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Strategies to Reduce Safety Accidents in Chemical Facilities

Travon Eshawn Herriotte
Walden University

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College of Management and Human Potential

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Review Committee

Dr. Meredith Wentz, Committee Chairperson, Doctor of Business Administration Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2026

Abstract

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by

Travon E Herriotte

MBA, University of Phoenix, 2014

BS, Bowling Green State University, 2012

Research Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

Walden University

February 2026

Abstract

Chemical-industry accidents remain a persistent threat capable of injuring workers, damaging communities, and destabilizing organizations, despite decades of safety regulations and technological advancements. Chemical facility managers, workers' families, emergency responders, local communities, and entire supply chains bear the burden of every preventable failure. Grounded in human capital theory, the purpose of this qualitative pragmatic research project was to identify and explore effective strategies that managers use to reduce safety accidents in chemical facilities. The participants were six managers from chemical facilities in the eastern United States. Data were collected using semistructured and publicly available documents. Through reflexive thematic analysis, five themes were identified: (a) leadership commitment to safety, (b) employee engagement in hazard control, (c) continuous learning, (d) overcoming cultural and operational barriers, and (e) strengthening organizational safety systems. A key recommendation is for chemical facility managers to implement a structured recurring system that integrates employee-driven hazard identification with targeted incident-based training to strengthen proactive safety performance. Implications for positive social change include the potential to reduce workplace injuries, prevent environmental harm, and strengthen community protection through improved safety cultures in high-hazard industries.

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Dedication

I want to dedicate this to the ones who have always encouraged me. The ones that always supported me, even when they didn't know what to do. Those that I could depend on. The ones that held me close. Those who enjoyed my success more than I did. The ones that I miss. The ones that will forever be in my heart. The ones that will never be forgotten. And the ones who are gone, that I hope to see again.

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Section 1: Project Foundation

Background of the Problem

Safety is a significant concern in many industries, especially the chemical industry. The Occupational Safety and Health Administration (OSHA) has been the primary enforcer of workplace safety standards since the passage of the Occupational Safety and Health Act of 1970 (Jung & Makowsky, 2014). OSHA imposes penalties and fines for workplace safety violations, and major corporations often receive substantial fines (Jung & Makowsky, 2014). OSHA imposes financial and reputational hardships in the form of penalties and workers' disability compensation, which can impact the profitability of chemical companies.

Despite advances in technology and regulation, chemical industry operations continue to expose workers, organizations, and surrounding communities to severe and often catastrophic safety hazards. Safety hazards are present and are unavoidable (Hanza, 2016). These hazards can lead to accidents that contribute to death and injuries. A 1916 explosion killed 108 and injured 97 workers in a fire and explosion at a munitions plant (Carson, 2016). Even with modern technological advances, the risk becomes increasingly significant and affects an increasing number of people. In 2013, 12 firefighters and three members of the public were killed in tank explosions from anhydrous ammonia and ammonium nitrate (Gyenes & Dechy, 2016). This accident also left 260 employees, members of the emergency response team, and community members injured (Gyenes & Dechy, 2016). The deaths and injuries from chemical accidents are not limited to the organization's employees, regardless of where the accident occurs. Effective strategies

must be developed to prevent and mitigate the consequences of chemical accidents. The general business problem is that some chemical company managers lack effective strategies to reduce safety accidents. Safety failures contribute to lost productivity, regulatory penalties, and reputational damage, whereas effective safety management supports operational continuity and long-term profitability.

Business Problem Focus and Project Purpose

The specific business problem was that some chemical company managers lack effective strategies to reduce safety accidents. The purpose of this qualitative pragmatic inquiry research project was to identify and explore the effective strategies that chemical company managers use to reduce safety accidents. The target population consisted of six chemical company managers working in the eastern United States who had effectively employed strategies to reduce safety accidents. I selected chemical company managers using purposive sampling. Purposive sampling is the purposeful selection of the sample population that is best suited and qualified for the research topic (Campbell et al., 2020). By using purposive sampling (Tajik et al., 2025), researchers can increase the thoroughness and reliability of the data and results (Campbell et al., 2020). The data sources included the chosen chemical company managers, who provided consent for interviews. I used OSHA, the Environmental Protection Agency (EPA), and other publicly available documents. I employed reflexive thematic analysis as my data analysis method. My conceptual framework was human capital theory, introduced by Smith in 1776 (see Gilead, 2013).

Project Research Question

What effective strategies do chemical company managers use to reduce safety accidents?

Assumptions and Limitations

Assumptions

Assumptions are thoughts, concepts, or ideas that are reasonable and widely accepted (Theofanidis & Fountouki, 2019). I had several assumptions in my research project. The first assumption was that interviewees would have successfully implemented safety strategies. The second assumption was that every chemical company has similar equipment, processing techniques, and raw material usage, which may pose hazards during use and storage. The third and last assumption was that every interviewee has encountered and overcome OSHA-recordable incidents.

Limitations

Limitations refer to the study's restrictive characteristics that the researcher cannot control or understand (Knoblauch, 2019). My study created two limitations. The first limitation was the interviewee's accuracy in responding. The interviewee could have been indirectly or secondhand associated with the safety strategies. The second limitation was that the results cannot be generalized because it was a qualitative study. However, the results could be transferable and used as a foundation in future studies.

Business Project Ethics

As the researcher, my role was to collect data and present the findings, while serving as an unbiased tool for analysis and interpretation. To accomplish this, I had to

gather relevant information from journals, articles, government agencies, and the search engine Google to enhance my knowledge (see Kosteniuk et al., 2016). I used supplemental sources, including publicly available organizational and regulatory documents, to strengthen the credibility of my research project by corroborating interview data and providing contextual support for identified themes. To complete this work, I recorded and presented facts without regard for personal feelings towards the topic (Nagasaka et al., 2016). The data collected were used to bridge the gap between research and practice for the target audience, rather than for personal reasons or gain (McVay et al., 2016). I also wrote in a manner that does not sermonize but reports facts accurately and without bias (G. Wu & Zhu, 2014).

As the researcher, I acknowledged the limitations of conducting research and strove to enhance the reliability and validity of my research project. Reliability refers to the repeatability of a researcher's results when using the same variables as the original researcher to produce the same outcomes (Ali & Yusof, 2011). Validity refers to the appropriateness of the process, the tools used, and the data collected by the researcher (Leung, 2015). When I conducted interviews within the framework of qualitative research, reliability and validity were considered in both data collection and analysis. I asked data-collection questions in a manner that did not influence interviewees' answers (Baserer et al., 2016), and my research project must accurately identify the common themes in the data (Tüzel, 2013).

My role as a researcher also involved maintaining high ethical standards in my research. The *Belmont Report* outlined the fundamental principles for conducting ethical

research (Miracle, 2016). Respect for persons is a basic principle. Each manager had complete autonomy to decide to participate, not participate, or withdraw at any time, without pressure from internal colleagues or external influences (Sims, 2010). I informed each participant in the consent form and before questioning that they had complete autonomy to withdraw from the research project with no penalty at any time before, during, or after the interview. Beneficence and justice are two other principles found in the *Belmont Report*. These two principles represent the benefit of doing good with equal treatment and fairness for all people (Miracle, 2016). The relationship built between two or more people is the first step to creating moral knowledge (Øye et al., 2016). I treated each participant equally and fairly throughout the recruitment process, including gaining consent, conducting the interviews, and conducting member checking.

Another way to conduct ethical research is a researcher introduction and sharing experience with the subject matter (Reid et al., 2014). Every participant received an overview of my background, including my education, job history, and the purpose of the research project. The researcher must also acknowledge the risk of sharing personal information (Kendall & Halliday, 2014). Any sharing of personal information has its risks. I assured the participants that their data would be safe. I reinforced the importance of keeping their information safe and the precautions they should take to secure their identities, employer, and responses. Preserving participants' trust is critical before, during, and after the interview (Kendall & Halliday, 2014).

I sent an informed consent form via email to participants. The informed consent form stated that the participant could withdraw at any time with no penalty, and this was

communicated to the interviewee electronically in advance. Participants could use the withdrawal form if they no longer wanted to participate, were allowed to withdraw, or had time to withdraw from the study. I kept a record of the email responses to the consent forms. For some, incentives act as a form of coercion to participate (Matheson et al., 2012), and they can become expensive; therefore, I did not offer incentives. I refrained from soliciting any personal information and maintained records and communications in a secure location for 5 years to ensure adequate ethical protection. I will store the records and communications on a password-encrypted hard drive for 5 years. Maintaining ethical protection is essential when conducting research. To accomplish this, I used coding to mask the participants' names and companies. I will also store the data on a secure hard drive for 5 years. After 5 years, I will permanently delete the records.

Appendix B is the interview protocol, a necessary tool for mitigating bias. In qualitative research, the researcher must account for the risk of bias from the interviewer's interpretation of the interviewee's responses (De Ceunynck et al., 2013). The interview protocol provides a script of unbiased questions and procedures (Jacob & Furgerson, 2012). Researchers use an interview protocol to structure the interview process (Karimi et al., 2017). My IRB number approval is 06-25-25-0593925. The interview questions were:

1. What strategies do you use to reduce safety accidents?
2. What are some strategies that are no longer being used?
3. What strategies were most effective?

4. What barriers or challenges have you encountered when implementing strategies to reduce safety accidents?
5. How did you overcome the barriers or challenges to successfully reduce safety accidents?
6. What additional information would you like to share about strategies to reduce safety accidents within the chemical organization?

Evidence-Based Integrative Review

The purpose of my qualitative pragmatic inquiry was to identify and explore effective strategies that chemical company managers use to reduce safety accidents. My review aimed to identify and highlight strategies that plant managers of chemical companies use to avoid safety incidents and protect employees, equipment, and assets. I explain how the human capital theory was founded and evolved. I use the evolution of human capital theory to explain how my conceptual framework can address the business problems identified in scholarly articles and how the topic affects businesses' finances and reputations.

I used the following keywords as a part of my comprehensive search for my research project: *human capital theory, Adam Smith, Jacob Mincer, Theodore Shultz, Gary Becker, Robert Lucas, chemical companies, chemical company, EPA, OSHA, Environmental Protection Agency, Occupational Health and Safety Organization, earning function, chemical industry, chemical statistics, chemical accidents, chemical infrastructure, chemical economy, chemical world, safety climate, leadership, work place accidents, process safety management (PSM), process safety, PMS, chemical legislation,*

Clean Air Act of 1970, Clean Water Act of 1972, clean air act, safe drinking water act, toxic substances control act, nuclear waste policy act, fishbowl policy, pollution preventive act, and food quality protection act. Databases including Academic Search Complete, Business Source Complete, EBSCOhost, and the search engine Google were used to exhaust academic journals, books, articles, and other relevant information. I referenced 99 sources, 82 of which were peer-reviewed journals. Among these sources, 72 were published within the last 5 years, while the remaining 27 were published more than 5 years ago. Eighty-three percent of the sources used were peer-reviewed.

The organization of the literature review consists of the following hierarchy: (a) conceptual framework of the human capital theory discussed in detail; (b) the evolution of the human capital theory; (c) the impact of the chemical industry on the national and global economy; (d) life and financial loss associated with chemical accidents; (e) how accidents can be observed in the work environment; (f) the workplace is modeled off leadership on the work place culture; (g) how PSM is used to create safer environments; (h) the positive effects of the OSHA on reducing unnecessary exposure to hazards chemicals; and (i) legislation set by the EPA that has worked to clean the air, water, and environment. The specific research question that drove my evidence-based integrative review was “What effective strategies do chemical company managers use to reduce safety accidents?”

Conceptual Framework: Human Capital Theory

I used the human capital theory as a conceptual framework for my research project. Adam Smith first introduced the concept of human capital theory in 1776 (see

Gilead, 2013). The theory refers to people as disposable machines, with the goal to invest as few resources as possible, as labor division drives prosperity (Spengler, 1977). Smith viewed labor division as the separation of job types and classes, recommending that workers remain in those jobs with no opportunity to move out of them (Spengler, 1977). This perspective minimized leadership's role in developing employee competence and judgment, positioning workers as static inputs rather than individuals capable of growth and learning. By isolating workers to specific roles, their knowledge and experience would lead to greater productivity and efficiency (A. Smith, 2000). Although this approach improved output, it limited adaptability and constrained employees' ability to recognize, communicate, and respond to emerging risks. Even though everyone had a role, there was an imbalance in social class and its corresponding roles. With increased productivity and efficiency, the outcome favored the upper class over the working class (Tribe, 2022). In safety-critical industries, such structural imbalance reduces shared responsibility for hazard identification and places greater risk on frontline workers. This early adaptation of human capital theory transformed the Scottish lowlands as it integrated itself into the global economy (Watson, 2022). However, the lack of emphasis on workforce development and leadership accountability exposed limitations in applying this early framework to complex, high-risk organizational settings. Later, Jacob Mincer in 1958, Theodore Shultz in 1961, Gary Becker in 1962 and 1964, and Robert E. Lucas in 1988 redefined the human capital theory (Fleming, 2017).

The key tenet of human capital theory is that organizations should invest in their employees' physical, mental, and emotional well-being to foster a profitable, innovative

working culture (Cabrilo et al., 2014; Fleming, 2017). This principle shifts organizational responsibility toward leadership, emphasizing that managerial investment decisions directly influence workforce performance and safety behavior. Human capital theory suggests that there should be a “deliberate investment in education” and that the knowledge and skills gained contribute to the economy, job market, and personal productivity satisfaction (Little, 2003). Within safety-critical industries, such investments support employees’ ability to identify hazards, apply procedures correctly, and make informed decisions under risk. Employers utilize human capital theory to foster a culture of value and appreciation for their employees by investing time and resources in people, thereby enhancing the organization’s effectiveness and efficiency (Phillips & Phillips, 2014). From a safety leadership perspective, this investment reinforces accountability, trust, and shared ownership of safety outcomes. Human capital theory applies to my study because it focuses on the development and safety of an organization’s most valuable asset: its employees. This alignment is particularly relevant in chemical operations, where employee competence and judgment directly affect accident prevention.

Human capital theory is employed to identify inequalities (Doane, 2023) and to understand the motivations for pursuing higher education (Fénye & Mohácsi, 2020). These applications highlight how disparities in training and opportunity can influence employee preparedness and risk exposure. According to the human capital theory, education can be justified by projected job-placement benefits (Ridley, 2024). In organizational safety contexts, education also serves as a protective mechanism, reducing

uncertainty and unsafe behaviors. Under this theory, education increases critical thinking abilities, knowledge, understanding, and the ability to make informed decisions, resulting in higher wages (Dogeje et al., 2024). Human capital theory can be argued to be most effective when resources are invested not in adults but in school-age children (Griffen, 2024). However, this approach does not account for inequalities in factors such as school type and degree type within the United States (Ridley, 2024). From a safety leadership perspective, these limitations underscore the need for organizational training programs that address uneven educational backgrounds.

These disparities are not balanced when comparing certain regions, for example, Russia. Russia finds that students' academic achievement and circumstances follow the human capital theory (Prakhov, 2021). Such variation illustrates that workforce preparedness is context-dependent and cannot be assumed to be uniform across industries or regions. The human capital theory differs significantly from that of the Gulf Cooperation Council. This council is a political and economic alliance comprising six Middle Eastern countries that aim to develop a knowledge-based economy, thereby increasing the demand for workers with diversified job skills and a reduced focus on general labor (Abu-Shawish et al., 2021). These global differences underscore the importance of leadership-driven training strategies rather than reliance on preexisting employee competencies. The inequalities across regions must be taken into account when deriving an outcome from the human capital theory. In chemical organizations, failure to account for such disparities may result in inconsistent safety practices and increased accident risk. These considerations have been taken into consideration by scholars who

contributed to the evolution of the human capital theory. This progression supports the present study's focus on how managerial decisions shape workforce capability and safety performance within high-risk environments.

The Evolution of Human Capital Theory

Following the end of World War II, a redefinition of labor economics research began to emerge (Teixeira, 2011). This shift marked a growing recognition that productivity alone was insufficient without considering how leadership decisions shape workforce capability and risk management. At the forefront were Jacob Mincer, Theodore Schultz, and Gary Becker (Cornacchione & Daugherty, 2013). These scholars redirected attention from static labor roles to the long-term value of education, training, and experience, concepts central to safety leadership in complex organizations. In 1958, Jacob Mincer's PhD dissertation was published in the *Journal of Political Economy*, marking the first structured contribution to the human capital theory (Teixeira, 2011). Mincer's work provided a framework for quantifying returns on investment in people, a concept that parallels how organizations evaluate returns on safety training and prevention efforts. Mincer later developed the Mincer Earnings Function (Hartog & Gerritsen, 2016). The Mincer Earnings Function is a formula that directly correlates with a person's earnings (Schady, 2003). Beyond earnings, the function underscores how accumulated experience and education enhance judgment and decision-making, which are critical in hazard recognition and accident prevention. The Mincer Earnings Function states that an individual's wage rate is directly associated with the years of completed schooling, reflecting the rate of return on experience (Schady, 2003). In safety-critical

environments, this relationship underscores the value of continuous learning in reducing operational risk. The Earnings Function was written after Mincer's postdoctoral fellowship in 1957 and 1958 with Theodore Schultz (Teixeira, 2011).

