Ergonomic Safety in Supply Chains

by

Andrew T. Prior

Dissertation

Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Ergonomic injuries within supply chain and logistics organizations, specifically the finished vehicle logistics realm, have become a global crisis. The only way to solve this crisis is through proactive steps to reduce the lagging indicator of incident frequency and costs. This mixed method research study demonstrates the use of wearable safety technology to lower both incident frequency and incident cost. Quantitatively, this study resulted in statistically significant results that reduced the incident frequency at one site within the United States. Qualitatively, and the studies mixed results from the leadership and hourly employee within a finished vehicle logistics organization. Leadership focused on the financial results of the technology implication, while hourly employees focused on the safety and growth of the holistic group of employees within the site. However, the organizational identification theory demonstrates why both groups focused on their in-group results and biases. The goal incongruence of both groups is due to agency theory, where the goals of both groups were not aligned before implementing the study. The results of this study demonstrate the need for future research into wearable safety technology within the supply chain and logistics organizations to lower work-related injuries.

Keywords: ergonomic injuries, wearable safety technology, agency theory, theory of organizational identification

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Approvals

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Dedication

This research study demonstrates the Doctoral persistence, dedication, and mindset needed to conquer tough challenges. First, I would like to thank God for giving me the courage, persistence, determination, and strength to complete this lengthy research study and the overall Doctoral program. Luke 1:37 reminds us that “nothing is impossible with God” (Today’s New International Version), and this statement was a true reflection of the doctoral persistence necessary for this research study's successful completion. Next, I would like to thank my wife, Heather Prior, for supporting me through this journey, her support was unparalleled, and I would not have been able to complete this journey without it. Also, I would like to thank Drs. Jessica and Craig Robinson for being great friends and mentors who demonstrated the previous persistence needed to complete similar journeys. Without this support structure, this journey would not be possible. Thank you for all your support.

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I would like to acknowledge the staff at Liberty University, especially my Dissertation Chair Dr. Scott Dickenson, for being there to support me through this journey. The staff at Liberty truly is there to help doctoral students succeed and provide guidance and support through this journey. Finally, I would like to thank all the staff at Wallenius Wilhelmsen for giving me the support, tools, and freedom to complete this journey while maintaining a global senior leadership role.

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Section 1: Foundation of the Study

Employee safety within supply chains is a growing workplace crisis. According to Hemphill and Kelley (2016), the 2013 collapse of the Rana Plaza in Bangladesh resulted in 1,129 people being killed and 2,515 injured. This example is one of the numerous examples where organizations put productivity above employee safety. However, the aftermath of this tragedy was a wake-up call for governments and organizations concerning employee safety in global supply chains. López-García et al. (2019) found that ergonomic injuries affect workers' health, safety, and many other production-related aspects of their day-to-day life. In the United States musculoskeletal injuries are the most common workplace injuries. Globally, the International Organization for Standardization (2018) stated that every 15 seconds, a worker dies from a work-related injury or disease, and 153 experience a work-related injury. That translates into nearly 5,700 work-related fatalities daily and 374 million non-fatal injuries each year.

The only way to solve this growing organizational problem is to counteract the problem with new proactive measures, senior leadership support, and harnessing the power of new technologies to solve the crisis. Koh et al. (2019) demonstrated that new technology could be implemented that helps supply chains ensure process safety and promote social sustainability. Safety is a cultural mindset within the organization, and the following research demonstrated the need to study ergonomic injuries within supply chains, specifically a finished logistics organization in the United States.

In this research study, wearable safety technology was implemented at two sites in the United States to help the finished vehicle logistics organization lower its lost-time injury frequency while providing qualitative and quantitative insight into this growing trend. After implementing the technology, one of those sites demonstrated statistically significant results in reducing the frequency of injuries. The other site did not demonstrate statistical significance but did see a decline in the number of injuries and the cost of those injuries. However, both sites saw a severe goal incongruence in the qualitative outcome due to leadership and hourly employee goals not being aligned prior to implementing the technology. Therefore, the results of this study call for future research into the implementation of wearable safety technology in supply chain and logistics organizations. Finally, further research is needed into the convergence of organizational identification and agency theory.

Background of the Problem

All members of an organization must provide the safest workplace possible. According to Hughes (2019), leadership must meet a higher workplace safety standard within a supply chain organization. This workplace safety is especially relevant in the supply chain and logistics industry due to the nature of injuries, where leaders must proactively mitigate the level of risk that the organization faces. Like many other logistics and supply chain facilities, the finished vehicle logistics facilities face a need to reduce employee-related ergonomic injuries. These injuries are measured by the organization's injury frequency rate is a trailing indicator of injuries used as a metric for measurement (Pater, 2017). The trailing indicator of injury frequency demonstrates the number of injuries per million hours worked that can be used to measure this research. However, the organization must proactively meet trailing indicators with new solutions to reduce the frequency of injuries in the future.

Pater (2017) also illustrated that a proactive approach to reducing ergonomic-related injuries is the best solution instead of organizations rehashing old habits. To achieve this goal, supply chain organizations must deliver safety programs that focus on reducing employee-related occupational injuries. These safer supply chains could be achieved by implementing new ergonomic technologies. Antwi-Afari et al. (2019) found that many technologies exist in the market that are designed to improve an organization's occupational health and safety programs, resulting in lower workplace injuries. Therefore, to be successful practitioners in the supply chain and logistics industry, the leadership must be knowledgeable and focus on not only production management techniques but also the overall safety of the employees and the organization. This pragmatic research focused on the quantitative and quantitative impacts of implementing wearable safety technology within the finished vehicle logistics facilities in the United States. This research's outcome provided the finished vehicle logistics organization with a guideline for lowering employee-related safety incidents by implementing wearable safety technology, giving the organization a proactive approach to meeting employee safety needs. Schulman (2020) illustrated that organizational safety would penetrate all levels of the employee's job function. Therefore, this research provided a pathway for the finished vehicle logistics organization to lower injuries, demonstrated safety-related behavioral impacts, and proactively implemented technology to reduce employee-related ergonomic injuries.

Problem Statement

The general problem to be addressed is employee-related ergonomic injuries within organizations, resulting in an increased organizational incident frequency rate. Pagell et al. (2016) found that in 2014, the U.S. Occupational Safety and Health Administration (OSHA) recorded 2.8 million non-fatal occupational injuries across all industries. Kao et al. (2021) illustrated that to address these occupational injuries, an organization must understand employees' safety behaviors and the safety climate of the organization, which are predictors of workplace injuries. To help address this problem, Antwi-Afari et al. (2019) illustrated that many technologies exist that improve an organization's occupational health and safety programs, which can result in lower workplace injuries. Within supply chain and logistics organizations, Schnittfeld and Busch (2016) found that organizational stakeholders demand a sustainable response to the changing health and safety challenges. The specific problem to be addressed is the lack of data to substantiate the potential usage of wearable safety technology at finished vehicle logistics facilities in the United States to reduce employee-related ergonomic injuries, possibly resulting in decreasing the organization's injury frequency rate.

Purpose Statement

The purpose of this mixed method convergent parallel research was to expand the understanding of how wearable safety technology could impact an organization's injury frequency rate through a proactive implementation of new technology. The research sought to determine the quantitative impact of wearable safety technology on the organization's injury frequency rate and the qualitative impacts that can also impact the injury frequency rate. In addition, this study would research the more significant problem of employee-related ergonomic injuries at organizations within the global logistics and supply chain.

Research Questions

RQ1: Quantitative Research Question: What are the historic injury rates for the U.S. warehousing and distribution industry compared to the organization's historic injury frequency rates?

RQ1a: What are the organization's historical injury frequency rates?

RQ1b: What are the organization's historical costs associated with ergonomic injuries?

RQ1c: What are the historical injury frequency rates for the U.S. warehousing and distribution sector?

RQ1d: How do the organization's historical injury rates compare to the U.S. warehousing and distribution industry's historical injury rates?

RQ2: Qualitative Research Question: What are the impacts of the injury frequency rate on the organization?

RQ3: Quantitative Research Question: What is the organization's injury frequency rate and injury costs after implementing the wearable safety technology?

RQ3a: What are the organization's injury frequency rates after implementing the wearable safety technology?

RQ3b: What are the organization's injury costs associated with ergonomic injuries after implementing the wearable safety technology?

RQ3c: How do the organization's injury frequency rates compare to those within the warehousing and distribution sector after implementing the wearable safety technology?

RQ4: Qualitative Research Question: What other behavioral changes can be observed positively influencing reducing injury frequency after implementing the wearable safety technology?

Hypotheses

$H1_0$. There is no statistically significant relationship between the implementation of wearable safety technology and the organization's incident frequency rate.

Alternative $H1_A$. There is a statistically significant relationship between the implementation of wearable safety technology and the organization's incident frequency rate.

Relationship to Research Question – H1 addresses RQ3, which sought to explain the influence of wearable safety technology on the organization's injury frequency rate.

Variables included – H1 includes the dependent variable of the organization’s injury frequency rate and the independent variable of the safety-related data gathered from the technology devices.

$H2_0$. There is no statistically significant relationship between the implementation of wearable safety technology and the organization’s cost of injuries.

Alternative $H1_A$. There is a statistically significant relationship between the implementation of wearable safety technology and the organization’s cost of injuries.

Relationship to Research Question – H2 addresses RQ3, which sought to explain the influence of wearable safety technology on the organization’s costs from ergonomic injuries.

Variables included – H1 includes the dependent variable of the organization’s costs and the independent variable of the safety-related data gathered from the technology devices.

Nature of the Study

The research concept presented follows a pragmatic mixed methods approach to researching the implementation of wearable safety technology at two finished vehicle logistics facilities across the United States. This research presented a pathway for leadership to meet a higher safety standard in their organizations. However, a critical understanding of the implications of all research paradigms, designs, methods, and triangulation must occur.

Research Paradigms

Several interpretive frameworks can be followed, which are the researcher's fundamental beliefs that guide their analysis. These interpretive frameworks provide the background for the research paradigm. Creswell and Poth (2018) illustrated that these interpretive frameworks are post-positivism, social constructivism, transformative, postmodern, and pragmatism.

Post-positivism research follows a grounded scientific approach that is logical, cause-and-effect oriented, and empirical. Creswell and Poth (2018) illustrated that post-positivist research would follow a series of logically related steps to view the perspective of the participant rather than a single reality. The researcher used computers to assist with their analysis and follow the grounded theory methodology. Those who follow a social constructivism paradigm, sometimes known as interpretivism, seek understanding in their world through developing meaning from subjective experiences. These researchers did not start with a theory; instead, the researcher developed their theory through research. Open-ended questions are used to give the researcher a greater perspective on the participant's viewpoint while the researcher listens carefully to what the participants are saying.

While the post-positivist would follow a structure, the constructivist may not advocate for action. One alternative framework that is available to the researcher is the transformative framework. Creswell and Poth (2018) demonstrated that the transformative framework allows the researcher to understand that knowledge reflects social relationships and power within society. Many transformative frameworks seek to understand a marginalized participant's worldview of a situation. Similarly, the postmodern researcher would seek to change thinking methods rather than call for action like the transformative researcher. The transformative researcher would see knowledge within a set of conditions and from multiple perspectives. Those conditions are seen as unfavorable through hierarchies and power and can have multiple meanings in languages.

This research implemented wearable safety technology into two finished vehicle logistics facilities across the United States and measured the qualifiable and quantifiable results. This research followed the pragmatic paradigm, which Creswell and Poth (2018) found that individuals who follow the pragmatic methodology develop meaning from their experiences, which is how they seek to understand their worlds. Clarke and Visser (2019) found that the pragmatic perspective would inform the researcher's understanding of specific methodologies. Therefore, the pragmatic approach to this design gave the most significant value to this research. In this instance, the sought experience is employee-related ergonomic injuries, which is correlated to the meaning of why those injuries happen and what can be done to help prevent them. Jucker et al. (2018) stated it best "data, in one form or another, form the essence of what pragmatic research is about" (p. 3). The pragmatic approach allowed the researcher to view this opportunity with an open mind and try to solve this research as best as possible.

