start of every job, will help prevent permit to work violations. That reminder must also explain that if an individual chooses to work outside of the scope of their permit, then that would be an individual responsibility. Managers must stress that a permit to work is specific where workers have detailed job information, an indication of the danger in the job activities, and the consequences of work permit violations. Managers and supervisors must set initial expectations that nothing is more important than getting the job done safely and that permit to work violations will attract progressive discipline.
>
> Instructions must be that workers do not work until verification of safe work is possible after the issuance and acceptance of a permit to work. This arrangement must hold even at locations where the supervisor is not present in person. The workers at remote locations must exercise self-discipline and not begin work until permits are received: Workers must always be reminded that accident victims are usually the individuals at the front-line. A failure to secure permits can result in improper testing, verification of conditions, lock out/tag out violations, or other dangerous possibilities that could result in serious injury, illness, or death. Closed loop communication, clearance, and control communication, which are necessary, is not known to all front line workers. Working within the defined scope of an operating order or permit to work is crucial to avoid injury.
>
> Training in the permit to work processes and procedures shall include hazard analysis and mitigation techniques and legal provisions on violations to this requirement.

Data saturation (solutions to *Permit to Work Violations*) occurred. It surrounded focus, strategies, culture, errors, incompetence, distraction, tailgate meetings, human error, complacency, overconfidence, job briefings, situational awareness, work methods, testing, verification, understanding, misunderstandings, written procedures, coaching, discipline, managers, and supervisors.

Table: Permit to Work Violations Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *Have more accountability for these permits. They are usually just boxes to check on a paper. More staff is needed to ensure rules are followed.* | *Supervisors are KEY*<br><br>*Train all frontline workers and document process* |
| **Political Frame** | **Symbolic Frame** |
| *Organizations need to create a train and document culture.* | *In a "Safety First" culture, permit to work violations needs to be corrected.* |

For the problem of *Lock-Out-Tag-Out-non-Compliance*: 96.3 % of participants believed that *Lock-Out-Tag-Out-non-Compliance* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Lock-Out-Tag-Out-non-Compliance* were desirable; 100 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Lock-Out-Tag-Out-non-Compliance* include:

> Managers and supervisors must encourage peer check, and effective communication as that will alleviate problems regarding instances of lock out tag out violations. In a safety-first culture, supported by managers and supervisors, lock-out-tag-out training will set the initial expectations and, provide a detailed description of why this is necessary and what will occur if there are procedural violations. Locks with combinations can be handy. These combinations should be changed periodically, so employees do not memorize codes to locks. Not complying lock-out-tag-out or not using a lock-out-tag-out procedure is rooted in a cultural problem and a heuristic trap. Removing the wrong tags can introduce hazardous conditions.
>
> Remove personnel from work functions where *Lock-Out-Tag-Out-non-Compliance* occurs if they cannot or are not willing to maintain the stringent requirements and responsibilities that accompany this task. The likelihood of individuals becoming injured or even killed because of lock-out-tag-out violations are significant. Non-compliance can

lead to accidental energization of circuits, by others, unaware of what is occurring with regards to the circuit.

Progressive discipline is often necessary in cases of indifferent lock-out-tag-out behavior. Managers and supervisors must ensure multiple levels of checking of lock-out-tag-out arrangements. Sometimes it is that supervising the personnel performing this function is not always possible because of the geographically spatial electric power network and the location where lock-out-tag-out operations occur. Technology can assist through pictures, and existing supervisory control and data acquisition signals. If these are not available or possible at all lock-out positions, a combination of safe work strategies can be employed to maintain full compliance.

Data saturation (solutions to *Lock-Out-Tag-Out-non-Compliance*) occurred. It surrounded peer check, unskilled, communication, expectations, training, recognize, focus, strategies, culture, errors, incompetence, distraction, tailgate meetings, human error, complacency, overconfidence, job briefings, situational awareness, work methods, recognize, verification, understanding, written procedures, discipline, managers, and supervisors.