Theodore Shultz played a crucial role in the development of human capital through his research program in economics (Holden & Biddle, 2017). Schultz emphasized leadership's responsibility for allocating resources to education and training rather than viewing labor as a fixed cost. Not only was Schultz a great encouragement to Mincer and Becker, but he also conducted his research to contribute to the field (Holden & Biddle, 2017). Although Smith's work set the foundation for human capital theory, Schultz's work introduced behaviors that were not traditionally studied in microeconomics (Dobbs et al., 2008). This expansion included attention to learning, adaptation, and decision-making, elements that directly influence safety performance. Schultz's work formalized the theory initially proposed by Smith (Dobbs et al., 2008). Schultz suggested that each person could be viewed as an asset, categorized alongside inanimate objects such as equipment, equity, and land (Fleming, 2017). In high-risk industries, this reframing elevates employee safety from a compliance obligation to a strategic investment. Before Schultz, the idea of education as an investment in human capital had not been introduced (Little, 2003). This shift is foundational to modern safety leadership, where training is viewed as a means of prevention rather than an expense. Schultz led the shaping of the new neoliberal subject, human capital theory, not only with Mincer but also with Gary Becker (Ridley, 2024).

Becker won a Nobel Prize in Economics in 1992 for his contributions to the concept of investing in education and its impact on an individual's development (Matache, 2023). Becker's work reinforced the managerial role in deliberately cultivating workforce capability rather than assuming it exists inherently. However, Schultz and Mincer developed the idea of human capital, which is on par with physical capital. Becker was responsible for the entire conceptual foundation of human capital theory (Coleman, 1993). By equating human and physical capital, Becker provided a theoretical justification for investing in safety systems that depend on human judgment and competence. Becker's work enabled economists and sociologists to estimate rates of return across various subgroups, including, but not limited to, men and women, high school graduates and college graduates, countries, and other types of training (Coleman, 1993). Such differentiation highlights how unequal access to training can translate into uneven safety performance across organizations. From Becker's work emerged another Chicago scholar, Robert Lucas.

Robert Lucas is known for advancing growth theory by applying human capital theory to explain how investing in human capital influences the inputs that drive profits (Uhlig, 2022). Lucas's contributions link human capital investment directly to organizational performance, reinforcing the business case for safety-focused leadership. Human capital contributes to an individual's financial earnings by enabling institutions to produce more with the same input (Lucas, 2015). In safety-critical operations, these inputs include employees' ability to follow procedures, respond to abnormal conditions, and prevent incidents. Productivity growth in industrialized nations' economies is

achieved through continuous cognitive progress, facilitated by the sustained flow of new ideas (Lucas, 2009). This perspective supports the present study by emphasizing that constant learning and leadership investment are essential to sustaining both safety outcomes and profitability in hazardous industries.

Business Problem Scholarship Evidence

The chemical industry is one of the most significant drivers of economic growth (Raghavan & Joshi, 2018). This economic importance places a heightened responsibility on organizational leaders to manage safety risks that could disrupt operations and harm stakeholders. The United States alone exported \$494 billion in chemicals (International Trade Administration, 2025), accounting for approximately 15% of all chemicals produced globally (Cybersecurity & Infrastructure Security Agency, 2019). Given this scale, safety failures extend beyond individual organizations and can influence national economic stability and supply chain reliability. More than 6 million jobs, direct and indirect, are due to the chemical industry (Cybersecurity & Infrastructure Security Agency, 2019). These employment figures underscore the need for managers to prioritize safety leadership to protect a workforce that is both economically and socially critical. The chemical industry, like any other, has a profound impact on everyday lives. Almost all of the commercial and household goods are produced by the chemical industry (Cybersecurity & Infrastructure Security Agency, 2019). Because of this ubiquity, safety incidents can have widespread consequences that reach far beyond facility boundaries. The foam that insulates refrigerators, the dashboards on vehicles, and even the grease that lubricates the gears in washing machines are just a few examples of how the chemical

industry supports everyday life. His dependence amplifies the importance of managerial strategies that prevent disruptions caused by safety accidents. Without the chemical industry's significant impact, the world would be completely different.

There are also significant risks associated with the chemical industry that includes financial losses, poor working environments, and even loss of life. These risks place safety leadership at the center of managerial responsibility, as leaders influence how hazards are anticipated and controlled. Chemical facilities often contain a high concentration of chemical hazards, including flammable materials, explosives, and toxic substances (An et al., 2021). Effective managerial oversight is essential to ensure that employees are equipped to manage these hazards safely. For example, if an explosion happened at a chemical park, it could create a domino effect (J. Wang et al., 2021). This interconnectedness heightens the need for consistent safety strategies across organizations and strong leadership coordination. Domino effects have the most substantial consequences for any process industry, including the chemical industry (Dueñas Santana et al., 2021). Preventing such cascading failures requires proactive risk management led by informed and engaged managers.

Within the chemical industry, scholars have identified gaps between companies' safety management systems and the results of major accidents (Lindhout et al., 2020). These gaps suggest that the presence of formal systems alone is insufficient without effective leadership implementation. The separation comes from faulty assessments of the chemical process and its severity (Lindhout et al., 2020). Inaccurate risk assessment often reflects deficiencies in training, communication, or managerial decision-making.

These flawed assessments leave hazards unresolved, threatening workers' safety and endangering the environment and company operations (Lindhout et al., 2020). When leaders fail to address these shortcomings, organizations become more susceptible to preventable accidents. Another concern for scholars is the frequency of accidents that continue to pose harsh threats to people's lives (Yang et al., 2022). The persistence of these events indicates that managers must move beyond compliance-based approaches toward proactive safety leadership. These harsh threats contribute to deaths, injuries, and billions in lost time and resources. Such losses directly affect organizational profitability and reinforce the business case for investing in effective safety strategies. There remains a significant concern about accidents in chemical companies, particularly concerning the implementation of procedures, effective communication, training, and maintenance (Gonyora & Ventura-Medina, 2024). These factors fall squarely within managerial control and align closely with the focus of the present study. Due to the lack of specific processes and procedures, chemical companies incur financial losses and bear the burden of loss of life. This evidence supports the need to examine how managers develop, implement, and sustain strategies that reduce safety accidents in chemical organizations.

Life and Financial Loss

Chemical companies produce and transport billions of tons of hazardous materials annually, with an increasing rate of accidents (Ma et al., 2023). This scale of operation intensifies the consequences of managerial decisions related to safety oversight and risk control. Between 1974 and 2001, eight major chemical industry accidents resulted in over 18,000 deaths, 505,000 injuries, and billions of dollars in damages to facilities, natural

resources, wildlife, and long-term adverse health defects affecting workers and civilians across Europe and Asia (Versluis et al., 2010). These outcomes illustrate how insufficient safety leadership can translate into catastrophic human and financial losses. An explosion at a chemical storage facility in Toulouse, France, resulted in an event equivalent to 40 tons of trinitrotoluene (TNT), leaving a crater greater than 80,000 cubic feet and measuring 3.4 on the Richter Scale (Dechy et al., 2004). The magnitude of this incident highlights the need for managers to anticipate worst-case scenarios rather than rely solely on routine controls. The explosion left 30 individuals dead, 2,242 treated for physical injuries, and 5079 people treated for behavioral health (Dechy et al., 2004). Beyond immediate casualties, such events create long-term psychological and social consequences that extend organizational responsibility beyond the workplace. In 2019, an explosion at a chemical facility in Taiwan resulted in a loss of \$3.5 billion and an 18-month shutdown (Liaw et al., 2023). These financial impacts demonstrate how safety failures directly threaten organizational viability and long-term profitability.

Safety is a persistent issue affecting chemical companies. They have accepted it into their culture. Normalizing risk within organizational culture can weaken leadership urgency and reduce proactive intervention. Even when making acquisitions or mergers, they inherit each other's unsafe working environments and all the repercussions that accompany them. This transfer of risk underscores the importance of leadership due diligence and safety integration during organizational change. For example, when DuPont initiated a strategic joint venture with Arabian Chemical Company, it also assumed \$947 million in asbestos-related liabilities, including future defense and processing costs

(MarketLine, 2024). Such inherited liabilities highlight how inadequate historical safety practices can impose substantial financial burdens on future leadership.

Work Environment

Accidents and losses, both physical and financial, also expand into office areas and positions that require repetitive movements. In Germany alone, over \$25 billion was attributed to workplace accidents and injuries (Holzwarth et al., 2025). These figures demonstrate that safety leadership must extend beyond production floors to encompass all work environments under managerial oversight. The general handling and storage of chemicals can create an unsafe environment. Managers play a critical role in ensuring that handling procedures, storage controls, and employee training are consistently applied to mitigate these risks. MI Services, a chemical supplier to drilling rigs, carries 59 chemicals. Of the 59 chemicals, eight were lethal if swallowed, three were lethal if inhaled, and 45 were flammable, creating toxic and high-risk working conditions (Astani et al., 2024). Such exposure profiles require managers to prioritize hazard communication, training, and engineering controls to prevent accidental exposure.

The manufacturing of fluoropolymers involves substances such as perfluoroalkyl and polyfluoroalkyl, which have been reclassified from possible carcinogens to confirmed carcinogens in humans (Consonni & Fustinoni, 2024). This reclassification highlights the need for leaders to adapt safety practices as scientific knowledge evolves. One of the fluoropolymers is polytetrafluoroethylene. Polytetrafluoroethylene is found on cookware and waterproof clothing, which, if mishandled, would cause cancers in some vital organs, such as the liver, and endocrine disruption (Consonni & Fustinoni, 2024).

Managers must ensure that employees understand both immediate and long-term health risks associated with such materials. There has also been a correlation between accidents and the presence of contractors handling hazardous materials due to insufficient training and experience (Shin, 2021). This finding underscores leadership responsibility for enforcing consistent safety standards across employees and contractors alike. Most training occurs in a classroom or through a series of videos, and trainees typically lose attention quickly (Chan et al., 2023). Without effective engagement strategies, leadership-led training efforts may fail to translate into safe work behaviors. Without effective engagement strategies, leadership-led training efforts may fail to translate into safe work behaviors.

Leadership

Leadership plays a crucial role in any organization, particularly in creating a safe and inclusive climate. This role is especially critical in high-risk industries, where leadership behavior directly shapes how employees interpret and enact safety priorities. A safety climate is the essential connection between leadership and the perceived seriousness of policies, procedures, health, and workplace safety (Lee et al., 2023). When leaders demonstrate consistency between stated policies and daily actions, employees are more likely to internalize safety expectations. When organizations prioritize production over safety, they create a culture in which workers exhibit risky behaviors rather than fostering a safety-first climate (Lee et al., 2023). Such trade-offs often originate from managerial decisions that undervalue long-term risk prevention in favor of short-term productivity. The perceived shift away from a strong safety climate has a detrimental

effect on workplace safety (Lee et al., 2023). This decline reinforces the importance of leadership visibility and accountability in sustaining safety norms. A railroad company's 2021 annual report mentions the word safety 40 times but never establishes a commitment or environment that fosters a safety climate (Craig & Amernic, 2023). This example illustrates how symbolic leadership without actionable commitment fails to influence employee behavior.

Workers' behaviors are directly influenced by the safety climate established by leadership (Taha et al., 2025). Employees look to leaders for cues regarding acceptable risk-taking and compliance with procedures. Without a collective commitment to a strong safety culture, companies and workers will be unable to effectively identify and anticipate safety concerns in their working environment (Mezentseva et al., 2023). Leadership alignment across organizational levels is therefore essential to proactive hazard recognition. Inconsistent leadership signals can undermine training efforts and weaken employee confidence in reporting hazards. Such breakdowns increase the likelihood that unaddressed risks will escalate into safety accidents.

Business Topic Scholarship

Daily interactions with chemicals, dangerous or not, allow people to maintain their lives (Dobor, 2017). Many societal advancements, such as rubber for tires, insecticides for plants and vegetation, and corrosion inhibitors for alloys, are products of the chemical industry (Dobor, 2017). Many of the chemicals encountered daily are dangerous (Dobor, 2017). Accidents are unavoidable; however, chemical companies

recognize the importance of preventing and mitigating serious risks and losses through PSM, as well as government regulations and legislation (Kwon, 2006).

PSM

Chemical companies are committed to protecting their employees, the environment, and the surrounding areas from major chemical releases, as well as fires and explosions (Kwon, 2006; Stephens, 2009). This commitment requires leadership to move beyond stated intent and translate safety goals into structured systems and enforceable practices. Protecting these areas not only reduces chemical exposures and releases but also reduces the amount of time the business is slowed or stopped (Stephens, 2009). From a managerial perspective, PSM functions as both a safety control and a business continuity strategy. Following an industrial chemical release, a prompt response can significantly reduce the risk of injuries, fatalities, and environmental damage (Cintora-Sanz et al., 2023). Leadership preparedness and decision-making speed are critical factors in the effectiveness of emergency response efforts. PSM is the primary strategy that organization leaders use to identify potential hazards and weaknesses to address, thereby containing hazardous materials and energy within the process design (Amyotte & Lupien, 2017). This positions PSM as a leadership-driven framework rather than a purely technical or compliance-based program.

Researchers have conducted considerable work to minimize safety accidents. PSM is used globally to prevent accidents (Cheraghi & Khodadadi-Karimvand, 2023). The widespread adoption of PSM reflects recognition that systematic hazard control must be supported by consistent managerial oversight. PSM, specifically in the chemical

industry, involves planning for accident response by identifying limits and making changes to, or establishing, processes that incorporate these limits to ensure safe work practices (Mattox et al., 2023). Such planning depends on the leadership's willingness to invest resources and enforce procedural discipline. To effectively implement PSM systems, key performance indicators have to be identified (Cheraghi & Khodadadi-Karimvand, 2023). Managers play a central role in selecting, monitoring, and acting on these indicators to prevent safety drift. Process safety has successfully reduced the total number of accidents and their severity over the past 30 years (Behie et al., 2020). These reductions support the argument that proactive, leadership-led systems can produce measurable safety improvements.

Auditors use drones for plant inspections, including thermographic and ultrasonic thickness measurements of smokestacks, tanks, and piping (Pinninti & Pinninti, 2023). The adoption of such technologies reflects leadership commitment to reducing employee exposure while improving hazard detection. Not only do drones survey vulnerable points, but they also eliminate the risk of falls or exposure to hazardous conditions for employees or contractors (Pinninti & Pinninti, 2023). These tools demonstrate how managerial investment in innovation can directly reduce safety risk. Virtual reality games enhance PSM evaluations for implementation by simulating scenarios under presumed working conditions (Sofri et al., 2025). Scenario-based simulations strengthen employee decision-making by allowing leaders to reinforce safe responses before real-world exposure. The improvement and growth of PSM stem from the advancement and refinement of operational practices and industry performance (Dagen & Nazaruk, 2017). Continuous

improvement in PSM depends on the leadership's willingness to learn from incidents and adapt controls accordingly.

Artificial intelligence has evolved rapidly and is used by companies to assess the risk associated with the processes (Balasubramanian et al., 2024). These tools support of managerial decision-making by providing data-driven insights into emerging hazards. Other ways PSM systems are expanding across the chemical industry include scheduled preventive maintenance, routine inspections and testing, visual inspections before use, and predictive maintenance (Olsen & Lewis, 2023). Such practices require consistent leadership enforcement to remain effective over time. To ensure that chemical companies employ safe practices, OSHA and the EPA are involved (Drennen & Dancey, 2023). Regulatory oversight reinforces, but does not replace, the need for internal leadership accountability in safety management.

OSHA

OSHA understands that there are gaps in safety knowledge, hazard identification, and the enforcement of corrective actions to protect employees. OSHA, regarding this research project, operates under the premise of identifying the root cause of safety-related incidents and providing public information to aid in preventing the recurrence of such incidents or related incidents. OSHA was created in 1970 to protect employees from hazardous chemicals and their waste (Earn, 2022). The establishment of OSHA marked a formal recognition that employee safety requires structured oversight and accountability beyond individual organizational practices. The mission of OSHA is to set and enforce standards, as well as provide anti-retaliation provisions, programs, training, outreach, and

assistance to support a safe and healthy environment for employees (OSHA, 2025). These functions place responsibility on organizational leaders to translate regulatory expectations into daily operational practices. The creation of OSHA has had a considerable impact on workplace safety (OSHA Online Center, 2023). This impact reflects the influence of external regulation on managerial priorities for hazard control. OSHA is responsible for labeling requirements, handling instructions, safety data sheet requirements, personal protective equipment mandates, and limits of exposure for handling chemicals (OSHA, n.d.-a, n.d.-b, 2025). Compliance with these requirements depends on leadership commitment to training, enforcement, and resource allocation. OSHA has established rules and regulations that limit chemical exposure (Reis et al., 2024). These limits provide a baseline, but effective safety outcomes require managers to exceed minimum compliance standards.