Research Designs

Several types of research designs could be used, depending on the type of research being performed and the suitability of each design. These research designs are fixed, flexible, and mixed method. Robson and McCartan (2016) illustrated that the fixed design is typically used with quantitative research designs. These designs are pre-determined before data collection and cannot be changed. At the same time, the flexible design is traditionally used with qualitative research, which allows for flexibility during the data collection process. However, the mixed method design combines qualitative and quantitative aspects into one research design.

This research focused on a mixed method design. Lukenchuk (2017) illustrated that mixed method designs have superiority over single-method research because of the ability to combine qualitative and quantitative research. This mixed method design used qualitative and quantitative methods, specifically convergent parallel research. Two research questions focused on the quantitative measurement of wearable safety technology implementation related to employee-related ergonomic injuries. Brunsdon (2016) illustrated that quantitative research must be rigorously tested and be repeatable by a third party. This part of the research would be data-driven and be able to be replicated by a third party for data integrity. Simultaneously, the other two research questions focused on the qualitative impacts of this same implementation. Denny and Weckesser (2019) illustrated that qualitative research must focus on understanding a person's experience and providing insights into the research. This methodology was appropriate for the other two research questions as the researcher sought to gain insight into the qualifiable outcomes from the organizational implementation of wearable safety technology.

Research Methods

The mixed method approach, focusing on convergent parallel research, allowed the researcher to examine this problem from qualitative and quantitative aspects. McKim (2017) found that "mixed methods added value by increasing validity in the findings, informing the collection of the second data source, and assisting with knowledge creation" (p. 203). For this research, the researcher was able to inform the organization of all aspects of reducing employee-related ergonomic injuries. According to Demir and Pişmek (2018), "a convergent parallel design entails that the researcher concurrently conducts the quantitative and qualitative elements in the same phase of the research process, weighs the methods equally, analyzes the two components independently, and interprets the results together" (p. 123).

First, the quantitative research questions correlated the wearable safety technology's implementation to the injury frequency and cost. Advanced statistics were used to measure the application of the technology and that correlation. Next, the qualitative research examined the two research questions that sought to learn the organization's subjective impacts after implementing the safety technology. This approach allowed the researcher to use a qualitative approach to explain the effects of the quantitative data and the implementation of wearable safety technology after collecting ample amounts of data.

Discussion of Research Triangulation

Since this research followed a mixed method approach, with fixed quantitative and flexible qualitative data, triangulation is critical for data and research validity. Gibson (2017) found that "triangulation allows scholars to document consistency in findings using different means of obtaining those findings, increasing our confidence that the findings are not driven by a particular method or data source" (p. 203). As previously demonstrated, the quantitative research questions focused on the quantitative measurement of wearable safety technology implementation related to employee-related ergonomic injuries. At the same time, the qualitative research questions focused on the qualitative impacts of this same implementation. The process of combining these findings is triangulation.

First, considering this research followed the convergent parallel method, both data sets were examined separately. Then, the results were listed together to find convergence from each method, complementary data from each method, and to find any discrepancies. Next, a triangulation protocol was developed using a coding matrix to display findings that emerged from each part of the study. Finally, considerations were decided regarding agreement, partial agreement, silence, and dissonance between the qualitative and quantitative data findings. This matrix and the protocol allowed the researcher to demonstrate the convergent parallel applications of this research between the qualitative and quantitative findings to answer all research questions.

Theoretical Framework

The following research framework demonstrates the connection between this research's concepts, theories, participants, and constructs, as demonstrated in Figure 1. First, the concepts demonstrate the need for this study to exist within the field of research. Next, several theories exist that explain the relationship of the concepts to the participants. For example, the two-party relationship describes how the organization's needs may not be congruent with employees' needs. Then, the research participants were part of this research to understand their perspectives. Several constructs and variables were used in this research, which was discussed. Finally, the relationship between the different elements was addressed, demonstrating a succinct platform for this research.

Research Concepts

When implementing new technology into supply chains, Straub (2018) found that management support was the most frequently selected barrier to implementing safety-related change in the workplace. This research demonstrated how a supply chain company lowered ergonomic injuries by implementing wearable safety technology at a finished logistics company. This implementation was demonstrated through the following research framework.

First is the concept that wearable safety technology could possibly reduce employee-related ergonomic injuries. Antwi-Afari et al. (2019) illustrated that many technologies exist that improve an organization's occupational health and safety programs, which can result in lower workplace injuries. For this research problem, wearable safety technology monitored if that technology could reduce employee-related ergonomic injuries.

Next, the concept that reducing employee-related ergonomic injuries could possibly decrease the organization's injury frequency rate. Pater (2017) found that a proactive approach to reducing employee-related ergonomic injuries is the best solution to this trailing indicator issue. However, these trailing indicators are past measurements and can determine what went wrong and how proactive implementations can help fix those indicators. Therefore, the proactive implementation of wearable safety technology, measured against the trailing indicator measurement of injury frequency, could decrease the organization’s future injury frequency rate.

The following research concept is that other safety-related behavioral changes were witnessed. These behavioral changes are a crucial concept that allowed the researcher to qualitatively demonstrate that these behavioral changes could flow to other facets of the organization. Cirjaliu and Draghici (2016) illustrated that lean manufacturing had led organizations to push productivity to achieve the organization's goals, but this shift has led to ergonomic issues in the workplace. This shift in focus from safety to production has led many supply chain organizations to see a rise in ergonomic injuries. This concept sought to identify the other safety-related behavioral changes during this research.

The final concept focused on the qualitative impacts of safety-related behaviors that can be measured through the convergent parallel approach. Schulman (2020) illustrated that safety would penetrate down to all employee-related job functions. Therefore, this qualitative approach measured the other impacts of new wearable safety technology on the organization outside of the previously defined safety-related behavioral changes.

Research Theories

Figure 1 shows the flow of information, action, and ideas that lead to the analysis and recommendations. First is a discussion of the theories that apply to this research. Agency theory explains a two-party relationship, in this case, an employee and employer relationship, whose goals may not be congruent. Ross (1973) initially stated that this theory seeks to minimize the goal-incongruence effect due to humans being self-interested individuals. The agency theory was applicable in this research because the organization's and employees' goals must be aligned for a successful implementation. For this research, agency theory was applied to all relationships between the participants regarding their incongruent goals.

Next, the innovation diffusion theory was described by Dearing and Cox (2018) as “innovation that is communicated through certain channels over time among members of a social system” (p. 183). This theory describes how innovations are adopted within the population of potential adopters. The hourly employees were the adopters, and the innovation diffusion theory helps explain the adoption of the new technology implemented at the finished vehicle logistics facilities. However, this theory was only applicable to hourly employees and site-level leadership. All other participants had a vested interest in adopting the new technology, but the diffusion of the innovation would happen at the site level.

Ajzen (1991) illustrated that the theory of planned behavior is a theory that proposes behaviors based on the individual’s intention regarding that behavior, which is a function of their attitude toward that behavior. In this research, employee-related ergonomic injuries are behaviors that need modification, and the technology provided information to change those behaviors. This theory solely revolved around the hourly employees adopting the new technology regarding their behaviors.

Robinson et al. (2018) illustrated that the theory of organization identification is demonstrated when visible group dynamics are formed and create an in-group bias and out-group discrimination. The in-group biases create a feeling of connectedness and belonging to the organization. This theory was seen within the research as the goal incongruence with the outcome of the quantitative research.

Research Participants

Next, there is a need to discuss the participants involved in this research. Within a supply chain organization, the site-level leadership is the local management team for each facility responsible for the facility's day-to-day operations. The site-level leadership at the finished vehicle logistics facilities is a crucial aspect of helping solve employee-related ergonomic injuries. Kao et al. (2021) demonstrated that the only way to address occupational injuries is for senior leadership to understand their employees' safety behaviors and climate. These behaviors were found to be early predictors of workplace injuries. By understanding these behaviors, leadership could take proactive steps toward improving workplace safety programs. Within global supply chain companies, site-level leadership was crucial in helping to work with the local employees while implementing, measuring, and researching the implemented technology. Also, the local leadership of the sites could see greater employee morale by reducing their individual site's employee-related ergonomic injuries.

The employees at each finished vehicle logistics site were crucial in this research. Employees within a supply chain organization are involved in every aspect of the site's day-to-day operations and would be a critical facet of this research. The hourly employees are the individuals responsible for handling the duties issued by the site-level leadership. These employees were the individuals who get injured from ergonomic-related injuries and would benefit if the technology could reduce the frequency of these injuries. Senior leadership and the board of directors for the finished vehicle logistics organization had a vested interest in the outcome of this research. Schnittfeld and Busch (2016) illustrated the growing demand of stakeholders to find sustainable solutions to the everchanging health and safety environment.

Therefore, the senior stakeholders of the finished vehicle logistics organization had a vested interest in the outcome of this study.

Hughes (2019) illustrated a demand for higher workplace safety standards within supply chain organizations. Senior leadership is responsible for proactively reducing these injuries while sponsoring the cost of the technology in the hope that it results in lower injury frequency. Also, if the injury frequency rate rises, there could be savings in insurance costs and future insurance premiums. This decrease in premiums would directly connect to the final participants, which means the finished vehicle logistics accounting team also had a vested interest in the study's outcome.

Research Constructs and Variables

A discussion must involve the constructs and variables for this research framework. First, the wearable safety implemented was the independent variable. Some employees wore these devices, while others did not. Next, the injury frequency rate variable was the dependent variable. This measurement had a measurable before and after rate based on implementing the dependent variable, the technology. The third variable is the cost of injuries within the organization, which was nominal data that is dependent. Then, the construct of the impact of injury frequency was measured through the convergent parallel approach. The researcher demonstrated any qualitative impacts on the organization from the previously defined quantitative injury frequency rate. These constructs were profit, insurance costs, internal motivation factors, or other measured issues. Finally, the behavioral construct measured the behavioral changes observed after implementing wearable safety technology.

Relationship between the Elements

The previous framework provided a concise guide to completing this research project. The concepts outlined how the research questions and problem statement relate to the participants and theories. The theories discussed demonstrated the issues and opportunities that involved all the participants within the organization. The actor was a variable mix of parties that all had a vested interest in the outcome of this research. At the same time, the constructs and variables outline the measurables for each research question and concept. Finally, the previous information leads to a research analysis for each path, followed by a concluding recommendation. This framework provided the researcher with the most information to conclude the research on implementing wearable safety technology.

Definition of Terms

For a better understanding of the study, the following terms are defined in the context of this research.

Behavioral change: The American Psychological Association (APA) (n.d.) defines behavioral change as a conditional technique to change behaviors through systematic conditioning.

Bureau of Labor Statistics (BLS): The Bureau of Labor Statistics (BLS; n.d.) self-defines itself as a government agency that collects, analyzes, and disseminates statistics for the public. For this research, BLS data are the statistical data from the U.S. Department of Labor.

Ergonomic: Mohamad Salleh and Hani Sukadarin (2018) defined ergonomics as the science behind engineering the interactions between humans and objects.

Ergonomic injuries: The Centers for Disease Control and Prevention (n.d.) defines ergonomic injuries as soft tissue and musculoskeletal disorders caused by sustained force, vibration, motion, or posture.

Exoskeleton Lumbar Motion Monitor: For this study, Marras et al. (1992) defined an exoskeleton lumbar motion monitor as a device placed outside the body, on top of the spine, that monitors the subject's motion.

Finished vehicle logistics: For this study, Werthmann et al. (2017) defined the finished vehicle logistics industry as a warehousing and logistics industry branch that deals with vehicle movement after being produced at the assembly plants.

Idiopathic injuries: For this study, Oranye and Bennett (2018) defined idiopathic injuries as injuries that occur from repetitive strains.

Incident frequency rate: The United Kingdom Health and Safety Executive (n.d.) defines injury frequency rate as the number of injuries within an organization per million hours worked by those employees.

Lagging indicators: For this study, Ota et al. (2021) defined a lagging indicator as an indicator of a realized outcome.