Table : Lock-Out-Tag-Out-non-Compliance Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Non-compliance is often due to a work plan that is too restrictive or not workable.* | *Having a detailed and proper review of a lock-out tag-out plan can help ensure that it is feasible and workable, therefore avoiding the need for workers to feel they need to work outside of a lock-out tag-out plan.* |
| **Political Frame** | **Symbolic Frame** |
| *Safety is a must.*<br>*If no one observing, workers will take chances.*<br>*Should have field experience and understanding of circuits and voltages.* | *More accountability is required. A safety check should confirm and verify lock-out tag out arrangements after installation and before work can begin.* |

For the problem of *Organizational Safety Culture*: 92.59 % of participants believed that *Organizational Safety Culture* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Organizational Safety Culture* were desirable; 100 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Organizational Safety Culture* include:

> Managers and supervisors must review work procedures and practices that fall under the banner of *That's the way we've always done it...*, measure them for continued relevance and determine if they can reveal that work practices have drifted from accepted organizational procedures and best safety practices. This drift would fall under a *safety culture* that has gone off track. Reigning these practices when discovered can lead to the reduction of accidents. Safety culture maintenance must be a top priority and management should ensure that it stays that way. Organizational leadership must support this direction, not just middle management.
>
> Company leaders must consider work safety issues as equal to profit, system reliability and production. That push for profit or production must never be over safety: a point of hypocrisy when company leaders preach that safety practices are foremost, but then blatantly disregard safety to meet scheduling, production quotas, or alleviate budgetary concerns. The saying *practice what you preach* must be an emphasis amongst management and company executives in all business concerns.
>
> Organizational safety culture begins at the very top. Top management must be safety trained, communicate safe work expectations and support from those under their influence.
>
> Data saturation (solutions to *Organizational Safety Culture*) occurred. It surrounded communication, expectations, training, recognize, strategies, incompetence, distraction, human error, situational awareness, work methods, verification, understanding, leaders, managers, and supervisors.

Table: Organizational Safety Culture Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *It is important to note that an organizational safety culture requires constant maintenance.* | *Accidents can be prevented by ensuring that 100% of the workforce is appropriately trained.*<br><br>*The challenge is to ensure that all are trained.* |
| **Political Frame** | **Symbolic Frame** |
| *This one is a joke.*<br><br>*Electric Utilities brag about their safety cultures, but numbers lie and liars figure.* | *Creating a "Safety First" culture needs to be a collaboration between leadership, management, and all employees.*<br><br>*Every single Employee needs to buy in.* |

For the problem of *Individual Risk-Taking and Negligence*: 92.59 % of participants believed that *Individual Risk-Taking and Negligence* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Individual Risk-Taking and Negligence* were desirable; 100 % found them feasible. In Round 3, 95.83 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Individual Risk-Taking and Negligence* include:

> Organizational leaders must support safety culture reinforcement and a zero tolerance for reckless risk-taking and negligence. Management and supervisors must enforce strict adherence to rules and procedures, by conducting sufficient and timely audits, which can help guide workers away from taking risks and being negligent. Sound control is the key to avoiding risk taking and negligence.
>
> Management and supervisors must encourage workers to follow all steps of an assignment and abhor a tendency for individuals to want to get things *over with*, and the perception of getting things done, quickly, will reap the most significant rewards.

> Managers and supervisors must maintain cognizance that human behavior is consequence-influenced: When an individual knows the result of personal actions, then it is conceivable that the individual may be more likely to avoid danger. Front line supervision and action must always aim at correcting safety-errant behavior.

Data saturation (solutions to *Individual Risk-Taking and Negligence*) occurred. It surrounded culture, personal actions, consequence, behavior, understand, communication, expectations, training, recognize, strategies, incompetence, human error, situational awareness, work methods, managers, and supervisors.