Since OSHA was established, there has been a significant reduction in deaths and injuries in the United States (Tupper & Swift, 2022). These reductions demonstrate the value of structured safety systems when supported by organizational leadership. In 1970, there were 38 work-related deaths on average every day, with 10.9 incidents per 100 workers (OSHA, 2023). As of 2023, these statistics have decreased to an average of 15 deaths per day and 2.4 per 100 incidents (OSHA, 2023). While these improvements are substantial, the persistence of incidents indicates that regulatory compliance alone does not eliminate workplace risk. OSHA has implemented the severe injury reporting program to better understand and identify trends, thereby reducing the vulnerability of processes (Alsharif et al., 2023). This program provides managers with data that can

inform proactive safety decision-making. By evaluating trends and reviews, companies can improve their health and safety processes (Al-Bayati et al., 2021). Leadership engagement is necessary to ensure these insights lead to corrective action.

As OSHA focuses on the employees' safety and security, the EPA monitors the environment (Smith, 2013). This division of oversight highlights the need for managers to balance worker protection with environmental responsibility. The OSHA and the EPA are collaborating to share information on areas of focus and mutual interest (Professional Safety, 2025). Such collaboration reinforces the expectation that organizational leaders integrate regulatory guidance into comprehensive safety strategies rather than treating requirements in isolation.

EPA

The EPA is an agency that works concurrently with OSHA. The EPA is relevant to the purpose of this research project because its regulatory requirements shape the safety strategies chemical company managers use to prevent accidents that can harm employees, the environment, and organizational performance. The EPA conducts assessments using epidemiologic and toxicologic studies (Shaffer et al., 2025). These assessments provide leaders with evidence-based insight into how chemical exposures affect both workers and surrounding communities. The EPA's exposure research focuses primarily on environmental health and how people are affected by environmental pollution (Stanek et al., 2025). For chemical company managers, this research informs decisions related to emission controls, process design, and long-term risk mitigation. Ninety days before conducting an audit, the EPA collects data from a monitoring site

focusing on airborne chemical products and byproducts (Chen et al., 2025). This advanced monitoring places responsibility on leadership to identify and correct deficiencies before regulatory intervention occurs proactively.

Organizations that experience major EPA violations typically remove their chief executive officer from duty, as it is their responsibility to set the company's environmental strategies (Lel, 2025). This consequence underscores how environmental safety outcomes are directly tied to executive leadership accountability. The EPA is constantly monitoring air quality in various situations that can negatively affect our health, such as buses with high levels of diesel exhaust (Adar et al., 2024). Continuous monitoring reinforces the expectation that managers remain vigilant in identifying environmental hazards associated with chemical operations. Air pollution, being one of the largest ecological topics (Underwood et al., 2024), is also a focus of the organization, along with bed bugs, cancer, chemicals, toxic and pesticide exposure, emergency response, health, land waste and cleanup, lead, mold, and radon (US EPA, 2025g). This broad scope highlights the interconnected nature of environmental protection and workplace safety.

There is substantial evidence of improvements to the environment since the EPA was created. Since its creation in 1970, the EPA has implemented policies that have resulted in 99 percent cleaner cars, SUVs, and pickup trucks (US EPA, 2025b). These outcomes demonstrate how sustained regulatory leadership can drive long-term risk reduction. Heavy-duty trucks are 99 percent cleaner than they were in 1970 (US EPA, 2025b). Although lead in gasoline was prohibited entirely after 1995, air lead levels

decreased by 94 percent between 1980 and 1990 (US EPA, 2025b). Such improvements reflect the effectiveness of combining regulatory enforcement with organizational compliance. Ultimately, it drastically lowered the amount of lead in our blood (US EPA, 2025b). From a managerial perspective, these gains illustrate the measurable public health benefits of preventive action. From 1990 to 2025, factories are expected to emit 1.5 million tons less toxic pollution (US EPA, 2025f). These reductions emphasize the importance of leadership-driven environmental controls within chemical organizations. Over \$20 billion has been spent on the water infrastructure of states, territories, and tribes, with 500,000 lead pipes replaced, benefiting more than 1.2 million people (US EPA, 2025e). Such investments highlight how environmental safety initiatives contribute to broader social and economic stability. Although the EPA was established in 1970, it was not until the Carter administration that the first environmental law, the Comprehensive Environmental Response, Compensation, and Liability Act, was signed, granting the EPA the authority to clean up hazardous waste sites and spills (US EPA, 2024c). This authority reinforces the expectation that organizational leaders proactively manage environmental risks to avoid severe legal and financial consequences.

Legislation

Legislation is defined as rules established by official authorities that can be enforced (Merriam-Webster, 2025). In safety-critical industries, enforceable legislation establishes minimum expectations while signaling the level of risk society is willing to tolerate. The creation of the EPA gave the United States a government agency to develop legislative policies to combat and mitigate the adverse effects of chemicals released into

the environment. This development formalized leadership accountability by linking organizational actions to legal and environmental consequences. The EPA created policies and acts that set enforceable guidelines for cleaner air, protecting wildlife and aquatic life, drinking water, and food. These guidelines require managers to integrate environmental protection into operational and safety decision-making. The first step to providing regulatory protection was the Clean Air Act of 1960

The Clean Air Act of 1970. In 1970, the EPA launched its campaign for a cleaner living environment. The Clean Air Act (CAA) was introduced in 1970 as the Air Pollution Control Act of 1970 (US EPA, 2024a). The act underwent name changes, including the Clean Air Act of 1963 and the Air Quality Act of 1967, before settling on the CAA of 1970, which is currently used today (US EPA, 2024a). As part of environmental regulations, the CAA was enacted to protect human and environmental health from the effects of air pollution (Carr & Yan, 2025). For chemical company managers, this act underscores the obligation to control emissions that can result from process failures and safety accidents. The EPA developed National Ambient Air Quality Standards and state implementation plans (US EPA, 2025d). These standards require leadership coordination across operations to ensure compliance and prevent environmental harm. The subsequent revisions, 1977 and 1990, were amendments to establish new goals and target dates (US EPA, 2025d). The evolving nature of the act underscores the need for managers to adapt safety and environmental strategies as regulations change. The focus and commitment to air quality have had significant success. Having to revise the CAA multiple times highlights the considerable impact of

air quality on sustaining life. After making successful strides, the EPA turned its attention to cleaner water.

The Clean Water Act of 1972. Our water is what sustains life, humans and animals alike. Water is an essential part of healthy living. The Clean Water Act of 1972 was enacted to address growing concerns about the environment and the country's waters (Holst, 2025). It stated that no one could dump any pollutant without an approved permit (Wu, 2025). This requirement places responsibility on managers to prevent unauthorized releases caused by operational failures or accidents. The act's goal is to restore and maintain the country's water by safeguarding its chemical, physical, and biological integrity. For chemical organizations, this goal aligns environmental stewardship with accident prevention strategies. The act was extended to cover the ocean with the Ocean Dumping Act. The Ocean Dumping Act prohibited the disposal of materials into the sea that would degrade or endanger human or aquatic life and conditions (US EPA, 2025c). These provisions reinforce leadership accountability for waste handling and disposal practices. Because chemical companies use United States waterways, including the ocean, as hazardous-waste disposal sites, land, aquatic, and marine life would be better protected. The Clean Water Act was quickly followed by the Safe Drinking Water Act, which would improve the health and lives of people as well.

Safe Drinking Water Act. Maintaining safe drinking water is essential to our well-being. Protecting the waters was a primary concern, and the need for policing was warranted. The Safe Drinking Water Act protected the public from aquifers that sourced drinking water from waste streams (Job, 2024). Managers must therefore ensure that

chemical handling and storage practices do not compromise water sources. From 1974 to the present day, the EPA has continued to initiate actions under the Safe Drinking Water Act, focusing on reducing lead exposure and decreasing health-based violations in drinking water (Tenpas et al., 2023). This sustained effort highlights the importance of preventive leadership rather than reactive correction. The health-based violations mentioned could result from intentional or accidental dumping of hazardous substances. Accidental releases, in particular, link water safety directly to workplace safety and process control. Through constant monitoring and policies, this act has helped reduce lead and other contaminants in drinking water. Drinking water is not the only outside resource we bring into our homes. The chemical makeup of commercial items also carries the opportunity for exposure to hazardous materials.

Toxic Substances Control Act (TSCA). With the chemical industry being a crucial part of our everyday lives, innovation and creation have made our routines easier and more enjoyable. Without proper checks and balances, daily routines could introduce hazardous chemicals. The Toxic Substances Control Act was enacted in 1976 to prevent the commercial use of dangerous substances before they are tested for safety (Young, 2025). This act emphasizes the managerial role in ensuring that materials are evaluated before integration into processes. Later in 2016, TSCA underwent a significant overhaul, mandating that the EPA conduct risk evaluations of chemicals used in commerce (McPartland et al., 2022). These evaluations require organizations to adapt safety practices as new risks are identified. TSCA also gives the EPA the authority to oversee manufacturing, domestic or imported, distribution, use, and disposal (Schlea & Wilkes,

2021). Such oversight reinforces leadership responsibility across the full chemical lifecycle. TSCA is a significant part of keeping the products we use safe. TSCA requires that all products be evaluated to improve our safety and reduce exposure to chemicals that could cause health complications or death. The process of creating products can generate hazardous waste that should be disposed of properly. One of the most dangerous by-products is nuclear waste.

Nuclear Waste Policy Act. Having waste is inevitable and cannot be avoided. How we dispose of waste can harm the environment and impact life. Nuclear waste is one of the most toxic waste streams and requires special consideration when disposing of it. Enacted in 1982, the Nuclear Waste Policy Act established a systematic approach to safely and permanently disposing of nuclear waste (Schoonover, 2025). This act illustrates how high-risk materials demand rigorous leadership oversight and long-term planning. The act tasked the Department of Energy with facilitating integrated waste management systems (Uribe et al., 2024). Integrated systems reduce reliance on individual judgment and strengthen organizational safety controls. The act created policies to protect the community, the environment, and employees from hazardous living and working conditions. Nuclear energy and waste are not common topics of discussion. That topic could lead to questions that challenge the EPA and its motives. To alleviate any concern, the Fishbowl Policy was introduced.

Fishbowl Policy. Transparency in policy-making, decision-making, and implementation could build trust. The EPA wanted to establish trust for support of its decisions. Thus, the Fishbowl policy was created. The Fishbowl Policy was introduced in

1983 to improve the availability and transparency of the EPA (US EPA, 2016b).

Transparency encourages organizational leaders to align safety practices with public accountability. The goal is to communicate with all environmentalists and citizens that the decisions directly affect (US EPA, 2016b). Such openness reinforces trust in safety and environmental governance. Giving citizens a sense of the policies not only made them aware of issues they may face but also of how the matters were being handled in a systematic and controlled way. Many of the preceding policies can be viewed as solutions to problems or as corrective actions after exposure. The Pollution Prevention Act was enacted to prevent hazardous situations before accidents or chemical releases.

Pollution Prevention Act. The EPA made noticeable changes and progress in cleaning up the environment, air, water, and living and working conditions. However, accidents happen and provide valuable lessons to avoid potentially making the same mistake. Following an 11-million-gallon crude oil spill, President George Bush signed the Pollution Prevention Act of 1990 (US EPA, 2024b). This act shifted leadership's focus to preventing hazards at the source rather than responding after damage occurs. The Pollution Protection Act, in summary, states that pollution must be stopped at the source (US EPA, 2024b). If this is not possible, it should be recycled; if not, it should be treated (US EPA, 2024b). If it cannot be treated, it should be destroyed in an environmentally safe manner and whenever feasible (US EPA, 2024b). This principle parallels proactive safety management approaches in chemical operations. The Pollution Prevention Act created a positive, efficient way to reduce costs and potential hazardous environments

and waste. With regulations and policies supporting a push for a better overall environment, President Clinton wanted to extend the exact expectations to food.

Food Quality Protection Act. With the rising population, a need for more sophisticated ways of feeding the masses. The increased demand could lead to unsafe conditions for employees and consumers due to unhygienic practices and contamination. In 1994, President Bill Clinton signed the Food Quality Protection Act (US EPA, 2016a). The Act not only strengthened the standards but also provided the EPA and the Food and Drug Administration with tools to enhance protection for the public and the environment (US EPA, 2016a). For chemical organizations involved in food-related processes, leadership must ensure that safety controls protect both consumers and workers. The Food Quality Protection Act was enacted to reduce foodborne allergens and chemical contamination at the farm, production, and consumer levels. This reinforces the connection between chemical safety management and public trust.

Conclusion

The evidence-based integrative review found that safety accidents continue to pose a significant challenge within the chemical industry, despite advances in regulation, technology, and safety management systems. Previous researchers consistently indicate that accidents are not solely the result of technical failures but are strongly influenced by managerial decisions, leadership behaviors, and the effectiveness of organizational safety practices. These findings reinforce the need to examine how chemical company managers develop and apply strategies to reduce safety accidents.

The reviewed scholarship demonstrated that the chemical industry plays a critical role in economic stability and daily life, while simultaneously presenting substantial risks to employees, communities, and the environment. Historical and contemporary evidence showed that safety accidents have resulted in loss of life, long-term health impacts, environmental damage, and significant financial losses. These outcomes highlighted the limitations of reactive and compliance-focused approaches and emphasized the importance of prevention-oriented safety strategies.

Previous researchers further showed that unsafe conditions are not confined to production environments but extend to contractors, support roles, and long-term exposure scenarios. Ineffective training methods, inconsistent communication, and insufficient oversight were repeatedly identified as contributors to elevated risk. Leadership research emphasizes that managerial priorities and behaviors shape safety climate; inconsistent leadership weakens hazard recognition and reporting, while visible, engaged leadership supports safer work practices.

PSM emerged as a foundational framework for controlling hazards and reducing accident severity. Previous researchers emphasized that the effectiveness of process safety systems depends on leadership commitment, continuous evaluation, and integration into daily operations. Regulatory oversight by OSHA and the EPA provided necessary standards and enforcement mechanisms; however, previous researchers indicated that regulatory compliance alone is insufficient without strong internal leadership and workforce engagement. Legislative actions addressing environmental and

public health risks further reinforced managerial accountability across the chemical lifecycle.

Human capital theory provided an appropriate conceptual framework for interpreting these findings. Previous researchers reflected an evolution from viewing labor as a fixed input to recognizing employees as organizational assets whose knowledge, skills, and decision-making capacity influence safety outcomes. Investment in training, communication, and employee involvement was consistently associated with improved safety performance. This framework aligned with the study's purpose by supporting an examination of how managerial strategies influence safety behaviors and accident reduction.

Overall, the evidence-based integrative review demonstrated that reducing safety accidents in the chemical industry requires leadership-driven strategies that integrate workforce development, proactive safety systems, and regulatory awareness.

Summary

Section 1 established the foundation for this research project by defining the persistent problem of safety accidents in the chemical industry, identifying the research project's purpose, and grounding it in relevant scholarly literature and human capital theory. Despite regulatory oversight and technological advancements, chemical companies continue to present significant risks due to hazardous materials, complex processes, and evolving regulatory demands, resulting in injuries, environmental harm, and financial losses. The purpose of this research project was to explore strategies used by chemical company managers to reduce safety accidents, focusing on managers with

demonstrated success, and recognizing the role of leadership, employee development, and organizational systems in accident prevention. The evidence-based integrative review showed that while the chemical industry is vital to the economic stability and daily life, gaps remain between formal safety systems and actual outcomes, particularly when leadership implementation is ineffective. The reviewed literature highlighted the human and financial consequences of chemical accidents, the extension of safety risks across the work environment, and the influence of leadership behaviors on safety climate. Process safety management and regulatory oversight by OSHA and the EPA were identified as an essential framework, with effectiveness dependent on how managers integrate these requirements into practice. Human capital theory provided the conceptual framework, emphasizing leadership investment in employee knowledge and skills as central to improving safety performance. Collectively, section 1 justified the significance of the business problem and provided the scholarly and theoretical foundation for this research project.

Section 2: Primary and Secondary Industry Data Analysis

Nature of the Project

Method and Design

Qualitative, quantitative, and mixed-methods research methodologies comprise the three research methodologies (Almalki, 2016). Quantitative studies employ correlation and causality to identify and isolate variables through quantifiable measurements (McCusker & Gunaydin, 2015; Park & Park, 2016). Quantitative studies also use questionnaires as data-collection tools to generate numerical data for hypothesis testing (Oltean & Gabor, 2016). Qualitative study data are collected through interviews, observations, and or recorded audio (Ingham-Broomfield, 2016; Tsai et al., 2016). The qualitative research method can also be used to gain clarity from interview participants' perspectives (Fassinger & Morrow, 2013). Mixed methods research is a combination of quantitative and qualitative methods (Venkatesh et al., 2013). Mixed-methods research can favor quantitative approaches over qualitative ones, but it still incorporates hypotheses, numerical data, and interviews (Lund, 2012). The mixed method approach combines the strengths of both quantitative and qualitative methods (Makrakis & Kostoulas-Makrakis, 2016).