Lean manufacturing: The U.S. Environmental Protection Agency (EPA) (n.d.) defines lean manufacturing as the collection of principles that eliminate non-value-added activities when producing a product or delivering a service.

Musculoskeletal injuries: The Centers for Disease Control and Prevention (n.d.) defines musculoskeletal injuries as damage to the muscular or skeletal system resulting from strenuous or repetitive activity.

Occupational injuries: U.S. Bureau of Labor Statistics (n.d.) defines an occupational injury as an injury that occurs from an event within the working environment.

Supply chain: The Council of Supply Chain Management Professionals (n.d.) defines supply chains as the functions or processes that focus on the flow of products or services related to customers or the point of demand.

Traumatic injuries: For this study, Oranye and Bennett (2018) defined traumatic injuries as injuries that occur from a single incident.

Trunk muscle: The National Cancer Institute (n.d.) defines the trunk muscles as those that move the vertebral column from the thoracic and abdominal walls and cover the pelvic outlet. These muscles primarily extend the vertebral column and maintain an erect posture.

Assumptions, Limitations, and Delimitations

Given the size of this study and the nature of the supply chain industry, many assumptions, limitations, and delimitations existed. First, a discussion of all assumptions must be illustrated. For example, the researcher assumed that the participants wore the devices properly and did not falsify data. Also, the researcher assumed that the participants were interested in improving their safety-related behaviors and that all historical data were reported accurately. Next, the researcher must understand the limitations of this study, given the national reach. However, many parties, who have a vested interest in this study, help to maintain the integrity of the results and data. Local supervisors were active in the study to ensure that participants wore the devices correctly during their entire shift and worked in their usual manner.

Finally, the researcher understood the delimitations of the study, given the academic guidelines involved with human research. Also, the qualitative research in the study would be survey related. Each of these categories has the possibility of impacting the study. However, the researcher had safeguards to maintain the research and data integrity to preserve the study. Also, the researcher traveled around the country to monitor this research's participation, accuracy, and integrity regularly. This combination of travel, safeguards, and recruiting other vested parties allowed the researcher to provide accurate information to the organization and university on how wearable safety technology could lower employee-related ergonomic injuries.

Assumptions

The first assumption was that participants who volunteered for this study wore the device in its intended capacity when performing their day-to-day activities. Hypothetically, employees could perform their jobs more unsafely to give the device false data, skewing the results. Kao et al. (2021) demonstrated that senior leadership must take proactive steps toward mitigating employee risk. To mitigate the risk associated with this assumption, supervisors at each facility monitored the wear and usage of the devices to protect data integrity.

Next, the assumption was made that participants were interested in improving their behavior to become safer within the workplace. Huang et al. (2017) illustrated that an organization's safety climate is the strongest predictor of employee-related injuries. Therefore, as part of the safety climate, participants must improve their safety while at work. The device provided feedback to the employees and safety-related tips, which helped the participant improve their overall workplace safety. The participant used this advice to improve their workplace safety related to ergonomic behaviors. However, it was assumed that the employees were willing and interested in improving this behavior. To mitigate the risk of this assumption, supervisors also provided this feedback one-on-one to the participants about the device and the organization's safety climate.

Finally, the historic injury frequency data were assumed to be truthful and accurate. Kamel (2009) illustrated that unauthorized changes to a database could result in a significant loss for the organization. The researcher had access to the global injury data for the organization, which is reported to the worker's compensation provider. However, the historical data did not include more minor injuries that do not require medical attention. To mitigate this risk, the researcher spoke with all senior management about the importance of data integrity for this research and benchmarking purposes to improve the organization. Also, the researcher was able to verify the data against insurance records.

Limitations

The first limitation was due to the geographic scope of the study. Given the size of the study across the United States, the researcher could not be physically present with all participants to monitor daily usage. To mitigate this risk, data were provided about usage per employee at the sites across the United States. The data allowed the researcher to see the adoption of the devices among the employee group within the finished vehicle logistics organization.

Next, another limitation was that participants wore the device during their entire scheduled work shift to collect as much data as possible. Data integrity is a crucial aspect of this research, and for that data integrity to be truthful, the participant must wear the device for the entirety of their working shift. Hypothetically, the participant could pick up the device at the beginning of their shift but never put it on their person. To mitigate this risk, the data showed that the employee did not have any activity for that day. Also, the device had a light on the top to show if the device was being worn properly and collected data. Therefore, the supervisor or researcher would visually monitor the participants for proper device usage during their shifts. Also, if the employee decided not to wear the device correctly, the supervisor could have a coaching session with that employee on the research behind this device and the importance of the data to the supply chain and organization.

Delimitations

The first delimitation was to maintain academic research integrity and follow IRB guidelines; only voluntary participation was allowed in this study. The finished vehicle logistics company employs thousands of employees across the United States. However, only individuals who implicitly volunteered were those who wore the new safety technology. Therefore, the data did not have the strength of the entire workforce but still proved beneficial to the organization for reducing employee-related ergonomic injuries.

Another delimitation coincides with the fourth research question, in which a semi-structured interview guide was used to preserve research integrity. That interview guide was presented to those willing to participate in the study. The interview guide's questions, specifically related to the qualitative research questions, were used to understand the behavioral impact of wearable safety technology and injuries within the supply chain organization. The data collected from the interviews was anonymized from the complete participant list.

Significance of the Study

Employee safety within supply chains is a growing workplace crisis. One of the leading causes for this trend in injuries within supply chains is that organizations have elevated productivity above safety within the workplace (Cirjaliu & Draghici, 2016). However, employers are responsible for paying for the cost of these injuries and the downtime the employee experiences after an injury. The studied finished vehicle logistics organization paid over $13 million in workers' compensation injuries between 2018 and 2020, as shown in Table 1, with an average cost per injury of $22,000. Table 1 demonstrates that the organization has a higher number of total injuries due to repetitive motion injuries, which were the type of injuries studied in this research. However, the highest amount of injuries due to cost came from slips, trips, or falling injuries. The organization was working on other ways to reduce the number of injuries due to slips, trips, or falls. Those injuries do not occur in the same manner and cannot be solved by implementing the new technology. Also, those injuries did not impact the outcome of this study because they can be quantified separately through post-injury reporting.

However, many new technologies exist that can help the supply chain industry lower this trend of injuries. After reviewing the literature, many studies showed that proactive management and senior leadership support had lowered injuries within supply chain organizations. However, there is a gap in the literature demonstrating the implementation of new technologies that would help supply chains lower these employee-related injuries. Therefore, this study demonstrated a new and proactive way to look at this problem, which helped to lower employee-related ergonomic injuries within the global supply chain industry.

Review of the Professional and Academic Literature

Employee safety within supply chains is a growing workplace crisis. The previously discussed collapse of the Rana Plaza in Bangladesh is an excellent example of employee safety being put aside for productivity. This tragedy demonstrated a need for organizations to increase safety and proactively lower ergonomic injuries within their supply chains. Matos et al. (2020) illustrated a more significant overall improvement in health, safety, and operational performance when ergonomic practices are implemented adequately within the supply chain management realm. The finished vehicle logistics company and other supply chain organizations have a duty to their employees to provide a safe workplace for all parties involved in the day-to-day operations. The following research demonstrates the need to research ergonomic injuries within supply chains, specifically the finished logistics organization.

Business Practices

Productivity within global supply chains has led to a trend in safety concerns in the workplace. Cirjaliu and Draghici (2016) illustrated that lean manufacturing forces organizations to push productivity to achieve the organization's goals, but this shift has led to ergonomic issues in the workplace. Many organizations focus more on efficiency and profit margins within their supply chains, overshadowing employee safety. However, this shift in focus has led to an increase in ergonomic injuries in the workplace. According to the U.S. Bureau of Labor and Statistics (BLS; 2019, *Table 1*), the transportation and warehousing industry, identified by NAICS codes starting with 48 through 49, had 4.4 recordable injuries per 100 full-time employees in 2019. The BLS (2019, *Table 2)* also showcased that during 2019, 38,770,000 injuries were recorded in the United States resulting from overexertion and bodily reaction. Tee et al. (2017) found that workers' musculoskeletal disorders are the most reported problem, resulting from a lack of knowledge and alertness to their ergonomics. From 2018 to 2020, the finished vehicle logistics organization studied had 599 injuries that incurred workers' compensation claims at their U.S. facilities. The source of the accident, number of injuries, total incurred cost, and average cost are demonstrated in Table 1.

The following research demonstrates the need to study ergonomic injuries within supply chains, specifically the finished logistics organization. As seen in Table 1, the finished vehicle logistics organization had 165 ergonomic-related injuries between 2018 and 2020, which calls for action to solve these injuries proactively. These injuries were the leading cause of injury in the organization, followed by slips, trips, or falls, and an employee being struck by an object. As

Koh et al. (2019) stated, the only way to solve these ergonomic injuries is with a proactive approach to employee safety using new technology that would lower ergonomic injuries in the workplace. Therefore, this study implemented wearable safety technology, which gave employees insight into their ergonomic movements. This insight allowed the management team and employees to work together to better combat these injuries.

The Problem

Employee safety within supply chains is a growing workplace crisis. According to López-García et al. (2019), ergonomic injuries affected workers' health and safety and production-related aspects, and those musculoskeletal injuries were the most common injuries in the United States. As Christian leaders of an organization, leadership must provide the safest workplace possible. These safe workplaces can be achieved by delivering safety programs that focus on reducing employee-related occupational injuries. Straub (2018) presented a study of leading ergonomic injuries in the workplace and found that management support was the most frequently selected barrier to implementing safety-related change. However, as a leader in the workplace, they push forward with the change to move the company forward.

Similarly, Pater (2017) illustrated that the only way to solve ergonomic injuries in the workplace is through new and proactive approaches. According to Antwi-Afari et al. (2019), one way to proactively approach injury reduction is by implementing new technologies to improve an organization's occupational health and safety programs. The implementation of these new technologies could result in a reduction in workplace injuries. This issue is especially relevant in the warehousing and distribution industry, where leaders proactively mitigate the risk level that the organization faces. Like many other logistics and supply chain facilities, the finished vehicle logistics facilities face a need to reduce employee-related ergonomic injuries.

Nath et al. (2017) performed a similar study using cell phones to track employees' ergonomic movements related to injuries in the workplace. This study illustrated that these musculoskeletal disorders have many impacts on the workplace outside of the direct worker's compensation costs and the most common injuries are sprains, strains, and tendonitis. This study concluded that proactive organizational policies and practices reduce musculoskeletal disorder risk. Therefore, to be successful practitioners in the supply chain and logistics industry, leaders be knowledgeable and focus on not only production management techniques but also the overall safety of the employees and the organization. This pragmatic research focused on the quantitative and quantitative impacts of implementing wearable safety technology within the finished vehicle logistics facilities in the United States. The outcome of this research could provide the finished vehicle logistics organization with a guideline for lowering employee-related safety incidents by implementing wearable safety technology, which gives the organization a proactive approach to meeting employee safety needs.

Anticipated Themes

As seen in Table 1, workers in the logistics and supply chain industry have very labor-intensive roles. The study by Nath et al. (2017) focused on assessing the risk levels of an employee's posture while performing manual tasks. This study concluded that proactive information gathering about the positioning of the employees was used better to relay proper posture and ergonomic-related behaviors to the employees. This information would help to lower the injuries seen at the workplace through proper training and workplace safety routines. It was anticipated that this research would have a similar theme. The technology implemented would allow the employee to see their ergonomic risk factors for their performing job. These monitors measured the employee's bending, lifting, and twisting speeds and angles throughout their daily work-related activities. The monitor then provides haptic feedback if an employee performs a task in a dangerous working position. It was hypothesized that the employees would become safer through behavioral modification by adjusting their behaviors after obtaining feedback from the safety technology.