Table: Individual Risk-Taking and Negligence Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *This type of person is very attracted to line work, but these people are also the most accident-prone.* | *Result of overconfidence, complacency, laziness, or possibly poor training.*<br><br>*Evaluate and coach* |
| **Political Frame** | **Symbolic Frame** |
| *Terminate employee contracts when individuals willfully violate workplace safety arrangements, procedures, and rules.*<br><br>*Fire employees who do not do what's required.* | *Pre-employment testing should be done to understand the type of people utilities hire and inextricably are putting into harm's way.* |

For the problem of *Equipment Failure*: 92.59 % of participants believed that *Equipment Failure* could be solved. In Round 2, 96 % of participants indicated that the solutions to *Equipment Failure* were desirable; 96 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 86.96 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Equipment Failure* include:

Engineering/Asset Management/Operations/Safety must create procedures for inspections, effective maintenance, and replacement of outdated equipment. The program should also consist of initial expectations training and periodic retraining. Managers and supervisors must conduct audits regularly.

A robust preventative maintenance program will help reduce worker injuries and death due to equipment failures. Electric power utilities perform more energized work to eliminate service interruptions. With more re-closers installed on the electricity transmission and distribution systems, enablement of circuit flexibility with re-closer scenarios occurs. Improperly maintained in-service equipment, inadequate quality control, poor handling, and shipping conditions for materials and spares are significant factors that contribute to equipment failure.

Managers, supervisors, and workers must remain mindful that knowing the operating limits of in-service equipment is essential in the safe management of the electric system. Understanding how practical drift allows for a stretch of the operating limits of the material, device or equipment, can provide an understanding of why in-service equipment fails.

Preventing equipment failure occurs through proper device operation, and adequate maintenance conducted by following technical standards, manufacturers recommendation, and within the appropriate period.

Managers must ensure training for employees on new systems, equipment or products and that the knowledge is practiced and effective.

Data saturation (solutions to *Equipment Failure*) occurred. It surrounded inspection, maintenance, work programming, equipment failure, prevention measures, assumptions, procedures, training, consultation, proactive work, personal protective equipment, high energy equipment, contingency, practical drift, situation awareness, managers, and supervisors.

Table: Equipment Failure Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Develop and implement work procedures that protect workers from failures. Challenge - workers do not follow procedures*<br>*Available preventative maintenance* | *Proper and effective maintenance can help prevent the failure of equipment, which can cause harm to individuals in the vicinity..* |
| **Political Frame** | **Symbolic Frame** |
| *Certification training is expensive and time-consuming.* | *Developing a robust preventative maintenance program can help with equipment failure.* |

For the problem of *Procedural Error*: 88.89 % of participants believed that *Procedural Error* could be solved. In Round 2, 100 % of participants indicated that the solutions to *Procedural Error* were desirable; 100 % found them feasible. In Round 3, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round 4, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Procedural Error* include:

> Managers and supervisors must effectively train employees to use procedures and audit the use of workplace procedures. Write clear procedures. Use a step policy and review before it is too late: A periodic and documented analysis of procedures will help avoid a sub-processes in a process or method which may not be the best way to perform a task. If there are errors in a work process, method, or procedure, and the procedure remains unchanged, the mistake will recur until it is. That usually happens after an accident where employees were seriously injured or even killed.
>
> Management and supervisors must enforce strict adherence to rules and procedures, by conducting sufficient and regular audits, to help guide workers away from procedural errors. Sound control is necessary. Engineering/Asset Management/Operations/Safety must create procedures emphasizing proper techniques and practices. The program should also consist of initial expectations training and periodic retraining. Conduct periodic assessments and continually improve. Examination of procedures must be through a series of *what if* questions.
>
> Supervisors must identify and correct all instances of improper training and poor communication which can cause confusion, misinformation, worker failure to implement new procedures, and workers' inability to communicate critical information.

Data saturation (solutions to *Procedural Error*) occurred. It surrounded culture, audits, practices, understand, communication, procedures, training, recognize, incompetence, human error, situational awareness, work methods, managers, and supervisors.