The research method used in my study was qualitative. Qualitative research is most appropriate when quantitative methods are not suitable for sharing individuals' experiences or for understanding the research topic's setting (Colorafi & Evans, 2016). I used the qualitative method to gather information from real people in their natural settings (Eyisi, 2016). Using this method, researchers collect the how-and-why data that

quantitative methods cannot, because it draws on a central phenomenon (Yates & Leggett, 2016).

A qualitative method was most suitable for this project because I aimed to explore the strategies chemical company managers use to reduce safety accidents, rather than to measure accident frequency or test predetermined variables. The qualitative approach enabled an in-depth examination of managerial experiences, decision-making processes, and contextual factors that shape the development and implementation of safety strategies in real-world chemical operations.

A researcher employs the pragmatic inquiry design to address real-world issues by offering actionable solutions (Kelly & Cordeiro, 2020). When using a pragmatic inquiry approach to research, the researcher focuses on information that directly addresses or helps solve real-world problems and creates change (Kaushik & Walsh, 2019). Researchers using pragmatic inquiry collect detailed information from participants' experiences and lives (Unicomb et al., 2015). The pragmatic inquiry design provides real-time usefulness in specific situations and contexts (Allemang et al., 2022). In my pragmatic inquiry study, I aimed to identify the strategies managers use to mitigate safety accidents in the chemical industry. To identify these strategies, I conducted interviews with managers from various chemical companies.

Safety management in the chemical industry is shaped by organizational culture, leadership priorities, and workforce engagement, all of which are best understood through participants' perspectives. A qualitative method provided the flexibility to probe complex issues such as training effectiveness, communication practices, and barrier

mitigation, while allowing participants to describe their experiences in their own words. This approach aligned with the pragmatic inquiry design and supported the study's goal of producing actionable, practice-oriented findings relevant to chemical company managers. For these reasons, the pragmatic inquiry design was the most suitable approach for my study.

Other designs I considered for this study included phenomenological, ethnographic, narrative, and case studies. Researchers use phenomenological studies to identify commonalities between participants through their personal feelings about a shared phenomenon and lived experiences (Akin et al., 2016; Mjørud et al., 2017). Researchers also use phenomenological studies to gain a more in-depth understanding of interviewees' day-to-day experiences related to a single research topic (Gearity, 2012). My study did not focus on the interviewees' personal feelings, so the phenomenological approach was not appropriate. In an ethnographic study, the researcher collects data by working or living in the field (Crampton, 2015; Jones et al., 2013). When used by researchers, data collected through an ethnographic study is derived from the researcher's immersion in the field environment (Everett & Johnston, 2012). Due to the time commitment, safety concerns, and the sensitive nature of private information within chemical companies, an ethnographic study was not a suitable fit for my research. Narrative studies enable the interviewee to express their personal feelings to the researcher for data collection, but may or may not reveal a common theme (Treloar et al., 2015). Researchers will also employ a narrative study to uncover meaning from the situation that the interviewee has personally experienced through the stories they share

(Nan et al., 2017; O'Shaughnessy et al., 2013). The narrative is not suitable for my study because the collected data documents the effectiveness of implemented safety strategies rather than collecting personal feelings and stories.

Reliability

I enhanced the reliability of my study by providing a summary of participants' interviews for member checking. The transcription and summarization of the interviews provided consistency in the data analysis. I demonstrated reliability through the consistency and repeatability of the data collected (Grossoehme, 2014; Savage & McIntosh, 2017). Repeatability measures the same data collected by the researcher using the same tools at different times (Grossoehme, 2014; Savage & McIntosh, 2017). I assessed the data for accuracy and reliability. The data collection process accurately represented the interviewees' responses (Noble & Smith, 2015). I provided consistency in the data analysis process through member checking. Member checking was satisfied by providing participants with a summary of their responses for confirmation that their responses were received and understood correctly.

After summarizing the data, presenting it to the participants, and making any necessary corrections, I included the data in my research project. The process of gathering data, member checking, and making findings public is called methodological triangulation (Dwayi, 2024). Methodological triangulation improves the credibility and depth of the data collection process (Donkoh, 2023). Methodological triangulation also validates the results of the study to make a sound summarization and explanation of the data collected (Bans-Akutey & Tiimub, 2021).

Population, Sampling, and Participants

In my research project, I used a purposeful sampling method. Purposeful sampling is a nonprobability method that covers a specific area or category (Robinson, 2014; Uprichard, 2013). I used purposeful sampling to shape the data collection process. The shaping of the data collection process is vital to the researcher because it ensures that the selected participants possess the necessary qualifications. The publicly available documents were used as an additional source of data on the strategies chemical managers use to reduce safety incidents.

There was one interview with six individual participants, conducted individually to reach data saturation. Data saturation occurs when no new themes remain for the researcher to gather (Hagaman & Wutich, 2017), and the researcher no longer collects new concepts (Francis et al., 2010). Qualitative studies often involve small numbers of interviewees (Shorten & Moorley, 2014). Small numbers of interviewees with a clearly defined research focus yield highly relevant data (Cleary et al., 2014). In this study, data quality was strengthened through purposive sampling to identify participants with appropriate experience, consistent with methodological guidance emphasizing the importance of participant expertise in qualitative inquiry (Reybold et al., 2013).

Participants were managers who had successfully reduced accidents in the chemical industry and had at least 5 years of experience. The managers considered for the interview were asked if they had successfully reduced accidents in the chemical industry to determine initial eligibility. Managers were selected as the target population because they are responsible for implementing safety procedures within their organizations

(Utikal & Woth, 2015). Managers have the technical capacity to implement strategies to reduce workplace accidents within their organizations (McCord & Heim, 2015). Managers shape an organization's culture and convey the importance of change to their employees (Kim & Yoon, 2015). I interviewed managers who had successfully implemented effective strategies.

Gaining access to participants was not easy. The first step to recruiting was gathering knowledge and understanding of the organization (Habibi et al., 2015). To identify managers who have implemented effective strategies within their chemical companies, I used search engines and professional social media outlets, such as Google and LinkedIn, to find qualified candidates.

Once the participants had agreed to participate in the interview, a relationship was formed between the interviewees and me. The initial ice-breaking step involved sending consent forms via email to the managers, introducing the instructions, structure, and purpose (Kilanowski, 2012). Next, I established multiple communication methods and identified the most comfortable mode for the interviewee (Kaba & Beran, 2014). Effectively communicating with interviewees was a crucial tool in conducting interviews (Augustine et al., 2016). I sent updates and reminders of the interview via email, along with background information on the researcher, confidentiality agreements, and the option to withdraw from the study at any point to maintain confidentiality and professionalism. I used these procedures to build trust and maintain professionalism by being transparent and informative with the participants. The time commitment was no longer than 30 minutes.

Data Collection Activities

I used a combination of semistructured interviews and publicly available documents for my data collection. I also used a pre-written question protocol with an option to ask follow-up questions if clarity was needed (Appendix B). I used an interview protocol to ensure that the questions were open-ended and to clarify the key topics to the interviewee (DeJonckheere & Vaughn, 2019). Microsoft Teams was used to record and transcribe the participants' interviews. The camera option was unavailable for security reasons. I enhanced the validity and quality of my study by providing participants with summaries of their answers for confirmation. The technique, as mentioned earlier, is called member checking. Member checking is recognized as a technique that enhances the quality and credibility of qualitative research by confirming the accuracy of participants' responses (Pierce, 2012; Twinn, 1998), which is why I used it in my study.

The overall data collection process involved several steps and incorporated procedures to ensure responses were captured correctly, reviewed, and published while maintaining well-documented, ethical research practices. First, I searched for chemical companies and reviewed publicly released documents that demonstrate a record of reducing safety incidents. Second, I contacted managers by emailing them a consent form, included in the body of the email, and asked them to respond with the words "I consent." After receiving consent, I scheduled a time that worked best for the interviewee. The interview was conducted and transcribed using Microsoft Teams. I then summarized the interviewees' answers and performed member checking by providing them with a copy of the summary. The interviewee made any necessary changes and

returned them to me, confirming whether any changes were required. After the summaries were reviewed, the data were analyzed, and the results were included in my final project.

Data Organization and Analysis Techniques

I used a pre-written protocol of questions (see Appendix B), with the option to ask follow-up questions when clarity was needed, to ensure that my qualitative pragmatic inquiry accurately captured the interviewees' responses for theme identification. Identifying themes or patterns in qualitative study interviews is one of the most effective ways of interpreting data (Aulgur, 2016; Toye et al., 2016). After the interview, I reviewed the transcription for accuracy. After reviewing the answers, I prepared a summary. My summary was reviewed and member-checked by the participants to ensure that their comments had not been taken out of context and were accurate. I added validity to the study by transcribing the interviews (Sagirli, 2010) and preparing summaries for member checking. Member checking enhanced the quality of my research (Pierce, 2012; Twinn, 1998). In my qualitative pragmatic inquiry, I utilized the human capital theory as a conceptual framework.

For data analysis, I employed reflexive thematic analysis to evaluate the interview data and identify patterns across participants' responses (Braun & Clarke, 2006; MacLean, 2025; Naeem et al., 2023). My first step was familiarization. After each interview, I reviewed the Microsoft Teams transcript multiple times to become familiar with each participant's responses and ensure I understood their meaning in context (MacLean, 2025). Each participant's responses were summarized, returned for

confirmation, and retained in a research log labeled P1-P6 (MacLean, 2025). My second step was the initial coding. I coded the transcripts by marking segments that reflected actions, decisions, and practices used to reduce safety accidents in chemical operations, focusing on programs, employee actions, and safeguards (Braun & Clarke, 2006; Naeem et al., 2023). After the initial coding, I moved to the third step, searching for themes. I compared codes across participants, labeled P1-P6, and organized related codes into preliminary categories that reflected recurring patterns across the interview summaries (Naeem et al., 2023; Neo et al., 2024). Step 4 is where I reviewed the themes. The preliminary themes were reviewed against the complete set of coded excerpts to confirm that the data supported each theme and ensured a clear distinction between themes (Braun & Clarke, 2006; Naeem et al., 2023). In the fifth step, I defined and named the themes. I refined the themes by defining what each captured and naming them in a way that reflected the underlying meaning in the data and the scope of my research question (Braun & Clarke, 2006). The sixth and final step was where I wrote up my interpretation. I interpreted the themes using the human capital theory to examine how managerial investments in people and safeguards were connected to organizational outcomes and whether those activities produced returns through safer performance (Carlbäck et al., 2024). Public documents were used as supplemental sources to support the themes, and the conceptual framework and literature were used to identify findings that aligned with or differed from prior evidence.

The data is securely stored digitally in a password-protected folder on an external hard drive for 5 years. Only I can open the hard drive. I will permanently erase all data collected from research after 5 years. No duplicate copies or information were saved.

Summary

My qualitative pragmatic inquiry unveiled strategies managers use to reduce safety accidents in the chemical industry. I used purposeful sampling to identify six managers who had successfully reduced accidents in their organizations and had at least 5 years of experience in the chemical industry. Publicly available company documents were also reviewed as an additional data source. All interviews were recorded, transcribed, summarized, and returned to participants for confirmation through member checking to ensure accuracy and reliability. Reflexive thematic analysis was used to identify themes and patterns in the data. The human capital theory served as the conceptual framework to interpret how investments in training, procedures, and safety programs yield positive outcomes for organizations. Methodological triangulation, including interviews, public documents, and member checking, enhanced the credibility and consistency of the findings.

Section 3: Data and Professional Practice

Project Results

The purpose of this pragmatic qualitative study was to identify and explore the effective strategies chemical company managers use to prevent safety accidents. This study had semistructured interviews with six plant managers, labeled P1-P6, from various chemical manufacturing settings to learn how they manage safety challenges. Using reflexive thematic analysis, there were five major themes uncovered as a result of the research conducted: (a) demonstrate leadership commitment to safety practices, (b) empower employees to participate in safety processes, (c) reinforce continuous learning as a safety strategy, (d) mitigate overcoming barriers to safety implementation, and (e) continuously improve organizational safety systems.

These themes explain how managers build a strong safety culture by investing in employee skills, reinforcing expectations, and continually adapting their approaches. The human capital theory provided a conceptual framework for understanding how managers develop and build employee capabilities to strengthen safety performance (Carlbäck et al., 2024). Recent research indicates that investments in human capital management practices, such as training and career development, improve employee engagement and performance outcomes (Isah Leontes & Hoole, 2024). This section explains each theme supported by participants' experiences, scholarly research, and public documents from the EPA, OSHA, and the U.S. Chemical Safety Board (CSB).

Theme 1: Demonstrate Leadership Commitment to Safety Practices

The first theme uncovered was leadership commitment to safety practices. The managers in the study consistently described leadership commitment as the foundation of all safety success. Employees watch what leaders do first and then follow. P1 mentioned that when leaders wear their personal protective equipment, correct hazards immediately, and stay engaged on the floor, employees understand that safety is not optional. P3 added that employees will not buy into the vision if leadership is not clearly living by the same standards. P2 discussed that employees watch what leadership does and emulate its behavior. P6 also emphasized being visible during training and onboarding to show employees that safety is valued. OSHA documents support the idea that management's leadership sets the foundation and core of an effective safety program (OSHA, 2016). Likewise, the CSB repeatedly cites inconsistent and weak leadership behaviors as the root cause of major chemical incidents (CSB, 2019). The CBS findings show how leadership engagement directly molds the safety culture (CSB, 2019). Researchers have shown that leaders who model safe behaviors and reinforce expectations can improve employee safety decisions (Wang et al., 2023; Zhao et al., 2022).

From a human capital theory perspective, investment in employee capabilities results from leadership's behaviors. When the leadership team models safety, employees internalize those standards and strengthen the organization. Leadership commitment and the safety climate are directly tied to continuous improvement, worker improvement, and the reinforcement of leadership behavior (McFadden et al., 2015). Leaders' involvement

strengthens the internalization and application of safety training (Casey et al., 2021). The same attributes are seen in the workforce when their participation influences change.

Data triangulation was achieved by comparing and corroborating evidence from multiple sources, including semistructured interview data, publicly available regulatory and industry documents, and peer-reviewed literature. First, participant interview responses were examined for consistency in how leadership commitment to safety practices was described and enacted across organizations. These participant perspectives were then compared against OSHA guidance and CSB reports to determine whether managerial behaviors identified by participants aligned with established regulatory and investigative findings. Finally, peer-reviewed empirical studies were used to confirm whether the leadership behaviors described by participants were consistent with documented relationships between leadership engagement, safety climate, and employee decision-making. The convergence of participant testimony, regulatory documentation, and scholarly evidence strengthened the credibility of the theme by demonstrating consistency across independent data sources.

Theme 2: Empower Employees to Participate in Safety Processes

Leadership involvement further strengthens employee participation by reinforcing the internalization and practical application of safety training. When leaders actively support training initiatives and demonstrate expectations through their actions, employees are more likely to apply safety knowledge consistently in the workplace (Zhao et al., 2022). Participants described that leadership presence during training sessions, safety meetings, and daily operations reinforced the importance of employee involvement and

clarified that safety participation was expected in each role rather than optional. For example, P3 noted that when leaders attended training alongside employees, it sent a clear message that “safety is part of everyone’s job, not just something talked about in a classroom.” Similarly, P6 emphasized that leadership visibility during onboarding helped new employees understand that safety expectations were nonnegotiable from the start.

OSHA emphasizes that effective safety programs depend on employees’ ability to report hazards without fear of retaliation and on management’s responsibility to create an environment where safety concerns are encouraged and addressed (OSHA, 2022).

Participants noted that when employees felt protected and supported, they were more willing to report near misses, unsafe conditions, and procedural gaps. P2 explained that employees were more forthcoming when leadership responded constructively to reported issues rather than assigning blame. P5 added that once employees saw hazards being corrected promptly, reporting increased because employees believed their input mattered. This open reporting culture increased hazard awareness and strengthened employee engagement in safety processes.

From a human capital theory perspective, these findings are supported by evidence that organizations perform more effectively when employee knowledge, skills, and experience are actively used and valued. When employees are given opportunities to participate in developing and improving safety practices, compliance and safe behaviors increase because they view safety as a shared responsibility rather than a management mandate (Wang et al., 2021). Clear and consistently enforced safety rules further increase employee participation in safety training and reinforce expectations across the

organization (Bayram et al., 2022). As equipment, processes, and chemical hazards evolve, employee experience becomes a vital resource that can be leveraged and expanded through continuous learning and the application of new hazard recognition and prevention techniques.

Data triangulation for this theme was achieved by comparing participant interview data with regulatory guidance and empirical research related to employee involvement in safety processes. Interview responses from multiple participants described how employee participation in hazard identification, reporting, and corrective actions influenced safety outcomes. These accounts were corroborated by OSHA guidance, which emphasizes worker involvement as a core component of effective safety programs. Peer-reviewed literature further supported the relationship between employee participation, hazard recognition, and improved safety performance. The convergence of participant experiences, regulatory expectations, and scholarly evidence strengthened the credibility of this theme.