Also, it was anticipated that this behavior modification translated to other non-ergonomic related safety injuries. The wearing of the new technology would lead to an overall heightened awareness of safety by the employee. Therefore, this study could reduce slips, trips, and fall injuries through the employee's overall heightened sense of safety awareness. Finally, it was anticipated that the proactive steps taken by the organization lead to a reduction in injury frequency, costs, and premiums. As illustrated previously, safety is a cultural mindset, and the previously anticipated discoveries could lead to a transformation of the mindset, leading to an overall safer supply chain and finished vehicle logistics organization. This proactive shift in the organization's mindset would lead to safer employees.

Summary of Section One

As previously demonstrated, there is a desperate need for organizations to take proactive steps to lower ergonomic injuries. These proactive steps were proper for the finished vehicle logistics organization and the global supply chain. The International Organization for Standardization (2018) statistics demonstrated that globally more than 300 million non-fatal workplace injuries happen annually. The number of workplace injuries provides a reason to research this growing tragedy. As Christian leaders, all organization members must provide a safe workspace for their employees, and this research provided a roadmap for those safer organizations. This safety can be achieved through senior leadership support, new technologies, and a proactive approach to employee-related injuries. Also, it is the legal responsibility of employers to provide a safe workplace. According to The U.S. Department of Labor (n.d.-b), within the general duty guidelines of OSHA, every employer shall provide a place of employment free of recognized hazards that are likely to cause physical harm or death to their employees. OSHA has the power to create workplace safety standards, penalize noncompliance, and audit organizations to ensure the safety of all employees. However, to prevent these injuries, leadership must first study the trailing indicators of these incidents to understand the organization's safety behaviors and climate. Then, proactive technologies can be introduced to lower this accident ratio within the supply chain organization. Finally, these implementations must be quantitatively and qualitatively measured to assess the success of the implementation.

According to Matos et al. (2020), these safety improvements would lead to a more significant overall health, safety, and operational performance. The growing trend within lean management of productivity over safety has led to this global crisis of workplace safety. This pragmatic research provided a roadmap to the finished vehicle logistics company and other supply chain organizations, which have a duty to their employees to provide a safe workplace for all parties involved in the day-to-day operations. The research included both qualitative and quantitative measurements, along with several hypotheses that could lower the organization's injury frequency rate. These measurements were combined with a pragmatic mix-method design to produce optimal results for the organization and the educational community. Also, the convergent parallel design allowed the researcher to use both data collection methods to approach one seamless summary while using research triangulation to increase confidence and consistency in the research. The previous research demonstrates all the elements of this study that provided new information on solving ergonomic injuries within a finished vehicle logistics organization.

In the next section of this study, the researcher understood how the previous information could lower this incident frequency ratio. First, an exhausting literature review is conducted to give the researcher and the reader the entire history of this problem, previous research, and other findings related to employee-related workplace injuries. Then, the research started, and the researcher quantitively and qualitatively measured the impact of wearable safety technology on the organization. This information includes the research design, participants, population, sampling, data collection, and analysis. Also, a detailed description of the wearable safety technology is to assure the reader of the validity of this instrument to the project. Descriptive statistics were used to evaluate the quality of the data, while anticipated and alternative hypotheses would be tested for validity. Finally, the data were used to test the hypothesis and develop a final project and recommendations. This next section is the key to unlocking the potential of this wearable safety technology and its uses to lower employee-related ergonomic injuries within supply chains and the finished vehicle logistics organization.

Literature Review

The following literature review connects existing academic knowledge to this research study. This literature review demonstrates a ‘360 degree’ view of the existing knowledge related to this study while proving that this research study must exist to fill in gaps where knowledge is missing. Injuries within the supply chain and logistics industry are prevalent due to the involved manual labor. Many tools and technologies exist to help organizations lower the amount and severity of these injuries. However, before applying these tools or technologies, the researcher must understand the entire realm of academic literature that applies to this research.

First, the reader must understand the Supply Chain Management (SCM) concept, which would give more insight into this study's implications for the overall supply chain and logistics management industry. Then, an evaluation of the framework behind this study while understanding the correlation to the supply chain and logistics industry. Next, understand how workplace injuries affect the organization and the employee. This is followed by a discussion on the specific form of employee-related ergonomic injuries, known as workplace musculoskeletal injuries. Also, a review of the tools that support the potential reduction of workplace injuries while understanding how the organization adopted new safety technologies. Then, an in-depth analysis of similar studies that have been performed throughout the last few decades must be performed. This cohesive and exhaustive literature review allows the researcher to better understand the existing academic literature before applying the new technology to the finished vehicle logistics organization. Finally, this literature review concludes with other studies that use technology to demonstrate how to create safer work environments in various organizations within the global supply chain were demonstrated.

Supply Chain and Logistics Management

To understand how modern technology can provide safer workspaces at organizations within the global supply chain, there must be an understanding of supply chain management and how the modern supply chain has evolved. In 1911, Fredrick Taylor wrote *The Principles of Scientific Management.* This literature is the first known work that focused on improving manufacturing processes. This work focused on improving manual loading processes and started the global trend of improving manufacturing operations. Fundamentally, the concept of supply chains has been around for thousands of years. However, the concept of supply chains has existed for thousands of years. However, the formal concept of supply chain management came to fruition during World War II, when many factories shifted to support the war efforts. Many operations around the United States were focused on supporting the United States in the war efforts overseas, which led to the first demonstration of integrating suppliers and manufacturers into one integrated flow of goods, also known as the supply chain.

During the 1940s, many operations focused on reducing manual labor and mechanizing operations through new machinery and technology. By the 1960s, many logisticians were focused on improving the physical distribution within their outbound supply chains. These outbound distribution improvements led to more competitive logistics. Modern SCM is the cornerstone of a competitive strategy for any organization seeking to be competitive in a global economy. According to Coyle et al. (2017), SCM became part of an organization's vocabulary during the 1990s when the dynamic global environment forced organizations to change their perspective on their respective industries.

However, change has dramatically impacted the modern supply chain in recent decades. During this time, five major factors led to a high rate of change in the economic landscape. Those factors were globalization, the empowered consumer, technology, organizational consolidation, and government regulations. These factors have combined to give rise to the modern competitive supply chain that demands practitioners continue to improve operations, increase competition, and provide safer work environments for all stakeholders.

Globalization

Globalization has been the driving force behind economic change due to the global marketplace and economy concept. According to Coyle et al. (2017), organizations now face a more competitive and geopolitical environment globally. Figurately speaking, there is no 'geography' in the current competitive global environment. This global environment was first driven by countries seeking materials and goods unavailable in their home countries. This environment is driven by organizations seeking goods and labor, manufacturing, transportation, and economies of scale from different global markets. This “flat earth” phenomenon for manufacturing has led to a highly competitive global supply chain and logistics environment. Also, given this global marketplace, smaller organizations can be highly competitive globally, leading to all organizations seeking more efficiency and effectiveness within their supply chains.

The Empowered Consumer

According to Coyle et al. (2017), many organizations focus market research on understanding consumer behaviors to serve their customers better. Previously, market insights would group consumers into like segments with similar needs. Those segments would be responded to with similar products and services. This consumer segmentation is the same for grouping similar companies into logistics and supply chain management segments. However, the modern consumer has a more significant impact on the supply chain than ever. For example, the demand for fresh fruit year-round has created a more global economy while putting a logistics strain on the supply chain. Also, modern consumers want their products available faster, more conveniently, in different variations, and available 24/7. These previous constraints have transformed the supply chain and logistics industry into the global behemoth it has become today.

Technology

Technology has become the largest facilitator of change in modern supply chains. According to Coyle et al. (2017), technology has created a more dynamic marketplace, connected individuals with organizations 24/7, and given organizations and consumers access to new information at their fingertips via the advent of the internet. Information is ‘pulled’ to organizations as needed. Also, these new technologies have allowed more countries to participate in the global economy, spreading the supply chain and logistics industry into many previously underdeveloped countries. This shift away from developed countries has allowed for outsourcing manufacturing and logistics operations to new countries across the globe. Finally, this technological shift has created a multidirectional supply chain flow given the commerce from all countries.

Organizational Consolidation

According to Coyle et al. (2017), modern product manufacturing became the driver in the global supply chain after World War II. For decades, the supply chain was dominated by very few companies that produced and distributed most global products. However, the 1980s saw a change in the supply chains due to the advent of mass retailers. These mass retail companies brought new aspects of change to the modern supply chain through their economic buying power and demands. Even though these new demands allow the retailer to operate more efficiently, changes in the logistics and design of the modern supply chain occurred to allow for more efficient operations at the end of the supply chain.

These organizational consolidation changes saw more collaboration between all partners within the supply chain, allowing all parties to grow revenue and become more efficient. For example, collaborative planning and forecasting models have become more relevant in modern times to allow all parties in the supply chain to have access to future inventory predictions to lessen the bullwhip effect of consumer demand.

Government Regulation

According to Coyle et al. (2017), the final factor leading to the modern supply chain has been seen through the various levels of government. During the 1980s, the U.S. transportation sector was deregulated to allow for a more competitive logistics and transportation environment, which resulted in lower prices for consumers and improved service. Modern transportation carriers could change their operations through negotiations to allow for more efficient operations at lower prices, which led to growth in the transportation and logistics industry.

Many new carriers entered the motor and ocean logistics industry, allowing for increased competition, which benefited the organizations in the supply chains. These modern transportation carriers also transformed into logistics carriers offering more services to their consumers. These carriers now offer more value-added services such as order fulfillment, inventory management, and warehousing instead of solely moving a product from point a to point b.

This brief overview gives insight into how the industry has changed in the last millennium and the supply chain's growth. All previous changes have led to what we now know in the modern SCM industry. To understand this concept at the micro-level, there must be a deeper analysis of the finished vehicle logistics industry, which is the focus of this research.

Finished Vehicle Logistics

The finished vehicle logistics industry is a small portion of the overall global supply chain that focuses on the movement of vehicles and equipment worldwide. Werthmann et al. (2017) illustrated that this industry can be defined as “the process of distributing the completed vehicle from the factory to a dealership or the end customer” (p. 4138). This industry is a mixture of modern technology and manual labor for a seamless transition from the point-of-origin of a vehicle, typically a factor, to the point of destination, which is usually a dealership. Many organizations exist within this industry, providing transportation, warehousing, vehicle movement, vehicle accessorizing, and other value-added services to the original equipment manufacturers (OEMs). The organization studied for this research provides its customers with all the previously mentioned services. Modern technology, such as mobile computing, is used within the supply chain to provide total visibility as automobiles move throughout the supply chain. However, this study aimed to add new technology to the mix for the safety of the employees within the supply chain.

The organizations within this industry are very employee-heavy due to the amount of vehicle movement and upfitting within this process. Many of the jobs within these organizations are ‘blue-collar’ manual jobs that require little technical ability but a high investment in hands-on training. Also, these jobs have a higher factor of ergonomic injuries due to the job's repetitive motion and overall repetition. For this reason, this subset of the supply chain and logistics industry was chosen to research the implementation of modern technology to lower employee-related ergonomic injuries.

Nature of the Study

Now that there is a better understanding of SCM and the finished vehicle logistics industry, there can be a greater understanding of the nature of the study. Specifically, the research paradigm, design, methodology, and triangulation. This understanding provided the reader with a cohesive understanding of all parts of this research before diving into the details of technology and employee-related injuries in future sections.

Research Paradigms

As discussed, this research followed a pragmatic paradigm by implementing wearable safety technology into finished vehicle logistics facilities across the U.S. and measuring the outcome's qualifiable and quantifiable results. The pragmatic approach allowed the researcher to view this opportunity with an open mind and try to solve this research as best as possible. Focusing on SCM, Liu and McKinnon (2019) suggested that research in this field should focus on a pragmatic path to enhance its practical utility. This team suggested that the pragmatic path, focusing on theory-driven research in the supply chain industry, would allow for more actionable knowledge for practitioners.

Like the framework of this study, theory-driven research was defined by Liu and McKinnon (2019) as “an approach to research that is driven to provide better insight and understanding into these and other issues by using empirical data to build and develop better theories” (p. 78). Figure 2 demonstrates a pragmatic approach to linking academia and practitioners by ensuring the practical utility of theory driven SCM research. Overall, this research followed the pragmatic approach, with the correlation between academia and practice, to allow for the most valuable research to be translated to the employees for a safer environment.