Table: Procedural Error Responses: Four-Frames

| Structural Frame | Human Resources Frame |
|---|---|
| *Procedures should be written by experts in the field and not by procedure writers.* | *Have a Safety Program that incorporates human performance improvement tools and strategies. For example, require that all procedures be executed by two Employees who can verify with each other that procedures are being implemented without error.* |
| **Political Frame** | **Symbolic Frame** |
| *Management inspection can happen with an unexpected change in the work.*<br><br>*Experienced supervisors monitoring crews and holding them accountable.* | *Recognize that humans are fallible and prone to error. Have a human performance improvement program to address human errors both proactively and reactively.* |

For the problem of *Poor Management Oversight*: 88.89 % of participants believed that *Poor Management Oversight* could be solved. In Round two, 100 % of participants indicated that the solutions to *Poor Management Oversight* were desirable; 100 % found them feasible. In Round three, 100 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round four, 95.65 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Management Oversight* include:

> Management must provide employee oversight. A program in place requiring field visits by managers and others by supervisors will help to prevent serious accidents. Training for managers must include techniques for measuring effective compliance and how to perform job oversight activities. Ensure manager training and appropriate resources (budget, time, materials, staffing).
>
> Holding individual managers accountable for their actions will prevent accidents caused by poor management oversight. Individual managers must know that they are responsible for the work outcome, regardless of whether they supervise the work

activities directly or through other individuals. Poor management oversight can attract personal fines and federal sanctions.

Managers must be familiar with what is required to accomplish the work they assign: The challenge is for managers to be familiar with the work they ascribe to others. Unengaged supervision, inexperienced supervisors, and management personnel unwilling to call out safety violators, are significant contributors to this issue and must be removed if that poor practice continues.

Data saturation (solutions to *Poor Management Oversight*) occurred. It surrounded conflicts, inexperienced, accountable, audits, practices, fines, unengaged, procedures, training, incompetence, work methods, and supervisors.

Table: Procedural Error Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
| --- | --- |
| *Procedures should be written by experts in the field and not by procedure writers.* | *Have a Safety Program that incorporates human performance improvement tools and strategies. For example, require that all procedures be executed by two Employees who can verify with each other that procedures are being implemented without error.* |
| **Political Frame** | **Symbolic Frame** |
| *Management inspection can happen with an unexpected change in the work.*<br><br>*Experienced supervisors monitoring crews and holding them accountable.* | *Recognize that humans are fallible and prone to error. Have a human performance improvement program to address human errors both proactively and reactively.* |

For the problem of *Poor Quality Material*: 70.37 % of participants believed that *Poor Quality Material* could be solved. In Round two, 92 % of participants indicated that the solutions to *Poor Quality Material* were desirable; 92 % found them feasible. In Round three, 79.17 % indicated that it was important to implement these solutions to prevent further and future accidents.  In Round four, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Poor Quality Material* include:

> Organizational leadership and management must demand that purchasing requirements are fully complied with and there is a good quality assurance program to help prevent issues caused by poor quality material.  When poor quality material gets to the workplace and discovered, workers and frontline managers and supervisors must provide details to procurement or purchasing personnel.  That feedback is critical to ensure that inferior quality materials do not end up causing an accident.
>
> It is imperative for engineers and designers to use superior quality materials when constructing, operating and maintaining equipment to drive actual safety performance. Purchasing officers must examine reviews which may be available to buyers before making decisions on purchasing items or materials.
>
> Organizational policies and procedures must always be sufficient to address the impact of inferior quality materials with both a proactive focus and otherwise.  Managers must maintain a good QA/QC program to ensure the use of high-quality materials and equipment.

Data saturation (solutions to *Poor Quality Material* ) occurred. It surrounded assurance, proactive, purchasing, equipment failure, cost, assumptions, training, consultation, contingency, situation awareness, managers, and supervisors.