Theme 3: Reinforce Continuous Learning as a Safety Strategy

The third theme uncovered was continuous learning as a safety strategy. The participants in this study focused on constant learning as a safety strategy. P2 explained that managers must tie employee training to real incidents. P6 gave an example of structured onboarding that provides new employees with the foundation they need to stay safe. P1 and P3 emphasized the importance of Job Safety Analysis, referred to as JSAs by participants, repeated reminders, and informal coaching to keep safety fresh in employees' minds. A CSB article mentioned repeatedly that the lack of communication

and training is the root cause of major accidents (CSB, 2018). Information transfer improves when managers repeat the message, it is scenario-based, and it is engaging (Casey et al., 2021). Safety knowledge can predict employees' safety participation (Saedi et al., 2020).

Using the human capital theory, training received increases the value of knowledge by building skills and judgment that help prevent accidents. A well-designed safety training program boosts engagement and applies that knowledge to daily tasks (Casey et al., 2021). By implementing an ongoing safety development program, employers can improve employees' skills and foster a safety culture that supports learning (Tappura, 2021). The commitment to safety from leadership, the empowerment of employees, and continuous learning do not come without pushback. Overcoming those barriers effectively strengthens the safety culture.

Triangulation for this theme involved examining participant descriptions of training, learning reinforcement, and knowledge transfer alongside public documents and academic research. Participants consistently described ongoing training, scenario-based learning, and refresher activities as essential to maintaining safety awareness. These findings were compared with OSHA training requirements and CSB recommendations that emphasize continuous learning following incidents and near misses. Peer-reviewed studies further supported the role of constant learning in improving safety-related decision-making. Agreement across these sources reinforced the validity of continuous learning as a key safety strategy.

Theme 4: Mitigate Overcoming Barriers to Safety Implementation

The fourth theme uncovered was overcoming barriers to implementing safety measures. Participants mentioned several barriers to implementing safety initiatives. P3 noted that long-tenured employees were resistant to change. Production efficiency created pressure for short-term contractors to take shortcuts, as cited by P5. In P4's experience, some employees have unsafe habits learned from a previous employer that the current manager must correct through retraining. P2 noted that these barriers also stem from communication breakdowns between shifts, leading to confusion and inconsistent expectations. Overcoming these barriers is a mandate by OSHA's duty clause, which requires employers to maintain a workplace free of recognized hazards (OSHA, 1998). The clause mandates managers to address cultural, operational, or behavioral barriers that prevent employees from working safely (OSHA, 1998). The barriers also align with researchers' views that organizational resistance, job stress, unclear communication, and cultural barriers impede the implementation of safety measures (Khoshakhlagh et al., 2023). The EPA agrees that communication gaps, outdated procedures, and poor management practices contribute to chemical accidents (US EPA, 2025a).

Using the human capital theory, when barriers exist, employees cannot apply their skills effectively. For management to use employees' skills effectively and safely, the employer must remove all obstacles. Sometimes, the barriers to employee success are a stagnant safety program. High-demand jobs, coupled with a poor safety culture, create increased stress that restricts workers' ability to work safely (Alshamsi et al., 2022).

Inconsistent safety rules and communication breakdowns limit clarity of expectations and training reinforcement, reducing safety behaviors. Organizations must continuously improve their safety practices to maintain a strong safety culture.

Data triangulation for this theme was conducted by aligning participant accounts of operational, cultural, and resource-related barriers with regulatory findings and scholarly research. Participants identified time pressure, production demands, and resistance to change as obstacles to effective safety implementation. These experiences were supported by CSB investigation reports that frequently identify organizational and leadership barriers as contributors to significant incidents. Peer-reviewed studies also documented similar barriers across high-risk industries. The consistency across interviews, investigative reports, and academic literature strengthened confidence in this theme.

Theme 5: Continuously Improve Organizational Safety Systems

The fifth and final theme uncovered was continuous improvement of organizational practices. All six participants explained that the safety culture and systems in place must continually evolve. P4 noted that personal protective equipment requirements should change as new hazards emerge. P1 and P2 emphasized regularly reviewing trends in chemical industry accidents to adjust training and procedures. P6 discussed having near misses shifted from quantity to quality. Quality of near misses allows employees to focus on identifying hazards that can result in injury or death, rather than on broad, general inconsistencies. The CSB also noted that managers need to continuously evaluate safety practices as more information becomes available (CSB,

2019). Organizational safety system maturity reduces accidents and increases the safety system's stability (Zhang et al., 2022).

By incorporating human capital theory, continuous improvement ensures that employees have up-to-date systems, equipment, tools, and a knowledge base to perform tasks safely. Strong safety climates and leadership engagement will drive motivation for continuous improvements (McFadden et al., 2015). Ongoing learning enhances employees' competence and ownership of safety behaviors. Providing employees with the latest equipment, training, and empowerment can significantly improve business practices.

Triangulation for this theme was achieved by comparing participant narratives regarding system reviews, corrective actions, and process updates with regulatory frameworks and research on safety management systems. Participants described ongoing evaluations of procedures, equipment, and controls as necessary for accident prevention. These practices aligned with OSHA PSM requirements and EPA expectations for continuous risk reduction. Peer-reviewed literature further confirmed that continuous system improvement is associated with reduced accident severity and improved organizational resilience. The alignment of participant practices with regulatory and scholarly sources supported the robustness of this theme.

Business Contributions and Recommendations for Professional Practice

The findings offer several contributions for managers in the chemical industry seeking to reduce safety accidents while still meeting production and financial goals. The core message from all participants was that the safety results were not accidental. The

safety outcomes are directly related to the clarity of leadership priorities, active employee participation, structured training, and a deliberate focus on continuous safety training. Managers who made safety visible in their daily decisions and supported those decisions with resources received better employee responses regarding compliance and proactivity to prevent safety accidents.

One contribution to professional practice is the emphasis participants placed on visible leadership commitment. P1 and P4 discussed regularly walking the production floor, engaging workers, following safety directions, and following up on reported hazards and the solutions to those hazards, instead of turning away from employees. P6 emphasized the importance of following up on near misses and not letting up until the necessary action is rectified. All participants expressed safety expectations as non-negotiable for everyone, regardless of job function. The experiences prove that safety leadership and safety climate are the molding vessels for employees. When managers are consistent and credible in their approach to safety, they can expect stronger engagement, improved compliance and participation, and a more positive safety climate (Omidi et al., 2023).

A second contribution to professional practice is the way managers tied employee participation to safety training. P2 and P5 explained that the posted rules were inadequate and that workers needed to be involved in risk assessments, job analyses, and safety committees to improve the environment. They also emphasized that training must be regular, specific, and interactive, rather than a presentation in a room. Managers' safety priorities and clear safety rules improve safety participation and behavior by mediating

through safety training (Bayram et al., 2022). This also means that just scheduling training is not enough. Managers must also monitor employees' engagement and interaction during relevant training sessions.

The third contribution to professional practice focuses on monitoring behavior and providing feedback. The participants discussed using behavior-based observations, coaching, and reinforcement rather than relying only on discipline after an accident. Their suggestion was to implement practical activities, such as peer observations, short feedback conversations, and participation in observations, rather than just counting injuries. Structured observations, feedback, and reinforcement programs can enhance safety performance when integrated into a comprehensive safety management system, rather than as a standalone campaign or single action item (Carra et al., 2024).

Implications for Social Change

This study also highlights significant implications for social change that extend beyond the boundaries of the individual chemical company. When managers invest in safety as a core business strategy rather than a minimum compliance requirement, they not only protect employees but also contribute to broader goals of sustainable work, community stability, and long-term human capital development.

Participants repeatedly tied safety practices to respect for employees and their families. P2 and P5 emphasized that every serious incident affects more than just the person injured or the equipment down; it ripples through families, coworkers, and the surrounding community. P3 highlighted that when employees see management taking safety seriously, responding quickly to hazards, pausing work to avoid unsafe conditions,

and providing thorough follow-up, they feel valued and more willing to stay with the organization long term. These experiences are consistent with researchers showing that occupational health and safety are critical components of social sustainability and sustainable development. Strong occupational health and safety practices are central to achieving sustainability because they protect employees' well-being and support stable, resilient communities (Kavouras et al., 2022).

In addition, participants described how transparent reporting and accountability were essential for maintaining public trust. P1 and P4 noted that serious chemical incidents often draw attention from regulators and the public, and that companies with a track record of strong safety management and transparent communication are better equipped to maintain credibility when problems occur. Occupational safety and health activities are increasingly highlighted in corporate social responsibility (CSR) and integrated reports, suggesting that stakeholders expect organizations to disclose how they protect workers and manage risk (Shimizu et al., 2022). When managers adopt the kinds of strategies described in this study, leadership commitment, workforce participation, continuous learning, and continuous improvement, they are also strengthening the quality of safety information that can be reported to external stakeholders.

The findings also reinforce the idea that safety investments are part of an organization's social responsibility, not just a cost of doing business. P6 discussed how the company's customers asked about safety metrics and major incidents during audits, linking safety performance to long-term business relationships. CSR investments are associated with fewer workplace injuries, revealing that CSR and employee safety are

closely related (Koo & Ki, 2020). This notion suggests that the strategies managers shared in this study, especially those that cultivate a strong safety culture and actively involve employees, can also support the organization's CSR profile and reputation, which, in turn, influence access to markets and partnerships.

From a broader policy and sustainability perspective, the strategies described by P1–P6 align with ongoing efforts to integrate occupational safety and health into global sustainability and decent work agendas. An Occupational Health and Safety Potential indicator within social life cycle assessment highlights the importance of measuring and managing occupational health and safety practices throughout supply chains as a key aspect of sustainable decision-making. (Tsalidis, 2024). Managing occupational health and safety is inseparable from social sustainability and calls on organization leaders to embed it into their business models and performance systems (Johanson et al., 2022). The strategies used by the managers in this study, especially continuous learning from near misses, cross-functional safety teams, and structured feedback loops, mirror these recommendations by treating safety as a strategic, value-creating activity rather than a narrow compliance function.

These implications are particularly relevant for the chemical industry, where incidents can have long-term environmental and community impacts. By strengthening safety systems, managers not only prevent injuries and fatalities but also reduce the likelihood of major process events that can contaminate air, water, and land in surrounding communities. Occupational health and safety management is positively associated with corporate sustainability performance, including social and environmental

outcomes (Tan et al., 2023). When organizations in the chemical sector adopt the strategies identified in this study, they contribute to safer workplaces, more stable employment, and more resilient communities, all of which support social change goals such as decent work and sustainable development.

Recommendations for Future Study

Although this study provides meaningful insight into the strategies chemical company managers use to reduce safety accidents, several opportunities exist for future researchers to deepen understanding, improve business practices, and directly address the limitations described in Section 1.4. Because the study relied solely on managers, future researchers should expand the sample to include frontline workers, engineers, operators, and safety technicians who regularly interact with hazardous processes. Broader involvement would help determine whether the strategies managers describe are consistently understood and applied throughout the organization. Research on the transfer of safety training demonstrates that frontline workers often interpret and apply safety expectations differently from managers, highlighting the need for multilevel sampling (Nielsen, Ng, Guglielmi, et al., 2023). This approach would address the limitation that managerial perspectives alone may not reflect the full range of operational safety practices.

Future researchers should also broaden the work's organizational and geographic scope. The smaller, region-specific nature of this study provided depth but limits transferability. Multi-site studies across various chemical and process industries would allow researchers to evaluate how corporate culture, resource availability, and regulatory

environments influence safety practices. Research on safety culture change has shown that maturity level and organizational context affect how effectively near-miss systems and other safety initiatives improve safety culture, supporting the need for broader cross-company designs (Pedrosa et al., 2025).

A key limitation of this study was its qualitative design, which cannot determine statistical relationships or quantify the magnitude of safety improvements. Future researchers should incorporate mixed-method or quantitative approaches to examine how leadership commitment, training quality, and employee participation relate to measurable outcomes. In high-hazard industries, longitudinal analyses have shown that a strong safety culture is associated with better financial performance, demonstrating that safety investments can yield strategic business advantages (Bautista-Bernal et al., 2024). Applying similar longitudinal or panel-based analyses to chemical operations would help business leaders understand whether safety initiatives improve not only injury rates, but also productivity, stability, and operational resilience. Applying a quantitative design could also address the limitation that participants could have been indirectly or secondhand associated with the safety strategies. A quantitative design would also address the limitation that results cannot be generalized from a qualitative study.

Future researchers should also examine factors influencing the transfer and retention of safety training, as participants emphasized the importance of scenario-based learning, coaching, and reinforcement. Studies on OHS training show that workers' intentions to apply training are shaped by organizational support, peer expectations, and confidence in their ability to perform tasks safely (Pham et al., 2023). Additional

researchers could test which training structures produce the most significant long-term behavioral improvement in chemical environments, such as blended learning, simulation-based training, or coaching models. A mixed-methods approach would be especially valuable, as it allows researchers to combine quantitative data on training outcomes with qualitative insights into worker experience (Nielsen, Ng, Vignoli, et al., 2023).

Finally, researchers should explore the long-term development of safety culture and human capital within chemical companies. Near-miss management research has shown that safety culture evolves over time and that repeated reinforcement is necessary to sustain improvement (Pedrosa et al., 2025). Longitudinal research could examine how leadership changes, workforce turnover, and technology adoption influence safety performance, training effectiveness, and workforce engagement. Understanding how safety culture matures over months and years would produce practical evidence that managers can use to strengthen long-term safety systems aligned with organizational strategy and human capital development.

Conclusion

Overall, this qualitative pragmatic inquiry, I found that reducing safety accidents in the chemical industry is influenced by managerial practices related to leadership behavior, employee engagement, and the reinforcement of learning in day-to-day operations. Through interviews with six managers, the project identified clear patterns in how safety is put into practice. Leadership must model the behaviors they expect; employees must be empowered to participate and speak up; training must be ongoing and directly tied to real tasks; operational barriers must be addressed rather than worked

around; and safety systems must be continuously improved as conditions change. These strategies were consistent across all participants and formed a practical framework grounded in the human capital theory, demonstrating how organizations strengthen safety by investing in their workforce's knowledge, skills, and judgment.

For practitioners, the message is straightforward: strong safety performance is not the result of programs on paper; it comes from visible leadership, engaged employees, and a commitment to continuous learning and improvement. Leaders who invest in their people build safer operations, more reliable performance, and a culture where safety becomes part of how work gets done every day.

References

- Abu-Shawish, R. K., Romanowski, M. H., & Amatullah, T. (2021). Policy borrowing and developing knowledge economies in GCC countries: A critique from a human capital theory perspective. *Asia Pacific Education Review*, 22(1), 77–88.
<https://doi.org/10.1007/s12564-020-09661-x>
- Adar, S. D., Pedde, M., Hirth, R., & Szpiro, A. (2024). Assessing the national health, education, and air quality benefits of the United States environmental protection agency's school bus rebate program: A randomized controlled trial design. *Research Report (Health Effects Institute)*, 221, 1–44.
<https://pmc.ncbi.nlm.nih.gov/articles/PMC11587696/>
- Akin, S., Yildirim, A., & Goodwin, A. L. (2016). Classroom management through the eyes of elementary teachers in Turkey: A phenomenological study. *Educational Sciences: Theory & Practice*. <https://doi.org/10.12738/estp.2016.3.0376>
- Al-Bayati, A. J., Bilal, G. A., Esmacili, B., Karakhan, A., & York, D. (2021). Evaluating OSHA's fatality and catastrophe investigation summaries: Arc flash focus. *Safety Science*, 140, 105287. <https://doi.org/10.1016/j.ssci.2021.105287>
- Ali, A., & Yusof, H. (2011). Quality in qualitative studies: The case of validity, reliability and generalizability. *Issues in Social & Environmental Accounting*, 5(2), 25–64.
- Allemang, B., Sitter, K., & Dimitropoulos, G. (2022). Pragmatism as a paradigm for patient-oriented research. *Health Expectations*, 25(1), 38–47.
<https://doi.org/10.1111/hex.13384>

- Almalki, S. (2016). Integrating quantitative and qualitative data in mixed methods research—Challenges and benefits. *Journal of Education and Learning*, 5(3), 288. <https://doi.org/10.5539/jel.v5n3p288>
- Alshamsi, A. I., Santos, A., & Thomson, L. (2022). Psychosocial safety climate moderates the effect of demands of hospital accreditation on healthcare professionals: A longitudinal study. *Frontiers in Health Services*, 2, 824619. <https://doi.org/10.3389/frhs.2022.824619>
- Alsharif, A., Albert, A., Awolusi, I., & Jaselskis, E. (2023). Severe injuries among construction workers: Insights from OSHA's new severe injury reporting program. *Safety Science*, 163, 106126. <https://doi.org/10.1016/j.ssci.2023.106126>
- Amyotte, P. R., & Lupien, C. S. (2017). Chapter three—Elements of process safety management. In F. Khan (Ed.), *Methods in Chemical Process Safety 1*, 87–148. <https://doi.org/10.1016/bs.mcps.2017.01.004>
- An, Z., Wang, N., Bai, D., Yu, X., & Liu, S. (2021). The enlightenment on emergency management of chemical parks. *IOP Conference Series: Earth and Environmental Science*, 791(1), Article 012181. <https://doi.org/10.1088/1755-1315/791/1/012181>
- Astani, S., Lorestani, B., Cheraghi, M., & Kiani Sadr, M. (2024). Assessing the health risks of chemicals in a company supplying chemicals to drilling rigs in Southern Iran using COSHH, SHEM-SAM, and SQRA methods. *Frontiers in Public Health*, 12, Article 1395695. <https://doi.org/10.3389/fpubh.2024.1395695>
- Augustine, E. F., Dorsey, E. R., Hauser, R. A., Elm, J. J., Tilley, B. C., & Kieburtz, K. K. (2016). Communicating with participants during the conduct of multi-center

clinical trials. *Clinical Trials*, 13(6), 592–596.