Research Design

As discussed, this research combined qualitative and quantitative research for a mixed method design. A single-method approach in supply chain and logistics research introduced bias, reducing the mixed method approach. Also, a mixed method approach in supply chain and logistics research increased the trustworthiness of data and the researcher's inferences. According to Golicic and David (2012), supply chain phenomena are complex, and the mixed method approach allowed the researcher to understand their research better.

For this research, there are two research questions for each approach. First, the qualitative approach was used to understand how implementing the new employee-related safety technology has a noticeable impact on other branches of the organization. At the same time, the quantitative approach gave the researcher an understanding of how the devices can create a safer work environment. Golicic and David (2012) demonstrated that this mixed method approach in supply chain research would be successful when proper triangulation was used, which is discussed later in this section.

Research Method

The mixed method design approach can only succeed when the proper method is applied. For this research, the convergent parallel method was used. This approach allowed the researcher to conduct qualitative and quantitative research during the same phase, with equal weight given to both approaches. Then the researcher analyzed the impacts separately while interpreting the results together. Bimha et al. (2020) recently used this same mixed method design with a convergent parallel methodology to research supply chain performance in Zimbabwe's petroleum industry. This approach allowed the research team to use qualitative and quantitative designs to understand supply chain and logistics research better.

Triangulation

The final step in understanding this study's nature is ensuring proper triangulation during this mixed method methodology to supply chain and logistics research. Gibson (2017) demonstrated that proper triangulation allowed for consistency, increased confidence, and guaranteed that the findings were not driven solely by one data source. Since this research relied on qualitative and quantitative data, proper triangulation ensured that the researcher correctly used the convergent parallel methodology to weigh both data sources equally. Chen et al. (2017) used the mixed method approach to research collaboration within supply chains to improve sustainability between partners. This research team found that triangulation provided a better comprehensive analysis and allowed the research team to view the phenomena differently.

Research Framework

This research demonstrated to organizations within the global supply chain the issue of employee-related ergonomic injuries. However, understanding the concepts, theories, and constructs must be understood in this research. This information gave the reader and researcher a complete view of the study before diving into the workplace injuries that are to be studied.

Research Concepts

The first research concept demonstrated through this research is that technology can improve an organization's safety. Sepulveda (2019) demonstrated that many technologies exist that can help an organization improve the performance of its organizational safety programs. The supply chain and logistics industry has seen vast improvements in efficiency by using technology to streamline processes. These technologies can improve an organization’s health and safety program more effectively. For example, mobile devices provided a new conduit for safety training and education in an organizational setting. Specifically, in this research, wearable safety devices provided safety feedback to employees. Those devices could decrease the organization’s incident frequency rate through haptic feedback and provide employees with more information on ergonomic safety.

The next research concept is that reducing employee-related ergonomic injuries could possibly decrease the organization's injury frequency rate. As demonstrated earlier, the supply chain and logistics industry relies on manual labor for many tasks, and most of those tasks have a higher level of ergonomic injuries due to bending, lifting, and twisting. However, the main concern with the injury frequency rate is that this is a lagging indicator, which shows past measurements of an indicator. For an organization to decrease its injury frequency rate, leadership must find proactive ways to solve the issue, adjusting the lagging indicator in the future. Pater (2017) agreed that the only way to solve the lagging indicator of employee-related ergonomics is with proactive steps toward improving an organization's health and safety programs. The technology implemented could reduce the number of injuries seen at the worksite, which could help the organization raise its injury frequency rate.

The final research concept is that other safety-related behavioral changes were witnessed. According to Huang et al. (2017), an organization's safety climate is the strongest predictor of safety outcomes. Especially in the supply chain and logistics industry, senior leadership must be present in all aspects of the day-to-day operations. This can be seen in the safety programs within this industry. Many aspects can be evaluated to see if the wearable safety technology's implementation has a qualitative impact on other parts of the organization. These impacts would be on the organization-level safety climate or the group-level safety climate, along with the employee's perceptions of both. This combination of these three research concepts provided a stable mixed method approach, which gave both readers a potential pathway to improving safety within organizations.

Research Theories

This research was based on three focal theories: agency theory, theory of planned behavior, innovation diffusion theory, and organizational identification. Figure 1 shows the flow of information, action, and ideas that lead to the analysis and recommendations. First, agency theory was seen in this research through the incongruence between senior leadership vision and the behaviors of the employees. Dubey et al. (2017) found that agency theory can be seen in supply chain organizations when they understand how top management can translate its vision and mission into desired actions. This research focused on how senior leadership can help translate the desired safety improvement into actions among hourly employees. Forslund et al. (2021) found that the biggest challenge within supply chains, related to agency theory, is goal conflict between the supply chain parties. Specifically, how can senior leadership use technology to help create a culture of safety which could improve the organization's injury frequency rate? Senior leadership had to work with the employees to have them believe in the mission of safety within the supply chain and have that become a goal of the employees.

Next, there must be an understanding of how the innovation diffusion theory applies to safer supply chains and this research. Marak et al. (2019) demonstrated that innovation diffusion theory offers a framework for adopting and diffusing new technology within supply chains. The technology in this research is relatively new and was not previously used within the organization or other finished vehicle logistics companies. Therefore, adopting the technology among all stakeholders could be problematic. The innovation diffusion theory classifies the adopters into five categories: innovators, early adopters, early majority, late majority, and laggards. These classifications are based on their degree of innovativeness and the time required for acceptance.

Given the previous information, the finished vehicle logistics organization being studied would be an innovator, considering the technology being trialed is in the alpha best test and the first launch of this technology. However, given all the previous information, the most significant factor for adopting the new technology was senior leadership support and vision to push the participants towards adopting and diffusing the new technology.

Then, the theory of organizational identification was applied to this research. This theory is the basis on which employees develop in-group biases and out-group discriminations. Robinson et al. (2018) demonstrated that this theory shows the incongruence between different organizational groups. For this research, the hourly employees were studied for their in-group biases against the discrimination of the out-group, which was leadership. The employee's in-group biases created a feeling of connectedness among themselves.

Finally, the last research theory was the theory of planned behavior. Miller et al. (2018) explained that the theory of planned behavior seeks to explain factors that influence an individual's behavior. In this instance, the theory of planned behavior addressed the participant's attitudes toward safety and the organization's push to implement the new safety-related technology. This goal-directed behavior would be related to the theory based on subjective norms, perceived sense of control, and behavioral intentions towards that goal. Subjective norms are the social pressure to adapt or not to the behavior. In this research, the subjective norm was the pressure from participants to adopt, use, and increase safety behavior by using the new technology. Sense of control refers to the participants perceiving that they can control a situation or its outcome.

The technology being studied gave the employees valuable feedback on their safety-related behaviors and allowed the participants to improve their ergonomic safety. Lastly, behavioral intentions toward a goal were their willingness to perform a given behavior. In this research, the behavioral intentions were the employee's willingness and individual participant's propensity towards adopting the new technology and willingness to change their safety behaviors. Overall, this theory provided great qualitative feedback at the participant level about the adoption and usage of the technology.

Research Participants

This research focused on new ergonomic technology's qualitative and quantitative impact on employee-related injuries within a supply chain. Therefore, the participants for this study were the vested parties in that supply chain organization. Senior leadership and site-level leadership are vested in lowering the number of injuries within the finished vehicle logistics organization. However, these leadership professionals must actively push the vision for safety and the new technology to the hourly employees participating in the study. Pater (2021) illustrated that leadership plays a vital role in safety within supply chains. These leadership professionals must focus efforts and resources on making the safety improvements and then be effective change agents of the new safety efforts. The misalignment of senior leadership pushing these safety efforts would lead to lowered efficiency and increased safety incidents due to the disconnection between safety expectations and operating procedures. Therefore, these two participants play a vital role in pushing the safety message and efforts to the other participants in the study.

Next, the hourly employees that participated are the focus of the quantitative research in this study. Gruchmann et al. (2021) found that the supply chain and logistics sectors suffer from a shortage of skilled labor and that the blue-collar workers in these industries have a higher risk of suffering from work-related musculoskeletal disorders (WMSD). This higher risk is due to the occupation's more labor-intensive and repetitive motion jobs. The technology introduced in this study aimed to lessen ergonomic injuries through haptic feedback and knowledge transfer to the hourly employee. Finally, the accountants within the finished vehicle logistics team were passive participants in this study. This team would see the economic benefit of implementing the new wearable safety technology. This team would quantify if the return on investment at the site were worthwhile compared to the investment cost.

Workplace Injuries Overview

Every year, millions of workplace injuries occur within supply chains across the United States. For this research, the finished vehicle logistics industry is most closely identified with the transportation and warehousing industry, identified by North American Industry Classification System (NAICS) codes starting with 48 through 49. According to the BLS (2019, *Table 1*) and

BLS (2019, *Table 2*), in 2019, this supply chain sector experienced 39 million recordable injuries that resulted from overexertion at an average rate of 4.4 recordable injuries per 100 full-time employees. However, given advancements in safer supply chains, this injury rate is much lower than the overall private sector of the United States, which was demonstrated by the BLS (2019, Table 3) at 26.1 musculoskeletal disorders per 100 full-time employees. Finally, the BLS (2019, Table 3) demonstrated that musculoskeletal disorders average 13 days away from work. Even though supply chains have a lower rate of injury than the overall U.S. private sector, these injuries still demonstrate a call to action for supply chain leaders to create safer workplaces by reducing the risk of work-related injuries. Boden et al. (2016) illustrated that these injuries directly affect the employee’s health, long-term earnings, and employment. Also, these injuries indirectly affect the organization’s financials, morale, culture, and turnover. However, the injuries also have a lasting financial impact on the organization.

Injuries and the Employee

When an employee has a non-fatal injury, many studies demonstrate what happens after that injury. The injury could result in a worker’s compensation claim that would impact the organization's bottom line. However, this section focused on the impact on the employee during and after the injury, along with a correlation to its impact on the supply chain. First, given the nature of the injury, the employee could miss time during that injury while recovering. The employee is often transferred from their regular job function to a light-duty work function that would not aggravate the recent injury. Barling et al. (2003) found that the average workplace injury results in the employee being off work for two weeks and up to three months. However, lean facilities are one of the basic principles of supply chain management. Therefore, when an employee misses time, another employee must fill in for the first employee. This lack of labor causes a downhill effect for the organization to carry additional labor to compensate for employees absent from their work duties for injuries.

Next, the physical consequences of the injury could linger for longer than the employee is off work. Employees may return to their regular job function within the supply chain but not perform to their previous level. This underperformance would also cause the supply chain to carry additional labor to compensate for the employee's underperformance due to the lingering physical consequences of the injury. Finally, once returning to work, the employee could have cognitive and behavioral problems associated with that injury that can impair their work-related duties. For example, an employee may be scared to perform their previous work duties within the supply chain, especially if machinery or tooling is involved related to a previous injury. Figure 3 demonstrates a model of the employee's attitudinal outcomes after a workplace injury.

First, the accident occurs, followed by either a distrust in management or a lack of influence. The detrimental effect of the accident was proven to have a detrimental result in distrust in management. Straub (2018) illustrated that management trust and support are critical in implementing safety-related change in the workplace. Therefore, this distrust occurs because management is the driver of occupation safety within the organization. Therefore, a distrust in management can occur relating to the accident. This distrust can leak into other areas of the employee's work within the supply chain. Distrust in management providing a safe work environment within the supply chain can also lead to distrust within the organization's entire management structure and vision.

However, the inverse can occur, labeled as a lack of influence. In this model, influence is the belief that employees can influence their environment or control the outcome of a situation. Therefore, after an accident, the employee may have a cognitive lack of influence or distrust in their personal control over the outcome of a situation. The employee may realize that even though they have practiced job function repeatedly, they may not have control over the situation's outcome. This outcome can also lead to distrust in management after the fact. Also, this perceived lack of influence can affect the employee's job performance within the supply chain and reduce performance.