Table:  Poor Quality Material Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Getting any history on the manufacturer of and the materials used. A challenge is to buy something that might be within the budget.* | *Buy quality not quantity* |
| **Political Frame** | **Symbolic Frame** |
| *Materials generally have not been the cause of accidents I know about. Usually, the issues occur due to improper installation and workmanship.* | *A national registry for defective material.* |

For the problem of *Non-use of Personal Protective Equipment*: 92.59 % of participants believed that *Non-use of Personal Protective Equipment* could be solved. In Round two, 100 % of participants indicated that the solutions to *Non-use of Personal Protective Equipment* were desirable; 100 % found them feasible. In Round three, 95.83 % indicated that it was important to implement these solutions to prevent further and future accidents. In Round four, 91.3 % expressed confidence that if applied in the electric power industry, workers will not become seriously injured or killed while doing work.

Solutions identified for the problem of *Non-use of Personal Protective Equipment* include:

> Organizational leaders must create and encourage a safety first culture where *non-use of personal protective equipment* is corrected. Managers and supervisors must ensure personnel training in the use of personal protective equipment; Provide periodic retraining. The only way to prevent accidents caused by *non-use of personal protective equipment* is to enforce the safety rules.
>
> Managers and supervisors must set initial expectations that nothing is more important than getting the job done safely and that not using personal protective equipment appropriately are not tolerated: Dismiss defaulters who willfully disregard this requirement.
>
> Managers and supervisors must enforce work procedures that highlight the consequence of not wearing personal protective equipment as this can cause a fatal injury. Non-use of personal protective equipment can be due to complacency and overconfidence. Inadequate training or non-issuance of personal protective equipment can be a possible cause. Occasionally workers make excuses for personal protective equipment violations, usually in regards to working constraints in tight places. Practical drift can occur and are dangerous: Especially if the worker has gotten away with non-use of personal protective equipment, or before the teaching or the inadequate application of equipotential grounding.
>
> Managers and supervisors must enforce full and strict compliance with the use of personal protective equipment at all times: Personal protective equipment, even if it is uncomfortable and sometimes restricts natural movement and mobility, is the last line of defense. Not using it means that the employee is defenseless and this is very likely to leave the individual susceptible to injury. Supervisors identifying poor behaviors must hold defaulting individuals accountable.

Data saturation (solutions to *Non-use of Personal Protective Equipment*) occurred. It surrounded conflicts, good fit, accountable, inspections, practices, careless, unengaged, procedures, training, negligence, work methods, managers, and supervisors.

Table: Non-use of Personal Protective Equipment Responses: Four-Frames

| **Structural Frame** | **Human Resources Frame** |
|---|---|
| *Safety not followed*<br>*More visits by the safety inspector.* | *Teaching about lessons learned from past incidents is an effective way of showing individuals at work the risks of not complying with safety rules.* |
| **Political Frame** | **Symbolic Frame** |
| *Severe discipline for individuals who choose to not comply with personal protective equipment rules will send the message that these rules are not optional.* | *Good education is the pre-emptive way of preventing non-compliance.* |

The design of this study was for a selection of a 3, 4, or a 5 on a 5-point Likert-type Scale for each item in each of the Delphi rounds resulted in 28 out of the 30 items originally identified and included in the Round 1 questionnaire remaining relevant throughout the Study. That made the data analysis and study management much more complex and complicated than originally anticipated. In the following Table, a comparison of the possible results if the acceptance criteria was set as a 4 or 5 only for each item in the different questionnaires in this study. Instead of participants' responses to 28 items moving from Round 1 to Round 2 as actually occurred in this study, solutions to 20 items would have remained relevant for later consideration. The reduction may or may not have impacted on the overall conduct of the study, but this was not assessed in its entirety.