<https://doi.org/10.1177/1740774516665596>

Aulgur, J. (2016). Governance and board member identity in an emerging nonprofit organization. *Administrative Issues Journal: Education, Practice, and Research*, 6(1). <https://doi.org/10.5929/2016.6.1.1>

Balasubramanian, A., Ganti, S., & Dharan, H. (2024, August). Implementing artificial intelligence in process safety studies. *Chemical Engineering Progress*, 120(8), 27–34.

Bans-Akutey, A., & Tiimub, B. M. (2021). Triangulation in research. *Academia Letters*. <https://doi.org/10.20935/AL3392>

Baserer, D., Baserer, Z., & Akcan, A. T. (2016). Ethical principles and violations in academy: A qualitative study. *Journal of Higher Education and Science*, 6(2), 242. <https://doi.org/10.5961/jhes.2016.160>

Bautista-Bernal, I., Quintana-García, C., & Marchante-Lara, M. (2024). Safety culture, safety performance and financial performance. A longitudinal study. *Safety Science*, 172, 106409. <https://doi.org/10.1016/j.ssci.2023.106409>

Bayram, M., Arpat, B., & Ozkan, Y. (2022). Safety priority, safety rules, safety participation and safety behaviour: The mediating role of safety training. *International Journal of Occupational Safety and Ergonomics*, 28(4), 2138–2148. <https://doi.org/10.1080/10803548.2021.1959131>

Behie, S. W., Halim, S. Z., Efaw, B., O'Connor, T. M., & Quddus, N. (2020). Guidance to improve the effectiveness of process safety management systems in operating

- facilities. *Journal of Loss Prevention in the Process Industries*, 68, Article 104257. <https://doi.org/10.1016/j.jlp.2020.104257>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Cabrilo, S., Grubic Nestic, L., & Mitrovic, S. (2014). Study on human capital gaps for effective innovation strategies in the knowledge era. *Journal of Intellectual Capital*, 15(3), 411–429. <https://doi.org/10.1108/JIC-05-2014-0058>
- Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing*, 25(8), 652–661. <https://doi.org/10.1177/1744987120927206>
- Carlbäck, M., Nygren, T., & Hägglund, P. (2024). Human resource development in restaurants in western Sweden – A human capital theory perspective. *Journal of Human Resources in Hospitality & Tourism*, 23(2), 289–314. <https://doi.org/10.1080/15332845.2024.2282215>
- Carr, D., & Yan, W. (2025). The clean air act and local employment base sensitivity. *Economic Development Quarterly*, 39(2), 111–123. <https://doi.org/10.1177/08912424241291974>
- Carra, S., Bottani, E., Vignali, G., Madonna, M., & Monica, L. (2024). Implementation of behavior-based safety in the workplace: A review of conceptual and empirical

literature. *Sustainability*, 16(23), Article 10195.

<https://doi.org/10.3390/su162310195>

Carson, P. (2016). The great explosion of 1916. *Loss Prevention Bulletin*, 251, 6–10.

Casey, T., Turner, N., Hu, X., & Bancroft, K. (2021). Making safety training stickier: A richer model of safety training engagement and transfer. *Journal of Safety Research*, 78, 303–313. <https://doi.org/10.1016/j.jsr.2021.06.004>

Chan, P., Van Gerven, T., Dubois, J.-L., & Bernaerts, K. (2023). Study of motivation and engagement for chemical laboratory safety training with VR serious game. *Safety Science*, 167, Article 106278. <https://doi.org/10.1016/j.ssci.2023.106278>

Chen, J. H., Russomanno, D., & Zhuang, W. (2025). Air pollution in the united states and misstatements in financial reporting. *Auditing: A Journal of Practice & Theory*, 44(2), 51–78. <https://doi.org/10.2308/AJPT-2021-099>

Cheraghi, S., & Khodadadi-Karimvand, M. (2023). Developing and implementation of leading and lagging indicators in process safety management. *Researcher*, 3(1), 36–45. <https://doi.org/10.55185/researcher.1286182>

Cintora-Sanz, A. M., Colmenar-García, C., Gómez-Usabiaga, C., García-Martinez, R., Lafuente-Saenz, R., Sierra-García, T., Montero-Pernía, C., Blanco-Lara, A., Vázquez-Rodríguez, T., & Horrillo-García, C. (2023). Lean approach in the application of new technologies: Integration of risk, situational awareness, and resilience by a prehospital emergency medical service. *Environment Systems and Decisions*, 43(4), 721–734. <https://doi.org/10.1007/s10669-023-09930-1>

- Cleary, M., Horsfall, J., & Hayter, M. (2014). Data collection and sampling in qualitative research: Does size matter? *Journal of Advanced Nursing*, 70(3), 473–475.
<https://doi.org/10.1111/jan.12163>
- Coleman, J. S. (1993). The impact of Gary Becker's work on sociology. *Acta Sociologica*, 36(3), 169–178. <https://doi.org/10.1177/000169939303600302>
- Colorafi, K. J., & Evans, B. (2016). Qualitative descriptive methods in health science research. *HERD: Health Environments Research & Design Journal*, 9(4), 16–25.
<https://doi.org/10.1177/1937586715614171>
- Consonni, D., & Fustinoni, S. (2024). Biochemical and haematological effects of serum PFOA, ADV and cC6O4 in workers of a chemical company producing fluoropolymers, Italy, 2013–2022. *International Journal of Hygiene and Environmental Health*, 262, Article 114440.
<https://doi.org/10.1016/j.ijheh.2024.114440>
- Cornacchione, E., & Daugherty, J. L. (2013). Trends in opportunity costs of U.S. postsecondary education: A national HRD and human capital theory analysis. *New Horizons in Adult Education and Human Resource Development*, 25(2), 62–82. <https://doi.org/10.1002/nha.20017>
- Craig, R., & Amernic, J. (2023). Using “CEO-speak” to prioritize a safety culture. *Strategy & Leadership*, 51(4), 32–36. <https://doi.org/10.1108/SL-03-2023-0033>
- Crampton, A. (2015). Ethnographic refusal as research method: Example from a study of a family court child custody mediation program. *Qualitative Social Work*, 14(4), 453–470. <https://doi.org/10.1177/1473325014557577>

- CSB. (2018). Emergency planning and response. The importance of preparation, training, and communication. *Safety Digest*, 1(17), 1–7.
- CSB. (2019). The importance of worker participation. *Safety Digest*, 1(6), 1–9.
- Cybersecurity & Infrastructure Security Agency. (2019). *Chemical sector profile*. 1–7.
- Dagen, J., & Nazaruk, M. (2017). Commentary: Integrating behavioral science with process safety management. *Journal of Organizational Behavior Management*, 37(3/4), 332–338. <https://doi.org/10.1080/01608061.2017.1367749>
- De Ceunynck, T., Kusumastuti, D., Hannes, E., Janssens, D., & Wets, G. (2013). Mapping leisure shopping trip decision making: Validation of the CNET interview protocol. *Quality & Quantity*, 47(4), 1831–1849. <https://doi.org/10.1007/s11135-011-9629-4>
- Dechy, N., Bourdeaux, T., Ayrault, N., Kordek, M.-A., & Le Coze, J.-C. (2004). First lessons of the toulouse ammonium nitrate disaster, 21st September 2001, AZF plant, France. *Journal of Hazardous Materials*, 111(1–3), 131–138. <https://doi.org/10.1016/j.jhazmat.2004.02.039>
- DeJonckheere, M., & Vaughn, L. M. (2019). Semistructured interviewing in primary care research: A balance of relationship and rigour. *Family Medicine and Community Health*, 7(2), 1–8. <https://doi.org/10.1136/fmch-2018-000057>
- Doane, J. (2023). Application of human capital theory to understand funding inequities in dual language programs. *Journal of Education Human Resources*, 41(1), 36–49. <https://doi.org/10.3138/jehr-2021-0055>

- Dobbs, R. L., Sun, J. Y., & Roberts, P. B. (2008). Human capital and screening theories: Implications for human resource development. *Advances in Developing Human Resources, 10*(6), 788–801. <https://doi.org/10.1177/1523422308325761>
- Dobor, J. (2017). Major chemical accidents in the 21st century europe and its lessons learned in higher education. *Academic and Applied Research in Military and Public Management Science, 16*(3), 93–108. <https://doi.org/10.32565/aarms.2017.3.6>
- Dogeje, F., Ngaruko, D., & Mpetta, D. (2024). Farmer’s literacy and contract farming participation in Tanzania’s cash crops agriculture: Application of human capital theory. *Discover Agriculture, 2*(1), 86. <https://doi.org/10.1007/s44279-024-00097-0>
- Donkoh, S. (2023). Application of triangulation in qualitative research. *Journal of Applied Biotechnology & Bioengineering, 10*(1), 6–9. <https://doi.org/10.15406/jabb.2023.10.00319>
- Drennen, T., & Dancey, J. (2023, April). Compliance auditing of pressure relief systems. *Chemical Engineering Progress, 119*(4), 32–39. ProQuest One Academic.
- Dueñas Santana, J. A., Orozco, J. L., Febles Lantigua, D., Furka, D., Furka, S., & García Cruz, A. (2021). Using integrated bayesian-petri net method for individual impact assessment of domino effect accidents. *Journal of Cleaner Production, 294*, Article 126236. <https://doi.org/10.1016/j.jclepro.2021.126236>
- Dwayi, V. V. (2024). Reimagining how the critical realist ways of methodological triangulation might allow for resolving paradigm in commensurability in research

methodologies. *Proceedings of the European Conference on Cyber Warfare & Security*, 23(1), 63–70.

Earn, J. (2022). Exploring the gap in the Occupational Safety And Health Administration (OSHA) laboratory standard: A literature review and recommendations to enhance histology laboratory safety practices. *Journal of Histotechnology*, 45(3), 107–115. <https://doi.org/10.1080/01478885.2022.2099720>

Everett, J. L., & Johnston, K. A. (2012). Toward an ethnographic imperative in public relations research. *Public Relations Review*, 38(4), 522–528. <https://doi.org/10.1016/j.pubrev.2012.05.006>

Eyisi, D. (2016). The usefulness of qualitative and quantitative approaches and methods in researching problem-solving ability in science education curriculum. *Journal of Education and Practice*, 7(15), 91–100.

Fassinger, R., & Morrow, S. L. (2013). Toward best practices in quantitative, qualitative, and mixed- method research: A social justice perspective. *Journal for Social Action in Counseling & Psychology*, 5(2), 69–83. <https://doi.org/10.33043/JSACP.5.2.69-83>

Fénye, H., & Mohácsi, M. (2020). Do students take the predictions of human capital theory into account? An analysis of motives behind further studies in higher education. *Hungarian Educational Research Journal*, 10(1), 74–84.

Fleming, P. (2017). The human capital hoax: Work, debt and insecurity in the era of uberization. *Organization Studies*, 38(5), 691–709. <https://doi.org/10.1177/0170840616686129>

- Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology & Health, 25*(10), 1229–1245. <https://doi.org/10.1080/08870440903194015>
- Gearity, B. T. (2012). Poor teaching by the coach: A phenomenological description from athletes' experience of poor coaching. *Physical Education & Sport Pedagogy, 17*(1), 79–96. <https://doi.org/10.1080/17408989.2010.548061>
- Gilead, T. (2013). Educational insights of the economist: Tibor scitovsky on education, production and creative consumption. *Studies in Philosophy and Education, 32*(6), 623–639. <https://doi.org/10.1007/s11217-013-9355-6>
- Gonyora, M., & Ventura-Medina, E. (2024). Investigating the relationship between human and organisational factors, maintenance, and accidents. The case of chemical process industry in South Africa. *Safety Science, 176*, Article 106530. <https://doi.org/10.1016/j.ssci.2024.106530>
- Griffen, Z. W. (2024). The economization of early life: Human capital theory, biology, and social policy. *Science, Technology, & Human Values, 49*(1), 175–205. <https://doi.org/10.1177/01622439221147701>
- Grossoehme, D. H. (2014). Overview of qualitative research. *Journal of Health Care Chaplaincy, 20*(3), 109–122. <https://doi.org/10.1080/08854726.2014.925660>
- Gyenes, Z., & Dechy, N. (2016). Risk and safety management of ammonium nitrate fertilizers: Keeping the memory of disasters alive. *Loss Prevention Bulletin, 25*, 32–36.

- Habibi, A., Sarkissian, A. D., Gomez, M., & Ilari, B. (2015). Developmental brain research with participants from underprivileged communities: Strategies for recruitment, participation, and retention. *Mind, Brain, and Education*, 9(3), 179–186. <https://doi.org/10.1111/mbe.12087>
- Hagaman, A. K., & Wutich, A. (2017). How many interviews are enough to identify metathemes in multisited and cross-cultural research? Another perspective on guest, bunce, and johnson's (2006) landmark study. *Field Methods*, 29(1), 23–41. <https://doi.org/10.1177/1525822X16640447>
- Hanza, A. (2016). Two-way safety training. *TCE: The Chemical Engineer*, 905, 40–43.
- Hartog, J., & Gerritsen, S. (2016). Mincer earnings functions for the netherlands 1962–2012. *De Economist*, 164(3), 235–253. <https://doi.org/10.1007/s10645-016-9279-y>
- Holden, L., & Biddle, J. (2017). The introduction of human capital theory into education policy in the United States. *History of Political Economy*, 49(4), 537–574. <https://doi.org/10.1215/00182702-4296305>
- Holst, A. (2025, July 6). *Clean water act*. <https://www.britannica.com/topic/Clean-Water-Act>
- Holzwarth, B., Webendörfer, S., & Claus, M. (2025). Prevalence of chronic musculoskeletal pain among different occupational groups of a large German chemical company: Results of a cross-sectional study. *International Journal of Occupational Safety and Ergonomics*, 1–8. <https://doi.org/10.1080/10803548.2025.2461911>

- Ingham-Broomfield, R. (Becky). (2016). A nurses' guide to mixed methods research. *Australian Journal of Advanced Nursing*, 33(4).
<https://doi.org/10.37464/2016.334.1559>
- International Trade Administration. (2025). *Select USA chemicals industry*.
<https://www.trade.gov/selectusa-chemicals-industry>
- Isah Leontes, N., & Hoole, C. (2024). Bridging the Gap: Exploring the Impact of Human Capital Management on Employee Performance through Work Engagement. *Administrative Sciences*, 14(6), 129. <https://doi.org/10.3390/admsci14060129>
- Jacob, S. A., & Furgerson, S. P. (2012). Writing interview protocols and conducting interviews: Tips for students new to the field of qualitative research. *Qualitative Report*, 17(6), 1–10.
- Job, C. (2024). Safe drinking water act 50th anniversary—Recognizing an evolving path of groundwater management and protection. *Ground Water Monitoring & Remediation*, 44(3), 22–27. Computers & Applied Sciences Complete.
<https://doi.org/10.1111/gwmr.12671>
- Johanson, U., Aboagye, E., & Yao, J. (2022). Editorial: Managing occupational health and safety: Incorporating social sustainability into the organization. *Frontiers in Sustainability*, 3, 1039573. <https://doi.org/10.3389/frsus.2022.1039573>
- Jones, C. H. D., Cohn, S., & Ogilvie, D. (2013). Making sense of a new transport system: An ethnographic study of the cambridgeshire guided busway. *PLoS ONE*, 8(7), e69254. <https://doi.org/10.1371/journal.pone.0069254>