Next, both previous outcomes can lead to job dissatisfaction. Barling et al. (2003) found a significant relationship between distrust in management and job dissatisfaction or a perceived lack of influence on their job function. Employee productivity levels, perceived safety, morale, and cultural impact on the organization would decline once the employee is dissatisfied with their job. This result can devastate overall organization productivity and morale within the supply chain.

Finally, this model results in either the employee exiting or voicing dissatisfaction with the situation. The employee leaving would lead to turnover costs, retraining costs, and future employees leaving for similar reasons. While the employee voicing their dissatisfaction would have potential consequences for the organization or other employees. Either way, this study and Figure 2 show the impact of an occupational injury on employees within the organization. All the previously demonstrated employee-related impacts can be detrimental to a lean supply chain. Therefore, the supply chain manager must provide the safest possible workplace to reduce these impacts' likelihood.

The Financial Impact of Injuries

The organization must invest capital in implementing a workplace safety program successfully. Cohn and Wardlaw (2016) demonstrated that over 3.5 million workplace injuries occur in the United States annually, with an estimated cost of $250 billion. To mitigate this risk, organizations must invest in workplace safety in many different areas, such as equipment, property, capital, and research investments. Therefore, workplace safety would directly impact the organization's balance sheet due to the injury cost and the investment needed to prevent injuries. Cohn and Wardlaw (2016) found that a one-standard-deviation change in an organization's debt-to-asset ratio can be associated with a 5.6% increase in total workplace injuries in the following year.

Like physical assets, the organization must invest in the policies and activities that produce a safety culture. Improved safety would reduce downtime, increase productivity, fewer lawsuits, improve insurance rates, and lower worker's compensation payouts. However, because safety is a lagging indicator, the long-run nature of investing in safety can make it more susceptible to cuts when financial constraints occur. Therefore, there is an inverse long-term correlation between investing in safety with future balance sheet returns.

Yang and Maresova (2020) studied the financial impact of investing in safety within Chinese pharmaceutical manufacturing and supply chain organizations. Between 2006 and 2018, there was a 103% increase in work-related injuries in this supply chain. Also, in 2018, there were 34,627 work-related fatalities within this Chinese supply chain. This spike in work-related injuries and deaths has led the Chinese supply chain to invest in better safety within these supply chain organizations. Also, Yang and Maresova (2020) found that firms that invested in safer supply chains had a 2.37% higher return on assets, a 6.37% higher return on equity, and earnings per share increased by 3.59%.

This study concluded that a financial investment in lowering work-related injuries and deaths through a proactive safety program would pay off the organization in long-term returns. Also, this study found that investing in a safety program would help improve the overall relationship with the employee, retain talent, and attract new talent through the organizational culture shift. Therefore, leadership can see that investing in safety does take capital away from the organization, but only in the short term. In the long-term, the organization would earn that money back in higher returns, which would lead to a more significant return on the investment.

Musculoskeletal Injuries

Now that there is an understanding of how workplace injuries impact the organization, supply chains, and the employee, the organization can understand how to reduce employee-related injuries. The first step in this understanding is building knowledge of how those injuries occur. For this research, the primary focus is on reducing workplace musculoskeletal injuries. These injuries result from work activities and most commonly affect the skeletal muscles, tendons, nerves, ligaments, joints, or a blood vessel that services a skeletal muscle.

Oranye and Bennett (2018) determined that musculoskeletal injuries result from a combination of work-related factors such as repetitive or heavy motion, repetitive trunk rotation, prolonged postures, or exposure to vibrations. Also, musculoskeletal injuries can occur from psychological factors such as work demands, social support, or psychological distress. Simultaneously, environmental factors such as shift work, lack of equipment, rest breaks, or an unorganized work environment can develop a musculoskeletal disorder. Finally, the injuries are classified as traumatic, which would result from a single incident, or idiopathic, which would result from repetitive strains.

Given the previous information, this research focused on an idiopathic musculoskeletal disorder known as WMSD. A WSMD is the most found injury in the workplace. It is defined by the Canadian Centre for Occupational Health and Safety (2021) as "work-related musculoskeletal injury as an injury resulting from repetitive strain or continuous stress placed on musculoskeletal groups and excludes forms of traumatic musculoskeletal injury" (p. 03). These injuries arise from repetitive or forceful bending, gripping, holding, twisting, clenching, reaching, or straightening.

These injuries affect muscles, tendons, and the nervous system, with pain being the most common symptom associated with a WMSD injury. Some WMSD injuries can also result in stiffness, tightness, redness, or swelling. These injuries must be evaluated by a medical professional for diagnosis and treatment. Oranye and Bennett (2018) illustrated that in 2003, nearly 176 million working days were lost in the U.K. resulting from WMSD injuries and that Canada reports that WMSD injuries are the most common injury claim for workers' compensation. To understand and relate these injuries more closely to the research, leadership must now look at how these injuries correlate to different areas of the global supply chain.

Musculoskeletal Injuries in Different Supply Chains

The global supply chain comprises many complex industries that support each other. However, one common theme is that WMSD injuries plague all these industries and organizations. Putz Anderson et al. (2020) demonstrated that in 2006 in the United States, 820,500 wholesale retail and trade workers experienced a work-related injury, with 55% of those injuries requiring time off work, work restrictions, or a job transfer. Also, in 2016 the same sector reported 461 work-related fatalities. The nature of that sector caused these injuries and fatalities with a vast array of product sizes, types of merchandise, handling of bulk products, and many other material handling applications. Syron et al. (2019) demonstrated that seafood processing in Alaska, representing 95% of Alaskan food manufacturing, is vital to the global supply chain.

Similarly, Yang et al. (2020) studied the impact of work-related injuries in the Korean motor vehicle parts manufacturing sector. This study found that in 2015, 1,609 WMSD injuries occurred in Korea's global supply chain sector, accounting for nearly 60% of all injuries within the Korean transportation sector. For the same industry, The BLS (2019, Table 2) also showcased that during 2019, 10,200 work-related injuries occurred. However, this industry is also plagued by similar WMSD injuries. The most common injury was repetitive motion or overexertion, resulting in 2,889 work-related injury claims between 2014 and 2015. As demonstrated previously, all forms of the global supply chain are plagued by WMSD injuries. From Korean automotive parts manufacturing to Alaska seafood processing, workplace injuries are common in the supply chain due to the nature of the involved work. However, a deeper analysis must continue to understand all factors that play a role in the occurrence and prevention of WMSDs.

Musculoskeletal Injuries in Different Age Groups

When a supply chain performs a job hazard analysis to identify potential risks associated with a specific job, the organization must also consider the employee's age while performing the job function. Oakman et al. (2016) performed a Finnish food processing company study to identify if the likelihood of WMSDs differed across several age groups performing the same job function. This study grouped the workers into three age groups, 20–35, 36–49, and 50+, with a mean age of 41. Both sexes and white- and blue-collar employees were included in the study. To maintain data significance, adjustments were made for an employee’s gender, occupational task, BMI, physical exercise, and general health.

The study found many predictors of WMSD risks significant to this study. First, repetitive movement was a high predictor of WMSDs in the middle age group. At the same time, awkward job position posture was a high predictor in the oldest age group. Next, statistical significance was associated with WMSDs for BMI in the youngest age group. However, physical strain from the job task was correlated with the two oldest age groups in the study but not the youngest age group. This outcome demonstrates that age can determine when a supply chain organization performs a job hazard analysis to understand the predictors of potential WMSDs in their organization.

Much data within the U.S. supply chains, defined by the previously demonstrated NAICS code, defines the employees' age where injuries occur. The BLS (2019, Table 4) illustrated that 45-54 had the most, with 24% of the reported injuries within this supply chain sector. Next, 55-64 had 22%, 35-44 had 21%, and 25-34 had 22% reported injuries. However, those under the age of 24% only reported 8% of the injuries. Therefore, age must be considered when determining the safety factors that affect each age group and which work function is suitable for an employee within a supply chain.

Ergonomic Studies Using Technology

The previous information gives the researcher a cohesive understanding of workplace injuries, the adoption of new technology, and how supply chain organizations can put policies and procedures to mitigate these injuries. However, this research focused on implementing technology to lower work-related injuries in a supply chain organization. Therefore, an understanding now exists that cohesively summarizes previous studies evaluating workplace ergonomics. Many of these studies demonstrated the likelihood of WMSDs but used obsolete technology. Therefore, this research continued the research demonstrated below but with modern technology.

Dr. Marras' Research

The basis for most future studies was developed from the first study on workplace ergonomics using technology, performed by Dr. William S. Marras of the Ohio State University Spine and Research Institute. Dr. Marris is the leading expert in evaluating ergonomics that could reduce WMSD injuries. This study focused on lowering WMSDs within supply chains by focusing on the employee's ergonomic movements when they bend, lift, and twist. Marras et al. (1992) focused on the employee's ergonomic movements when lifting objects. When an employee lifts an object, the load on the spinal cord is increased due to the increased trunk muscle activity. Therefore, the observed rapid movement and improper positioning while lifting objects led to occupational lower back disorders, one of the leading causes of WMSDs. Marras et al. (1992) used an exoskeleton lumbar motion monitor to assess the employee's trunk position, velocity, and acceleration while lifting in a three-dimensional space. This study was performed across 403 supply chain jobs within 48 companies in the United States. Only jobs with repetitive motion were used for the study, which was a previously discussed causation of WMSDs.

The study aimed to determine factors the exoskeleton lumbar motion monitor read, leading to lower back disorder risk groups. The risk groups were classified as low, medium, and high-risk groups. Motion from each plane was considered when determining the risk group. Like the research, this study used technology to give risk feedback to the employees on their risk profiles, allowing for adjustments in behavior to help lower those risk profiles. Also, the study would allow shop-floor management to identify work-related activities that were critical factors in the observed high-risk movements.

Wearable Technology Studies

A few studies currently exist that are like this research, demonstrating how wearable technology can help create safer employees within supply chain organizations. Compared to some of the other technologies discussed, wearable technology can be a more cost-effective approach to creating safer supply chains. Choi et al. (2017) stated that using these technologies allowed organizations in hazardous and physically demanding environments to advance occupational health and safety management. First, many technologies allow the employer to understand the employee's physiological status by monitoring heart rate, blood pressure, and skin temperature. These technologies allow the organization to understand the effects of a workplace environment on the employee. The organization can use this information to create a safer work environment for the employees.

However, modern technologies give organizations a deeper analysis of creating safer work environments. Choi et al. (2017) specifically studied how Global Positioning Systems (GPS), accelerometers, and Inertial Measurement Units (IMU) can be used to continue to advance organizational health and safety programs in industries like supply chains.

First, GPS technology was integrated into a safety vest for real-time tracking of the employee's location. This technology has allowed management to monitor the location of the employees working in sites with hazardous areas. Also, the modern safety vest allows the organization to define hazardous GPS zones to send notifications to the employee via the vest when they are approaching those areas. Kim et al. (2018) used accelerometers built into safety helmets to help reduce injuries to an employee's head. Safety helmets are an essential piece of safety equipment because the head is the most vulnerable part of the body. The accelerometer used a three-axis sensor that identified if the user was adequately wearing the safety helmet. This sensor allowed the organization to reduce the number of injuries because when the safety helmet was appropriately worn, it allowed the employee to lower the severity of injuries to the head. Yes, all organizations' goal is to lower the frequency of injuries, but this type of safety technology can ensure that employees are properly wearing their safety equipment. Therefore, lowering the severity of an injury when it does occur.

Finally, few studies exist that prove the value of IMUs to help improve the health and safety of an organization. This technology is the same type of technology in this research study. Zhao et al. (2021) used IMUs to study WMSDs due to awkward positioning and posture in the construction industry. This study applies to supply chain management due to the similarities between the injuries in both industries. The study concluded that IMU technology allowed management and construction workers to understand better how the WMSDs occurred, which introduced new information to reduce WMSDs proactively. This proactive approach to reducing WMSDs was proven to help reduce injuries and insurance claims in the construction industry.