| | Round 2 Delphi Considertation | % Response >2 on 5-point Likert-type Scale | | | | | | % Response >3 on 5-point Likert-type Scale | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Des | Feas | Y/N | Total | % D | %F | Des | Feas | Y/N | Total | %D | %F | Imp | Conf |
| 1 | Poor Design | D | F | Y | 1 | 92 | 100 | D | NF | N | 0 | 84 | 68 | XXX | XXX |
| 2 | Management System Flaw | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 92 | 84 | IMP | CONF |
| 3 | Poor Regulatory Oversight | ND | NF | N | 0 | 68 | 64 | ND | NF | N | 0 | 24 | 24 | XXX | XXX |
| 4 | Poor work ethics; history of wrongdoing that went unaddressed | D | F | Y | 1 | 96 | 96 | D | F | Y | 1 | 88 | 76 | IMP | CONF |
| 5 | Incorrect labeling | ND | F | N | 0 | 62 | 100 | ND | NF | N | 0 | 56 | 64 | XXX | XXX |
| 6 | Medical and other personal issues | D | F | Y | 1 | 96 | 92 | D | NF | N | 0 | 80 | 56 | XXX | XXX |
| 7 | Grounding, earthing failures/errors | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 96 | 92 | IMP | CONF |
| 8 | Ineffective and inefficient maintenance | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 92 | 76 | IMP | CONF |
| 9 | Animals/living organisms | D | F | Y | 1 | 80 | 92 | ND | NF | N | 0 | 56 | 44 | XXX | XXX |
| 10 | Hazardous work-site conditions | D | F | Y | 1 | 100 | 92 | D | NF | N | 0 | 88 | 68 | XXX | XXX |
| 11 | Unplanned events | D | F | Y | 1 | 92 | 88 | D | NF | N | 0 | 84 | 56 | XXX | XXX |
| 12 | Inappropriate work methods | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 92 | 84 | IMP | CONF |
| 13 | Stakeholder demands | D | F | Y | 1 | 80 | 84 | D | NF | N | 0 | 72 | 60 | XXX | XXX |
| 14 | Poor judgment by individuals or work crews | D | F | Y | 1 | 96 | 92 | D | F | Y | 1 | 92 | 84 | IMP | CONF |
| 15 | Poor attitude and or behavior by individuals or work crews | D | F | Y | 1 | 100 | 96 | D | F | Y | 1 | 92 | 80 | IMP | CONF |
| 16 | Ineffective or no workplace training | D | F | Y | 1 | 100 | 96 | D | F | Y | 1 | 88 | 84 | IMP | CONF |
| 17 | Poor supervision | D | F | Y | 1 | 92 | 92 | D | F | Y | 1 | 92 | 88 | IMP | CONF |
| 18 | Work planning | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 92 | 88 | IMP | CONF |
| 19 | Management priorities | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 88 | 72 | IMP | CONF |
| 20 | Poor team communication | D | F | Y | 1 | 96 | 96 | D | F | Y | 1 | 92 | 88 | IMP | CONF |
| 21 | Willful disregard for safety rules | D | F | Y | 1 | 100 | 96 | D | F | Y | 1 | 88 | 80 | IMP | CONF |
| 22 | Permit to work violations | D | F | Y | 1 | 100 | 92 | D | F | Y | 1 | 92 | 80 | IMP | CONF |
| 23 | Lock-out tag-out noncompliance | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 96 | 92 | IMP | CONF |
| 24 | Organizational safety culture | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 96 | 88 | IMP | CONF |
| 25 | Individual risk-taking and negligence | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 92 | 76 | IMP | CONF |
| 26 | Equipment failure | D | F | Y | 1 | 96 | 96 | D | NF | N | 0 | 84 | 68 | XXX | XXX |
| 27 | Procedural error | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 88 | 84 | IMP | CONF |
| 28 | Poor management oversight | D | F | Y | 1 | 100 | 96 | D | F | Y | 1 | 92 | 80 | IMP | CONF |
| 29 | Poor quality material | D | F | Y | 1 | 92 | 92 | ND | NF | N | 0 | 64 | 52 | XXX | XXX |
| 30 | Non-use or personal protective equipment | D | F | Y | 1 | 100 | 100 | D | F | Y | 1 | 96 | 96 | IMP | CONF |
| | | | | Total | 28 | | | | | Total | 20 | | | | |