- Jung, J., & Makowsky, M. D. (2014). The determinants of federal and state enforcement of workplace safety regulations: OSHA inspections 1990–2010. *Journal of Regulatory Economics*, 45(1), 1–33. <https://doi.org/10.1007/s11149-013-9229-4>
- Kaba, A., & Beran, T. (2014). Twelve tips to guide effective participant recruitment for interprofessional education research. *Medical Teacher*, 36(7), 578–584. <https://doi.org/10.3109/0142159X.2014.907489>
- Karimi, M., Brazier, J., & Paisley, S. (2017). How do individuals value health states? A qualitative investigation. *Social Science & Medicine*, 172, 80–88. <https://doi.org/10.1016/j.socscimed.2016.11.027>
- Kaushik, V., & Walsh, C. A. (2019). Pragmatism as a research paradigm and its implications for social work research. *Social Sciences*, 8(9), 255. <https://doi.org/10.3390/socsci8090255>
- Kavouras, S., Vardopoulos, I., Mitoula, R., Zorpas, A. A., & Kaldis, P. (2022). Occupational health and safety scope significance in achieving sustainability. *Sustainability*, 14(4), 2424. <https://doi.org/10.3390/su14042424>
- Kelly, L. M., & Cordeiro, M. (2020). Three principles of pragmatism for research on organizational processes. *Methodological Innovations*, 13(2), 2059799120937242. <https://doi.org/10.1177/2059799120937242>
- Kendall, S., & Halliday, L. E. (2014). Undertaking ethical qualitative research in public health: Are current ethical processes sufficient? *Australian and New Zealand Journal of Public Health*, 38(4), 306–310. <https://doi.org/10.1111/1753-6405.12250>

- Khoshakhlagh, A. H., Sulaie, S. A., Yazdanirad, S., & Park, J. (2023). Examining the effect of safety climate on accident risk through job stress: A path analysis. *BMC Psychology, 11*(1), 89. <https://doi.org/10.1186/s40359-023-01133-2>
- Kilanowski, J. F. (2012). Breaking the ice: A pre-intervention strategy to engage research participants. *Journal of Pediatric Health Care, 26*(3), 209–212. <https://doi.org/10.1016/j.pedhc.2012.01.001>
- Kim, S., & Yoon, G. (2015). An innovation-driven culture in local government: Do senior manager's transformational leadership and the climate for creativity matter? *Public Personnel Management, 44*(2), 147–168. <https://doi.org/10.1177/0091026014568896>
- Knoblauch, S. H. (2019). Therapists' subjective experience during improvisational moments in the clinical encounter-discussion of I'mprovisation. *Psychoanalytic Dialogues, 29*(3), 306–310. <https://doi.org/10.1080/10481885.2019.1614831>
- Koo, J. E., & Ki, E. S. (2020). Corporate social responsibility and employee safety: Evidence from Korea. *Sustainability, 12*(7), 2649. <https://doi.org/10.3390/su12072649>
- Kosteniuk, J. G., Morgan, D. G., Bracken, J., & Kessler, P. (2016). Adventures in rural and remote health services innovation: The role of researcher as collaborator. *Rural and Remote Health, 14*(2898), 1–7.
- Kwon, H. (2006). The effectiveness of process safety management (PSM) regulation for chemical industry in Korea. *Journal of Loss Prevention in the Process Industries, 19*(1), 13–16. <https://doi.org/10.1016/j.jlp.2005.03.009>

- Lee, J., Sylvara, A., Choi, J., & Lee, S. (2023). On different pages? More dangerous than a papercut: Implications of incongruence between leader and member safety climate perceptions. *Safety Science, 163*, Article 106111.
<https://doi.org/10.1016/j.ssci.2023.106111>
- Lel, U. (2025). Toxic chief executive officers; environmental, social, and governance institutional investors as watchdogs; and the labor market outcomes. *Management Science, 71*(7), 5722–5745. <https://doi.org/10.1287/mnsc.2023.02372>
- Leung, L. (2015). Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care, 4*(3), 324.
<https://doi.org/10.4103/2249-4863.161306>
- Liaw, H.-J., Liu, C.-C., Wan, J.-F., & Tzou, T.-L. (2023). Process safety management lessons learned from a fire and explosion accident caused by a liquefied petroleum gas leak in an aromatics reforming unit in Taiwan. *Journal of Loss Prevention in the Process Industries, 83*, Article 105058.
<https://doi.org/10.1016/j.jlp.2023.105058>
- Lindhout, P., Kingston-Howlett, J., Hansen, F. T., & Reniers, G. (2020). Reducing unknown risk: The safety engineers' new horizon. *Journal of Loss Prevention in the Process Industries, 68*, Article 104330.
<https://doi.org/10.1016/j.jlp.2020.104330>
- Little, A. W. (2003). Motivating learning and the development of human capital. *Compare: A Journal of Comparative and International Education, 33*(4), 437–452. <https://doi.org/10.1080/0305792032000127748>

- Lucas, R. E. (2009). Ideas and growth. *Economica*, 76(301), 1–19.
<https://doi.org/10.1111/j.1468-0335.2008.00748.x>
- Lucas, R. E. (2015). Human capital and growth. *American Economic Review*, 105(5), 85–88. <https://doi.org/10.1257/aer.p20151065>
- Lund, T. (2012). Combining qualitative and quantitative approaches: Some arguments for mixed methods research. *Scandinavian Journal of Educational Research*, 56(2), 155–165. <https://doi.org/10.1080/00313831.2011.568674>
- Ma, F., Yu, D., Xue, B., Wang, X., Jing, J., & Zhang, W. (2023). Transport risk modeling for hazardous chemical transport companies—A case study in China. *Journal of Loss Prevention in the Process Industries*, 84, Article 105097.
<https://doi.org/10.1016/j.jlp.2023.105097>
- MacLean, S. (2025). Nurses' how-to guide to thematic analysis. *The Journal of Stomal Therapy Australia*, 45(1), 10–13. <https://doi.org/10.33235/jsta.45.1>
- Makrakis, V., & Kostoulas-Makrakis, N. (2016). Bridging the qualitative–quantitative divide: Experiences from conducting a mixed methods evaluation in the RUCAS programme. *Evaluation and Program Planning*, 54, 144–151.
<https://doi.org/10.1016/j.evalprogplan.2015.07.008>
- MarketLine. (2024). Market line company profile: The Dow Chemical Company. *In Dow Chemical Company MarketLine Company Profile*, 1–36.
- Matache, I. C. (2023). Human capital theory – one way of explaining higher education massification. *Journal of Public Administration, Finance and Law*, 29, 363–371.
<https://doi.org/10.47743/jopaf1-2023-29-30>

- Matheson, F. I., Forrester, P., Brazil, A., Doherty, S., & Affleck, L. (2012). Incentives for research participation: Policy and practice from canadian corrections. *American Journal of Public Health, 102*(8), 1438–1442.
<https://doi.org/10.2105/AJPH.2012.300685>
- Mattox, T. M., Pham, A. L., Connolly, M. D., Klivansky, L. M., Dhall, R., & Urban, J. J. (2023). Performing hazard analyses and setting triggers for reevaluation in lab-scale chemical reactions. *Journal of Chemical Education, 100*(3), 1219–1226.
<https://doi.org/10.1021/acs.jchemed.3c00017>
- McCord, S. A., & Heim, W. A. (2015). Identification and prioritization of management practices to reduce methylmercury exports from wetlands and irrigated agricultural lands. *Environmental Management, 55*(3), 725–740.
<https://doi.org/10.1007/s00267-014-0425-5>
- McCusker, K., & Gunaydin, S. (2015). Research using qualitative, quantitative or mixed methods and choice based on the research. *Perfusion, 30*(7), 537–542.
<https://doi.org/10.1177/0267659114559116>
- McFadden, K. L., Stock, G. N., & Gowen, C. R. (2015). Leadership, safety climate, and continuous quality improvement: Impact on process quality and patient safety. *Health Care Management Review, 40*(1), 24–34.
<https://doi.org/10.1097/HMR.0000000000000006>
- McPartland, J., Shaffer, R. M., Fox, M. A., Nachman, K. E., Burke, T. A., & Denison, R. A. (2022). Charting a path forward: Assessing the science of chemical risk evaluations under the toxic substances control act in the context of recent national

- academies recommendations. *Environmental Health Perspectives*, 130(2), Article 025003–1. Academic Search Complete. <https://doi.org/10.1289/EHP9649>
- McVay, A. B., Stamatakis, K. A., Jacobs, J. A., Tabak, R. G., & Brownson, R. C. (2016). The role of researchers in disseminating evidence to public health practice settings: A cross-sectional study. *Health Research Policy and Systems*, 14(1), 42. <https://doi.org/10.1186/s12961-016-0113-4>
- Merriam-Webster. (2025). *Legislation definition & meaning*. <https://www.merriam-webster.com/dictionary/legislation?src=search-dict-box>
- Mezentseva, A., Gracia, F. J., Silla, I., & Martínez-Córcoles, M. (2023). The role of empowering leadership, safety culture and safety climate in the prediction of mindful organizing in an air traffic management company. *Safety Science*, 168, Article 106321. <https://doi.org/10.1016/j.ssci.2023.106321>
- Miracle, V. A. (2016). The Belmont Report: The triple crown of research ethics. *Dimensions of Critical Care Nursing*, 35(4), 223–228. <https://doi.org/10.1097/DCC.000000000000186>
- Mjørud, M., Engedal, K., Røsvik, J., & Kirkevold, M. (2017). Living with dementia in a nursing home, as described by persons with dementia: A phenomenological hermeneutic study. *BMC Health Services Research*, 17(1), 93. <https://doi.org/10.1186/s12913-017-2053-2>
- Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research.

International Journal of Qualitative Methods, 22, 16094069231205789.

<https://doi.org/10.1177/16094069231205789>

Nagasaka, K., Böcher, M., & Krott, M. (2016). Are forest researchers only scientists?

Case studies on the roles of researchers in Japanese and Swedish forest policy processes. *Forest Policy and Economics*, 70, 147–154.

<https://doi.org/10.1016/j.forpol.2016.06.006>

Nan, X., Futerfas, M., & Ma, Z. (2017). Role of narrative perspective and modality in the

persuasiveness of public service advertisements promoting HPV vaccination.

Health Communication, 32(3), 320–328.

<https://doi.org/10.1080/10410236.2016.1138379>

Neo, L. S., Tan, K., Tan, H. H., Teo, E., Ng, L. L., & Tan, W. L. (2024). Thematic

analysis of observed interviewer misbehaviours: An audit approach. *International Journal of Market Research*, 66(1), 73–90.

<https://doi.org/10.1177/14707853231206356>

Nielsen, K., Ng, K., Guglielmi, D., Lorente, L., Pătraș, L., & Vignoli, M. (2023). The

importance of training transfer of non-technical skills safety training of

construction workers. *International Journal of Occupational Safety and*

Ergonomics, 29(1), 444–452. <https://doi.org/10.1080/10803548.2022.2052624>

Nielsen, K., Ng, K., Vignoli, M., Lorente, L., & Peiró, J. M. (2023). A mixed methods

study of the training transfer and outcomes of safety training for low-skilled

workers in construction. *Work & Stress*, 37(2), 127–147.

<https://doi.org/10.1080/02678373.2022.2086646>

- Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence Based Nursing, 18*(2), 34–35. <https://doi.org/10.1136/eb-2015-102054>
- Olsen, J. E., PE, & Lewis, G. B. “Bart.” (2023, May). Predictive maintenance basics for process safety engineers. *Chemical Engineering Progress, 119*(5), 26–33. ProQuest One Academic.
- Oltean, F. D., & Gabor, M. R. (2016). Service diversification – a multi-method analysis in Mures County hotels. *Engineering Economics, 27*(5), 618–628. <https://doi.org/10.5755/j01.ee.27.5.14153>
- Omid, L., Karimi, H., Pilbeam, C., Mousavi, S., & Moradi, G. (2023). Exploring the relationships among safety leadership, safety climate, psychological contract of safety, risk perception, safety compliance, and safety outcomes. *Frontiers in Public Health, 11*, Article 1235214. <https://doi.org/10.3389/fpubh.2023.1235214>
- OSHA. (n.d.-a). *Hazard communication—Overview: Occupational Safety and Health Administration*. Retrieved July 18, 2025, from <https://www.osha.gov/hazcom>
- OSHA. (n.d.-b). *Personal protective equipment—Overview Occupational Safety and Health Administration*. 2025. <https://www.osha.gov/personal-protective-equipment>
- OSHA. (1998). *OSH Act of 1970* [https://www.osha.gov/laws-regs/oshact/section_5].
- OSHA. (2016). Recommended practices for safety and health programs. *Safety Management*. <https://www.osha.gov/sites/default/files/publications/OSHA3885.pdf>

- OSHA. (2022, August). *OSHA's whistleblower protection program*. Occupational Safety and Health Administration.
<https://www.osha.gov/sites/default/files/publications/OSHA3638.pdf>
- OSHA. (2023). *Commonly used statistics Occupational Safety and Health Administration*. <https://www.osha.gov/data/commonstats>
- OSHA. (2025). *About OSHA*. <https://www.osha.gov/aboutosha>
- OSHA Online Center. (2023, March 6). The evolution of OSHA: A brief history of workplace safety in the United States. *OSHA Online Center*.
<https://blog.oshaonlinecenter.com/the-evolution-of-osha-a-brief-history-of-workplace-safety-in-the-united-states/>
- O'Shaughnessy, R., Dallos, R., & Gough, A. (2013). A narrative study of the lives of women who experience anorexia nervosa. *Qualitative Research in Psychology*, *10*(1), 42–62. <https://doi.org/10.1080/14780887.2011.586100>
- Øye, C., Sørensen, N. Ø., & Glasdam, S. (2016). Qualitative research ethics on the spot: Not only on the desktop. *Nursing Ethics*, *23*(4), 455–464.
<https://doi.org/10.1177/0969733014567023>
- Park, J., & Park, M. (2016). Qualitative versus quantitative research methods: Discovery or justification? *Journal of Marketing Thought*, *3*(1), 1–7.
<https://doi.org/10.15577/jmt.2016.03.01.1>
- Pedrosa, M. H., Salazar, A. K., Cardoso, C., & Guedes, J. C. (2025). Study on safety culture following the implementation of a near-miss management system in the

traditional manufacturing industry. *Safety*, 11(1), 23.

<https://doi.org/10.3390/safety11010023>

Pham, T. T., Lingard, H., & Zhang, R. P. (2023). Factors influencing construction workers' intention to transfer occupational health and safety training. *Safety Science*, 167, Article 106288. <https://doi.org/10.1016/j.ssci.2023.106288>

Phillips, J., & Phillips, P. (2014). Developing a human capital strategy in today's changing environment: Eight forces shaping HC strategy. *Strategic HR Review*, 13(3), 130–134. <https://doi.org/10.1108/SHR-01-2014-0002>

Pierce, J. L. (2012). Using geosemiotic analysis to explore power and interaction in ESL classrooms. *TESL-EJ*, 16(1).

Pinninti, V. R. R., & Pinninti, P. (2023). Using drones to reduce plant inspection risks and costs: Real-world case studies. *IUP Journal of Information Technology*, 19(3), 7–20. Computers & Applied Sciences Complete.

Prakhov, I. (2021). The determinants of expected returns on higher education in Russia: A human capital theory approach. *Higher Education Quarterly*, 75(2), 302–320. <https://doi.org/10.1111/hequ.12281>

Professional Safety. (2025). OSHA & EPA enter into MOU to manage chemicals. *Professional Safety*, 70(3), 10. ProQuest One Academic.

Raghavan, R., & Joshi, J. B. (2018, December). India's expanding chemical industry. *Chemical Engineering Progress*, 114(12), 49. ProQuest One Academic.

Reid, J., Schmied, V., Sheehan, A., & Fenwick, J. (2014). 'Be our guest': Challenges and benefits of using 'family conversations' to collect qualitative data about infant

- feeding and parenting. *Journal of Clinical Nursing*, 23(17–18), 2404–2413.
<https://doi.org/10.1111/jocn.12224>
- Reis, T., Moura, P. C., Gonçalves, D., Ribeiro, P. A., Vassilenko, V., Fino, M. H., & Raposo, M. (2024). Ammonia detection by electronic noses for a safer work environment. *Sensors*, 24(10), Article 10. <https://doi.org/10.3390/s24103152>
- Reybold, L. E., Lammert, J. D., & Stribling, S. M. (2013). Participant selection as a conscious research method: Thinking forward and the deliberation of ‘emergent’ findings. *Qualitative Research*, 13(6), 699–716.
<https://doi.org/10.1177/1468794112465634>
- Ridley, D. (2024). Educating for a just transition, or the poverty of human capital theory. *New Formations*, 110(110), 131–146. <https://doi.org/10.3898/NewF:110-111.08.2024>
- Robinson, O. C. (2014). Sampling in interview-based qualitative research: A theoretical and practical guide. *Qualitative Research in Psychology*, 11(1), 25–41.
<https://doi.org/10.1080/14780887.2013.801543>
- Saedi, A. M., Ab. Majid, A., & Isa, Z. (2020). Relationships between safety climate and safety participation in the petroleum industry: A structural equation modeling approach. *Safety Science*, 121, 240–248.
<https://doi.org/10.1016/j.ssci.2019.08.045>
- Sagirli, M. O. (2010). The examination of the educational effects of some writing activities in the light of student opinions. *Kuram Ve Uygulamada Egitim Bilimleri*, 10(4), 2521–2530.