Other Workplace Safety Studies Using Technology

Like this research, previous studies demonstrating modern technology have been used to monitor ergonomic situations within supply chains. Ozorhon and Karahan (2017) illustrated that these technologies could lead to numerous safety and non-safety benefits within manufacturing, construction, and supply chain organizations. To fully understand how technology can benefit organizational safety programs, the organization must understand the use of other technologies outside of ergonomic risk-based technologies to comprehend all facets of the potential implementation fully.

Drone Technology

The advent of the fourth industrial revolution has given light to many new technologies that can help organizations lower employee-related injuries in the workplace. Gheisari et a. (2018) studied drone technologies to monitor potential fall hazards within supply chains. Computer vision on the drone was used to detect potential fall hazards that could lead to a WMSD, or the potential of a fatality, depending on the height from which the employee falls. First, the drone would use computer vision to detect if the proper guardrails were used, which would help to reduce the potential of a fatal fall. Next, the drone would detect if the proper decking was used to allow the employee the proper walkway and places to put his or her foot. Finally, the drone would use spatial recognition to monitor if the employee had the proper workspace area, allowing them to move within the tight spaces properly. This combination of factors would then be transferred to leadership to inform them that a workplace was unsafe and could lead to a WMSD or possibly a fatality.

Similarly, Irizarry et al. (2012) studied drones as a safety inspection tool. This study was not as advanced as the previous study, but the use of technology for safety-related performance is still applicable. This study used a drone to allow a safety manager to conduct a job site survey for real-time analysis of any safety risks. For larger supply chain applications, this would allow a safety manager to identify risks faster, and in real-time, which could lead to future WMSDs.

Virtual Reality Training

One of the most significant factors in workplace safety is proper on-the-job training. Before starting a specific job function, employees must understand all aspects of their job function, both safety and non-safety related. Modern technology can help improve the effectiveness of on-the-job training, which can also be correlated to job functions with a higher risk for WMSDs. Li et al. (2012) demonstrated virtual reality training to allow employees to complete job function training in a risk-free environment. Like many job functions in the supply chain industry, this study focused on assembling and disassembling equipment. Specifically, this study focused on constructing and disassembling construction tower cranes. The study found that virtual reality training helped reduce obvious human-related errors through suitable training in a risk-free environment, leading to WMSDs or fatalities.

Exoskeletons

Another modern technology that is helping to lessen WMSDs within manufacturing or supply chain organizations is exoskeletons. Kim et al. (2019) demonstrated that exoskeletons are wearable technology that helps employees augment or assist their physical activity or capacity. The exoskeleton decreases the physical demand on the employee during manual labor jobs, decreasing their fatigue level. De Looze et al. (2016) illustrated that these devices reduced muscular strain, improved endurance, and improved employee work performance. This technology can be used as an alternative workplace intervention technique to reduce WMSDs within supply chains when other options have been exhausted first.

Creating Safer Work Environments Within Supply Chains

The primary focus of any organization, outside of providing a superior product to stakeholders, is to provide a safe work environment for all employees. However, many factors either hinder or encourage safety within supply chain organizations. Sendlhofer and Lernborg (2018) illustrated that the primary way for an organization to promote employee health and safety is with external codes, internal standards, and employee training. Globalization of the supply chain has seen a rise in competition within the supply chain, which has led to an increased demand for lean management. However, lean management was shown to have a tradeoff between competitive production and health and safety within manufacturing and supply chain organizations. Therefore, organizations must balance a fine line to maintain global competitiveness while promoting employee health and safety.

To ensure workplace safety within all organizations, the U.S. Congress created the OSHA in 1970. The U.S. Department of Labor (n.d.-a) defines OSHA's mission as "to ensure safe and healthful working conditions for workers by setting and enforcing standards and by providing training, outreach, education and assistance" (p. 02). OSHA has the power to create workplace safety standards, penalize noncompliance, and audit organizations to ensure the safety of all employees. Since OSHA's inception, the government agency claims to have reduced workplace fatalities by 60% and occupation injuries by 40%. Following the guidelines and regulations provided by OSHA allowed the organization to improve organizational safety. However, this is only the first step in promoting safety within the supply chain.

Kabir et al. (2018) demonstrated that leadership must become increasingly concerned with workplace safety due to the significant impact on cost, delivery, and quality to continue to grow safety within a supply chain organization. Leadership within these supply chains ensures safe work environments from operational and cultural aspects. However, these individuals must be provided with the financial resources required to expose and mitigate unsafe working conditions to achieve a safer workplace. Also, if an organization does not focus on the safety and well-being of the employee, there is the possibility of damaging the organization's reputation. Kabir et al. (2018) illustrated that in 2016, OSHA increased fines for unsafe working conditions for the first time since 1990, and those fines increased by nearly 80%. The increase in fines was put into place to allow the organization to increase the rate of inspections at unsafe organizations. However, it was found that firms that did incur a fine from OSHA took a proactive approach to mitigate the risk from the fine. This mitigation resulted in an increase in the overall safety of the supply chain organization. Therefore, it can be assumed that increased fines would lead to an overall safer supply chain through more OSHA inspections.

Another way that organizations have promoted safer supply chains is by emphasizing the sustainability of the organization's practices. Paulraj et al. (2017) defined sustainable supply chain management practices as "sustainable product and process design, as well as external practices, such as supplier and customer collaboration, which are taken to make its supply chain more sustainable in terms of all three dimensions of the triple bottom line" (p. 240). One of the drivers of this sustainability is corporate social sustainability, which includes safety within the supply chain. Corporate social responsibility is the notion that the organization has a duty to society to go above and beyond the pursuit of profit, and one key factor of this sustainability effort is treating employees well in terms of workplace safety. This research found that companies who invest in sustainable supply chain management practices have tremendous success in their respective fields and provide more long-term value to stakeholders and the local communities.

Safety Within Finished Vehicle Logistics Operations

One of the most significant facets of the finished vehicle logistics operations is the port and terminal operations. Saruchera (2020) found that man-made and natural disasters have created a need for elevated safety and risk management by organizations that operate ocean terminals. The studied organization handles hundreds of thousands of tons of material each year through many global ocean terminals and must adequately address the need to increase safety within its supply chain. Specifically, Saruchera (2020) illustrated that many safety precautions must be taken when transporting cargo in-port and operating the logistics centers that integrate inland and maritime transportation.

Lu et al. (2017) illustrated that 75-96% of maritime casualties are attributed to human error, and the causes of the crew injuries or fatalities are unclear. Many marine terminals reduced the number of safety incidents by promoting the organization's safety climate, explicitly promoting the safety procedures through clear information flow. However, this study was found to reduce injuries within the maritime industry through a perceived mutual obligation to safety within the workplace. The leadership at the marine terminal and the labor had a mutual obligation to the safety of all employees within the organization. This social exchange included feedback, the contribution of ideas, and working together to mitigate safety risks. All the previous contributions are built on mutual safety obligations to all parties on the terminal through mutual respect and trust. This mutual obligation to safety enhanced overall safety at the terminal due to organizational citizenship behaviors from all parties.

Tools that Support Safety Within Supply Chains

A cohesive understanding of workplace injuries provides tools to organizational leadership that can help reduce workplace injuries. However, those technologies must be partnered with a workplace climate supporting organizational safety. This climate can be achieved by safer procedures for on-the-job training, job hazard analysis, workplace personal protective equipment, several lean management techniques, safety best practices, and overall organizational support for a safety climate.

Safety Climate. A significant factor in the organization’s workplace injuries is its climate for the safety of its employees. Throughout the numerous studies for this literature review, safety climate and safety training were the highest determination of an organization’s employee health and safety performance within supply chain organizations. Therefore, the most significant step an employer can take to improve safety within their organization is to provide ample training to the employees while promoting the vision of a safer work environment within their supply chain organization.

Abubakar et al. (2020) defined an organization’s safety climate as the policies, procedures, behaviors, and practices that management puts forth conducive to safety. This climate can be measured by safety systems, communication, training, competence, and risk. Within any organization, especially the supply chain industry, the safety climate is a top-down approach to safety performance that starts with senior management support. One of the keys to the safety climate within a supply chain is leadership being present on the shop floor to address safety issues as they arise immediately. This leadership from the shop floor proved to the employees that management has a vested interest in the safety and well-being of all employees.

Similarly, Abubakar et al. (2020) found that the safety climate is psychological and refers to the employee’s perceptions of the safety-related associations of the previous organization's practices. Employees would assign cognitive behaviors to their supervisor’s actions and reactions to safety-related practices. This social interaction would create the climate that creates the meanings behind the organization’s values and priorities associated with safety. Abubakar et al. (2020) found a reduced chance of incidents or injuries in an organization with a high safety climate due to the worker’s positive safety behaviors correlated to the safety climate. Gao et al. (2016) illustrated that safety performance is the qualitative measurement of accidents and injuries. These are the lagging indicators that organizations can benchmark their year-to-year safety objectives to measure the impact of a safety program. This study determined a significant interconnection between an organization's safety climate and overall safety performance. Therefore, safety climate plays a key role in reducing WMSDs within the organization.

Safety Training. Especially in the supply chain industry, employers should implement safety and health procedures into day-to-day training to minimize accidents in the workplace. Proper training for safe work procedures must be included in the employee's on-the-job training for their job function. According to Taufek et al. (2016), implementing safety training into job function training allowed the organization to provide a safer work environment. The study proved that workplace injuries were minimized by implementing proper safety training by reducing human error that results in workplace injuries. Also, this training allowed safety to be implemented when training the employee on the proper use of tooling and machinery. Improper handling of tooling and machinery was a predictor of workplace accidents that could be reduced through proper safety training.

One of the most strategic pieces of training that the organization can offer to help improve the safety of its employees is situational awareness training. Wang et al. (2021) demonstrated that employees must behave safely in their everyday duties to be safe in the workplace. This study found a positive relationship between an employee's emotional intelligence and situational awareness. Specifically, when the organization provides inadequate safety training, the employee's emotional intelligence drives their safety-related cognitions. However, the study concluded that when an organization provides an adequate level of situation awareness training, the employee is less likely to rely on their intelligence and more likely to rely on the training provided. Therefore, in industries with higher danger levels, like supply chains, employers must provide more situational awareness training to rely on it instead of their emotional intelligence.

Job Hazard Analysis. A job hazard analysis is one of the most important tools at the organization's disposal. Pouya et al. (2019) demonstrated that "a number of accidents and injuries in work environments can be prevented through the identification and assessment of hazards" (p. 541). A job hazard analysis systematically examines the hazards for any process, occupation, or job task. The first step is to watch the employee perform their day-to-day work function or activities while conversating with them to understand the hazardous parts of their job function. Next, the person watching the employee would document any parts of the job function that were unsafe or resulted in a WMSD. Finally, an investigation is performed to help reduce those job hazards and lower the future risk of that employee being injured while performing their job.

Rajkumar et al. (2021) studied implementing a job hazard identification and risk assessment within manufacturing supply chains in India. Like the supply chain being studied in this research, the manufacturing sector was found to have many repetitive job functions that can lead to WMSDs. Considering the amount of repetitive motion that is present within jobs in the supply chain industry, a job hazard analysis is a very simple-to-use methodology that would allow the organization to lower on-the-job injuries or hazards simply by understanding the risk of the job and helping to provide alternatives to reduce those risks. The job hazard analysis can be seen in Figure 4. This hazard analysis was then combined with a risk assessment for each job function to provide a qualitative analysis of the risk for each job. Each hazard within the supply chain was then mitigated using the hierarchy of controls, as shown in Figure 5. This hierarchy of controls shows that job hazards can be lessened through elimination, Personal Protective Equipment (PPE), administrative control, engineering control, or substitution. This study found that more than 50% of hazards were eliminated through this methodology.