- Savage, T. N., & McIntosh, A. S. (2017). Tackling reliability and construct validity: The systematic development of a qualitative protocol for skill and incident analysis. *Journal of Sports Sciences, 35*(5), 449–456.
<https://doi.org/10.1080/02640414.2016.1172722>
- Schady, N. R. (2003). Convexity and sheepskin effects in the human capital earnings function: Recent evidence for filipino men. *Oxford Bulletin of Economics and Statistics, 65*(2), 171–196. <https://doi.org/10.1111/1468-0084.00042>
- Schlea, S. H., & Wilkes, W. (2021). Using the toxic substance control act for source water protection. *Journal: American Water Works Association, 113*(6), 26–36. Computers & Applied Sciences Complete. <https://doi.org/10.1002/awwa.1745>
- Schoonover, S. C. (2025). Energizing federal action toward a more coherent national nuclear waste policy. *Vanderbilt Law Review, 78*(3), 1037–1076. Academic Search Complete.
- Shaffer, R. M., Lee, A. L., Nachman, R., Christensen, K., & Bateson, T. F. (2025). A perspective from US Environmental Protection Agency (EPA) scientists: How your epidemiologic analyses can inform the human health risk assessment process. *Environmental Health Perspectives, 133*(3–4), 45001. MEDLINE with Full Text. <https://doi.org/10.1289/EHP15203>
- Shimizu, T., Nagata, T., Fujimoto, A., Inoue, S., Nagata, M., & Mori, K. (2022). Occupational safety and health aspects of corporate social responsibility reporting in Japan: Comparison between 2012 and 2020. *BMC Research Notes, 15*(1), 260. <https://doi.org/10.1186/s13104-022-06145-6>

- Shin, K. (2021). In-house contractors' exposure to risks and determinants of industrial accidents; with focus on companies handling hazardous chemicals. *Safety and Health at Work*, 12(2), 261–267. <https://doi.org/10.1016/j.shaw.2020.12.006>
- Shorten, A., & Moorley, C. (2014). Selecting the sample. *Evidence Based Nursing*, 17(2), 32–33. <https://doi.org/10.1136/eb-2014-101747>
- Sims, J. M. (2010). A brief review of the Belmont Report. *Dimensions of Critical Care Nursing*, 29(4), 173–174. <https://doi.org/10.1097/DCC.0b013e3181de9ec5>
- Smith, A. (2000). *Wealth of nations*.
- Smith, B. (2013). Triple jeopardy: When OSHA, EPA and DOJ work together. *EHS Today*, 6(12), 38–40. Business Source Complete.
- Sofri, S., Reddy Prasad, D. M., Azri, M. H., & Raja Sekhar, Y. (2025). Undergraduates' process safety knowledge development with virtual reality game. *Interactive Learning Environments*, 33(2), 1422–1440. <https://doi.org/10.1080/10494820.2024.2371938>
- Spengler, J. J. (1977). Adam Smith on human capital. *American Economic Review*, 67(1), 32–36.
- Stanek, L. W., Cascio, W. E., Barzyk, T. M., Breen, M. S., DeLuca, N. M., Griffin, S. M., Melnyk, L. J., Minucci, J. M., Thomas, K. W., Tolve, N. S., Weaver, C. P., & Cohen Hubal, E. A. (2025). Environmental public health research at the U.S. environmental protection agency: A blueprint for exposure science in a connected world. *Journal of Exposure Science & Environmental Epidemiology*, 35(4), 539–547. <https://doi.org/10.1038/s41370-024-00720-8>

- Stephens, S. J. (2009). Case study on industrial hazmat response teams. *Journal of Business Continuity & Emergency Planning*, 4(1), 22.
<https://doi.org/10.69554/coeb5953>
- Taha, S., Osaili, T. M., Griffith, C. J., Fadhel, A., Holley, R., Sprenger, R., Albloush, A., Nasaj, M., & Hilal, H. (2025). Fostering food safety culture in restaurants in the United Arab Emirates (UAE): Leadership impact on food handlers' commitment and compliance. *Journal of Food Protection*, 88(7), Article 100523.
<https://doi.org/10.1016/j.jfp.2025.100523>
- Tajik, O., Golzar, J., & Noor, S. (2025). Purposive sampling. *International Journal of Education Language Studies*, Online First.
<https://doi.org/10.22034/ijels.2025.490681.1029>
- Tan, Z. C., Tan, C. E., & Choong, Y. O. (2023). Occupational safety & health management and corporate sustainability: The mediating role of affective commitment. *Safety and Health at Work*, 14(4), 415–424.
<https://doi.org/10.1016/j.shaw.2023.10.006>
- Tappura, S. (2021). *OHS management skill development and continuing learning*. Human Systems Engineering and Design (IHSED2021) Future Trends and Applications.
<https://doi.org/10.54941/ahfe1001139>
- Teixeira, P. N. (2011). A reluctant founding father: Placing Jacob Mincer in the history of (labor) economics. *The European Journal of the History of Economic Thought*, 18(5), 673–695. <https://doi.org/10.1080/09672567.2011.629055>

- Tenpas, R., Snow, C., & Flesch, H. M. (2023). Safe drinking water act enforcement: Updates and information for water utilities. *Journal: American Water Works Association, 115*(9), 60–64. Computers & Applied Sciences Complete. <https://doi.org/10.1002/awwa.2181>
- Theofanidis, D., & Fountouki, A. (2019). *Limitations and delimitations in the research process*. <https://doi.org/10.5281/ZENODO.2552022>
- Toye, G., Sheppard, S., & Chen, H. L. (2016). Data sharing and reuse within the academic pathways study. *Advances in Engineering Education, 5*(2), 1–19.
- Treloar, A., Stone, T. E., McMillan, M., & Flakus, K. (2015). A narrative in search of a methodology: A narrative in search of a methodology. *Perspectives in Psychiatric Care, 51*(3), 202–210. <https://doi.org/10.1111/ppc.12081>
- Tribe, K. (2022). Framing the wealth of nations. *History of Political Economy, 54*(5), 951–973. <https://doi.org/10.1215/00182702-10005802>
- Tsai, A. C., Kohrt, B. A., Matthews, L. T., Betancourt, T. S., Lee, J. K., Papachristos, A. V., Weiser, S. D., & Dworkin, S. L. (2016). Promises and pitfalls of data sharing in qualitative research. *Social Science & Medicine, 169*, 191–198. <https://doi.org/10.1016/j.socscimed.2016.08.004>
- Tsalidis, G. A. (2024). Introducing the occupational health and safety potential midpoint impact indicator in social life cycle assessment. *Sustainability, 16*(9), Article 3844. <https://doi.org/10.3390/su16093844>
- Tupper, C., & Swift, C. (2022). *OSHA chemical hazards and communication*. <https://www.ncbi.nlm.nih.gov/books/NBK580552/>

- Tüzel, S. (2013). The analysis of L1 teaching programs in England, Canada, the USA and Australia regarding media literacy and their applicability to turkish language teaching. *Educational Sciences: Theory and Practice*, 13(4), 2310–2316.
- Twinn, D. S. (1998). An analysis of the effectiveness of focus groups as a method of qualitative data collection with Chinese populations in nursing research. *Journal of Advanced Nursing*, 28(3), 654–661. <https://doi.org/10.1046/j.1365-2648.1998.00708.x>
- Uhlig, H. (2022). The lasting influence of Robert E. Lucas on Chicago economics. *Journal of Economic Methodology*, 29(1), 48–65. <https://doi.org/10.1080/1350178X.2022.2032272>
- Underwood, A., Marcantonio, R., Wood, D., & Crippa, P. (2024). Interstate air pollution governance in the United States: Exploring clean air act section 126. *Environmental Management*, 74(3), 401–413. <https://doi.org/10.1007/s00267-024-02002-3>
- Unicomb, R., Colyvas, K., Harrison, E., & Hewat, S. (2015). Assessment of Reliable Change Using 95% Credible Intervals for the Differences in Proportions: A Statistical Analysis for Case-Study Methodology. *Journal of Speech, Language, and Hearing Research*, 58(3), 728–739. https://doi.org/10.1044/2015_JSLHR-S-14-0158
- Uprichard, E. (2013). Sampling: Bridging probability and non-probability designs. *International Journal of Social Research Methodology*, 16(1), 1–11. <https://doi.org/10.1080/13645579.2011.633391>

- Uribe, J., Saraeva, N., Petry, K., Bickford, E., Kreuzer, R., & Howard, R. (2024). Current progress on the development of the integrated waste management consent-based siting process in the united states. *Nuclear Technology*, 210(9), 1748–1753.
<https://doi.org/10.1080/00295450.2023.2262283>
- US EPA. (2025a, February 26). *Final amendments to the risk management rogram (RMP) rule*. United States Environmental Protection Agency.
<https://www.epa.gov/rmp/final-amendments-risk-management-program-rmp-rule>
- US EPA, O. (2016a, Winter). *Clinton administration proposes sweeping new legislation on pesticides and food safety laws* [Announcements and Schedules].
<https://www.epa.gov/archive/epa/aboutepa/clinton-administration-proposes-sweeping-new-legislation-pesticides-and-food-safety-laws.html>
- US EPA, O. (2016b, 16). *Ruckelshaus takes steps to improve flow of agency information* [Reports and Assessments].
<https://www.epa.gov/archive/epa/aboutepa/ruckelshaus-takes-steps-improve-flow-agency-information-fishbowl-policy.html>
- US EPA, O. (2024a, 12). *Evolution of the clean air act* [Overviews and Factsheets].
<https://www.epa.gov/clean-air-act-overview/evolution-clean-air-act>
- US EPA, O. (2024b, 12). *Pollution prevention act of 1990* [Overviews and Factsheets].
<https://www.epa.gov/p2/pollution-prevention-act-1990>
- US EPA, O. (2024c, October 8). *Superfund success stories* [Overviews and Factsheets].
<https://www.epa.gov/superfund/superfund-success-stories>

- US EPA, O. (2025b, 07). *Accomplishments and successes of reducing air pollution from transportation in the United States* [Overviews and Factsheets].
<https://www.epa.gov/transportation-air-pollution-and-climate-change/accomplishments-and-successes-reducing-air>
- US EPA, O. (2025c, 28). *EPA history: Marine protection, research and sanctuaries act* [Collections and Lists]. <https://www.epa.gov/history/epa-history-marine-protection-research-and-sanctuaries-act-ocean-dumping-act>
- US EPA, O. (2025d, 14). *Summary of the clean air act* [Overviews and Factsheets].
<https://www.epa.gov/laws-regulations/summary-clean-air-act>
- US EPA, O. (2025e, January 13). *New report celebrates EPA's unprecedented successes under Biden-Harris administration's investing in america agenda* [News Release]. <https://www.epa.gov/newsreleases/new-report-celebrates-epas-unprecedented-successes-under-biden-harris-administrations>
- US EPA, O. (2025f, March 19). *Progress cleaning the air and improving people's health* [Reports and Assessments]. <https://www.epa.gov/clean-air-act-overview/progress-cleaning-air-and-improving-peoples-health>
- US EPA, O. (2025g, May 15). *U.S. Environmental Protection Agency* [Collections and Lists]. <https://www.epa.gov/home>
- Utikal, H., & Woth, J. (2015). From megatrends to business excellence: Managing change in the German chemical and pharmaceutical industry. *Journal of Business Chemistry*, 12(2), 41–47.

- Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly*, 37(1), 21–54.
- Versluis, E., Van Asselt, M., Fox, T., & Hommels, A. (2010). The EU seveso regime in practice. *Journal of Hazardous Materials*, 184(1–3), 627–631.
<https://doi.org/10.1016/j.jhazmat.2010.08.082>
- Wang, D., Mao, W., Zhao, C., Wang, F., & Hu, Y. (2023). The cross-level effect of team safety-specific transformational leadership on workplace safety behavior: The serial mediating role of team safety climate and team safety motivation. *Journal of Safety Research*, 87, 285–296. <https://doi.org/10.1016/j.jsr.2023.05.001>
- Wang, J., Guo, Q., Wang, F., Aviso, K. B., Tan, R. R., & Jia, X. (2021). System dynamics simulation for park-wide environmental pollution liability insurance. *Resources, Conservation and Recycling*, 170, Article 105578.
<https://doi.org/10.1016/j.resconrec.2021.105578>
- Wang, J.-M., Liao, P.-C., & Yu, G.-B. (2021). The mediating role of job competence between safety participation and behavioral compliance. *International Journal of Environmental Research and Public Health*, 18(11), Article 5783.
<https://doi.org/10.3390/ijerph18115783>
- Watson, M. (2022). The place of glasgow in the wealth of nations: Caught between biography and text, philosophical and commercial history. *History of Political Economy*, 54(5), 975–990. <https://doi.org/10.1215/00182702-10005816>

- Wu, G., & Zhu, Y. (2014). Self-mention and authorial identity construction in English and Chinese research articles: A contrastive study. *Linguistics & the Human Sciences*, 10(2), 133–158. <https://doi.org/10.1558/lhs.v10.2.28557>
- Wu, V. Y. (2025). Watering down enforcement: Inadequate criminal liability in state clean water act programs. *Stanford Law Review*, 77(5), 1303–1374. Academic Search Complete.
- Yang, N., Jiang, J.-C., Huang, A.-C., Tang, Y., Li, Z.-P., Cui, J.-W., Shu, C.-M., & Xing, Z.-X. (2022). Thermokinetic model-based experimental and numerical investigation of the thermal hazards of nitrification waste. *Journal of Loss Prevention in the Process Industries*, 79, Article 104836. <https://doi.org/10.1016/j.jlp.2022.104836>
- Yates, J., & Leggett, T. (2016). Qualitative research: An introduction. *Radiologic Technology*, 88, 225–231.
- Young, C. E. (2025). Inhance technologies, L.L.C. v. EPA: Navigating “new” and narrowing the EPA’s reach under the toxic substances control act. *Tulane Law Review*, 99(4), 913–929. Academic Search Complete.
- Zhang, S., Hua, X., Huang, G., & Shi, X. (2022). How does leadership in safety management affect employees’ safety performance? A case study from mining enterprises in China. *International Journal of Environmental Research and Public Health*, 19(10), 6187. <https://doi.org/10.3390/ijerph19106187>

Zhao, L., Yang, D., Liu, S., & Nkrumah, E. N. K. (2022). The effect of safety leadership on safety participation of employee: A meta-analysis. *Frontiers in Psychology*, *13*, Article 827694. <https://doi.org/10.3389/fpsyg.2022.827694>

Appendix A: Interview Questions

1. What strategies do you use to reduce safety accidents?
2. What are some strategies that are no longer being used?
3. What strategies were most effective?
4. What barriers or challenges have you encountered when implementing strategies to reduce safety accidents?
5. How did you overcome the barriers or challenges to successfully reduce safety accidents?
6. What additional information would you like to share about strategies to reduce safety accidents within the chemical organization?

Appendix B: Interview Protocol

Action	Script
<p>Introduced the purpose of the interview before sending the consent form and how it would assist safety research and my degree completion.</p>	<p>Hello, thank you for taking the time to participate in this research study. I appreciate your willingness to share your experiences. I have been working on a degree for a Doctor of Business Administration for the past few years. In this study, I am exploring strategies used in the chemical industry to reduce safety accidents.</p> <p>Prior to today, you agreed to the informed consent form via email. Do you have any questions for me or any matter that requires my attention? This interview is confidential, and your identity and that of your organization shall remain anonymous and represented by codes.</p> <p>I will collect data using semistructured interview questions. The idea is to allow you to explain any strategies, events, and memories that answer the interview questions. During your narration, I may prompt you for further explanation and details.</p> <p>I will be recording the audio and there will be a live transcription to ensure accuracy.</p> <p>Note that you may rescind your decision to participate in the research anytime.</p>
<p>Asked Interview Questions to get in-depth responses. Listenend for nonverbal cues.</p>	<p>What strategies do you use to reduce safety accidents? What are some strategies that are no longer being used? What strategies were most effective? What barriers or challenges have you encountered when implementing strategies to reduce safety accidents? How did you overcome the barriers or challenges to successfully reduce safety accidents?" What additional information would you like to share about strategies to reduce safety accidents within the chemical organization?</p> <p>In a few days, I will need your assistance in authenticating my understanding of your responses to the interview questions as part of the research process. I will send the transcript and a summary of what I understood from your responses by email. You may adjust the script or add to your initial responses if needed. If needed or requested we can discuss it by phone if you agree.</p> <p>Again, thank you for participating. I have attached a copy of the transcript, as well as my summary. Please review for accuracy. This is also a chance to add or delete any information you have missed or misunderstood.</p> <p>Your support and contribution to this doctoral research is greatly appreciated, and I thank you very much for helping me to achieve my doctoral degree. Upon degree completion, I will share my findings with you. I hope you will find the research findings can be of some benefit to your organization and safety development.</p>
<p>Scheduled transcript review by email.</p>	
<p>Reiterated the opportunity to add or remove information.</p>	
<p>Wrap up the interview by thanking participants.</p>	