Personal Protective Equipment. To help mitigate the risk of workplace injuries within supply chains, many employees wear PPE. This PPE is specialized equipment for employees that would help lower the chance of a WMSD in specific job functions. PPE can range from high-visibility vests, safety shoes, helmets, ear protection, eye protection, or dust masks. Seçkiner and Ünal (2021) found that designing the appropriate PPE for employees' job tasks is very demanding but required to design an effective workplace safety program. This study suggested that employers must go above and beyond when evaluating their employee's PPE instead of buying something "off-the-shelf" that could not be suitable for the job. Like the safety climate within the organization, supply chain organizations would achieve better results from the PPE provided when the organization puts effort into designing a more effective PPE program for the employees.

5S and Safety. The concept of 5S has been shown to bring efficiency to lean management operations. However, more recent studies have proven that the 5S methodology can help improve safety within supply chains. The 5S methodology is a concept that helps organizations standardize work environments and processes. The five "S" stand for sort, set in order, shine, standardize, and sustain. This methodology would constantly repeat to allow for continuous improvement. Soltaninejad et al. (2021) demonstrated that this methodology would uncover hidden problems, eliminate waste, and improve efficiency. However, this methodology can also provide safer work environments within supply chains. Integrating safety into the 5S methodology was proven to get employees thinking about safety when applying lean programs, which improved organizational safety. The reason that safety was improved when applied in correlation to the 5S principles was through safety climate. Getting the employees to think about safety when applying the 5S principles demonstrated a rise in the safety climate within supply chain organizations, leading to safer work environments.

Visual Management and Safety. Another concept demonstrated to improve safety within supply chain organizations is visual management. Like the 5S methodology, the visual management technique is a lean management tool that helps to reduce waste and improve efficiency. However, this concept was also shown to help improve organization safety within supply chain organizations. Sá et al. (2021) illustrated that visual management uses percept information to normalize, guide, and organize production. This concept allows for improved efficiency within supply chain organizations through standard work and visual perceptions. The concept of visual management relies on the speed of intuitive communication to relay information to any employee—for example, more signage throughout the work environment allows an employee to identify work procedures quickly.

Combining 5S and visual management was demonstrated to significantly increase safety within supply chain organizations by improving the safety climate, reducing clutter, and giving the employees better visualizations of the task at hand. The concept of visual management also creates higher levels of safety within supply chain organizations through visual and audible controls such as barriers, cones, sirens, and lights. These tools can be used by any lean management practitioner in their supply chain to increase organizational productivity and create a safer work environment for all employees through organizational controls.

Safety Best Practices. Another tool that can help supply chain organizations create safer work environments is sharing best practices. Best practice sharing was found to help create safer work environments for all employees, whether internal or external. Internal best practice sharing can be conducted between sites with similar job roles or functions for larger organizations. Each time a new and safer way to perform a job is identified, that updated function would be shared among the other facilities in the network to allow all facilities to benefit from this new information. Organizations can share best practice information between similar organizations or trades informally or formally. For example, worker's compensation insurance companies have a vested interest in seeing their customer companies provide safer workplaces for their employees. Those insurance companies may provide safety forums, conferences, information from other companies, and many different avenues for the organization to learn new safety techniques that could benefit the organization's safety. Many organizations perform similar operations within the supply chain industry or have employees who perform similar job functions. Internally, those organizations can share best practices between similar sites, while externally, those supply chain organizations can share benchmarks and best practices.

ISO 45001:2018. Another modern safety trend within supply chains is the recent addition by the American National Standards Institute to include occupational health and safety. The newly revised International Organization for Standardization (ISO) 45001:2018, released in March 2018, set a new global standard for organizational health and safety performance. Kapp (2018) demonstrated that organizations that follow the ISO 45001:2018 standard have an option to address many of the shortfalls of current occupational health and safety practices. Organizations that implement this new standard are given ways to identify and mitigate safety risks, which was demonstrated to improve bottom-line performance, employee morale, and the organization's overall safety.

Wells (2018) answered the question posed by most organizations, which is why they should adopt the IS0 45001 standard. First, to compete globally, ISO is becoming a standard certification that would set them apart from their competition. This standard can be on the documentation standard, 9001, or the environmental standard, 14001. Also, for many organizations who already understand the ISO process, the 45001 standard is a natural progression. Next, it was developed by safety experts worldwide who understand organization safety, especially within supply chains. Therefore, the organization gains valuable information from these individuals by implementing this standard. Finally, the ISO standard was built on Edward Deming's plan-do-check-act cycle, which allows organizations to continually monitor and improve any piece of their process within the supply chain. Therefore, the ISO 45001:2018 standard is an easy way for organizations to improve their occupational health and safety programs, which provide safer supply chains for all stakeholders.

Adoption of New Safety Technology

As stated previously, for a supply chain organization to reduce its injury frequency, it must adopt safer procedures for on-the-job training, job hazard analysis, safety best practices, and overall organizational support for a safety culture. However, modern technologies could help enhance workplace safety and reduce the possibility of WMSDs within a supply chain organization. Nnaji et al. (2019) studied the adoption rate of technology to improve organizational safety in the construction industry. First, this study focused on industry professionals' adoption rate of new safety technology. This was done using a survey of potential safety technology adoption predictors categorized into external, internal, organization, and technology. Overall, cost savings was the primary factor influencing the organization's decision to adopt new technology.

This study used a 5-point Likert scale to measure the level of importance of each predictor of adopting the new technology. To summarize, the reliability of the technology and its proven effectiveness were the highest predictors of the adoption of the predictor subcategory of technology. The level of training to use the new technology and the amount of technical support was the highest predictors of the adoption predictor subcategory of individual adoption. Changes in the organizational culture and deriving a competitive advantage from the new technology were the highest predictors of the adoption of the predictor subcategory of the organization. Finally, external client demand and government policies were the highest predictors of the adoption predictor subcategory of external. These predictors were evaluated during the adoption phase of the technology implementation for this research. This study provided a substantial framework for addressing the adoption of new safety technologies in workplaces.

Technology Adoption Within Supply Chains

Many new technologies have helped supply chains become more effective and efficient within their day-to-day operations and provide a safer work environment. However, understanding how a new safety technology was adopted is imperative to understanding how other technologies are adopted within supply chains. Liu et al. (2016) illustrated that simply adopting new technology within a supply chain would not benefit the organization. For the technology to create an impact, it must be adopted into existing business practices and processes. This adoption is defined by how the supply chain organization employs, utilizes, and implements the new technology into internal and external business practices. The organization cannot just put technology in place without promoting that technology within the organization's vision.

First, the organization must understand the drivers and performance implications of adopting a new supply chain technology. Saldanha et al. (2015) found that most supply chain managers resist utilizing new technologies. To address the ‘ground-floor’ implementation of the new technology, senior leadership must communicate the vision and motivations behind the organization’s implementation of the new technology. Like the communication needed to develop the safety climate, the adoption of new safety technology is led by top-down management with a clear vision for why the organization is implementing this new technology.

Next, the organization must understand that even though the technology may have significant findings of its effectiveness, this may not translate into organizational performance. Richey et al. (2007) illustrated this phenomenon as the technology productivity paradox. This paradox illustrates a significant difference in technology performance when measured against adoption instead of utilization. Adoption rates may be higher, but utilization rates may be lower when measured against technology performance. This relates to the top-down management needed to push the organization's vision for utilizing the new technology.

Finally, the organization must understand that many internal and external drivers may affect the new technology's adoption. These drivers can include perceived usefulness, complexity, compatibility, organization size, and structure. Liu et al. (2016) concluded that organizations demonstrating the efficiency and legitimacy behind a new technology would see higher adoption rates and utilization of new supply chain technologies. These drivers increased adoption rates when overall management support was higher within supply chain organizations. Also, adoption rates were higher at the strategic level and lower at the operational level, which relates to the top-down support for the vision of adopting the new technology. Finally, technology utilization was higher when an organization's processes or systems were changed to integrate the new technology.

Discovered Themes

After the study's conclusion, the discovered themes differed slightly from the anticipated themes. First, it was anticipated that the information gathered by the employees using the technology would reduce ergonomic injuries within the workplace. This anticipated theme held true and was demonstrated in the statistically significant reduction in injuries at one of the sites. Next, it was anticipated that wearing the new technology would lead to an overall heightened awareness of safety by the employee. This anticipated theme also held true, but not specifically to the employee. The employees focused on the overall heightened awareness of the collective group of employees and not necessarily themselves. This is reinforced by the organizational identification theory, in which the employees focused on the in-group. The final anticipated theme was that the proactive steps taken by the organization lead to a reduction in injury frequency, costs, and premiums. For this anticipated theme, one of the sites did have a reduction in injury frequency. Both sites saw a reduction in insurance costs, and premiums could not be measured because that information is severely lagging and is not measured until the year after the study concluded.

Summary of Literature Review

Previous information in this research demonstrated how modern technology was used to monitor the ergonomics of employees. However, an exhaustive review of the current literature was needed to demonstrate the need for this research to be conducted in modern supply chain organizations. First, the literature review demonstrated supply chain management and the finished vehicle logistics industry review to understand this reader better. Then, a review of current literature related to this study's nature and the research framework. This allowed the reader to understand better how workplace injuries affect the organization and the employee. Next, the review demonstrated the organization's financial and psychological impact on the employee. Next, this review allowed the researcher to understand the specific form of work-related injuries studied. These WMSDs are the most common workplace injury plaguing organizations and were the basis for this research. Then, a cohesive understanding of the tools used with the new technology allows an organization to lower WMSDs. Also, an understanding of how this new technology would take place.

Next, this review demonstrated previous studies using technology that created safer work environments and demonstrated other modern safety technologies that helped create safer work environments. Then the literature review concluded with a working understanding of safety within the supply chain and many facets of the finished vehicle logistics industry. This cohesive and exhaustive ‘360-degree’ view of existing knowledge allowed the researcher to fill in gaps where knowledge is missing through this research study.

Section 2: The Project

Globally, the International Organization for Standardization (2018) stated that every 15 seconds, a worker dies from a work-related injury or disease, and 153 experience a work-related injury. That translates into nearly 5,700 work-related fatalities daily and 374 million non-fatal injuries each year. In section one, the researcher has demonstrated the growing need for organizations to take steps toward counteracting the growing workplace crisis of employee safety within supply chain organizations. Also, the U.S. Department of Labor (n.d.-b), within the general duty guidelines of OSHA, illustrated that every employer shall provide a place of employment free of recognized hazards that are likely to cause physical harm or death to their employees. So, workplace injury reduction is socially responsible, but organizations also have a governmental duty to take steps to lower injuries within their organizations. However, workplace injuries were found to be a lagging indicator. Therefore, as Pater (2017) demonstrated, organizations must break the status quo and take more proactive steps to reduce WMSDs. Which leads to the question, how do employers create a safer work environment?

Koh et al. (2019) demonstrated that new technology could be implemented that helps supply chains ensure process safety and promote social sustainability. Section two demonstrated that modern technology was used as a proactive step toward lowering WMSDs within an organization. This section demonstrates the in-depth role that the researcher, participants, and data played in proving or disproving the feasibility of the new wearable safety technology. This section demonstrates all facets of the research methodology, the role of each participant, how the population was gathered, and all steps related to the data in this study. Finally, this section demonstrates how reliability and validity were upheld during the study. This information combines into a succinct overview of the research, which is needed to demonstrate whether wearable safety technology benefited the organization and the global supply chain.

Purpose Statement

The purpose of this mixed method convergent parallel research was to expand the understanding of how wearable safety technology could impact an organization's injury frequency rate through a proactive implementation of new technology. The research sought to determine the quantitative impact of wearable safety technology on the organization's injury frequency rate and the qualitative impacts that can also impact the injury frequency rate. In addition, this study would research the more significant problem of employee-related ergonomic injuries at organizations within the global logistics and supply chain.

Role of the Researcher

Pater (2017) illustrated that the best approach to reducing ergonomic-related injuries is to take a proactive approach instead of rehashing old habits. For this research, the role of the researcher is to present the finished vehicle logistics organization with a new technology that could reduce employee-related ergonomic injuries within this supply chain organization. The researcher presented the new technology to the organization, guided the site-level leadership on how the technology should be worn appropriately, and monitored the results. For the quantitative results of this study, the researcher monitored the data coming from the new technology and compared that with historical data from the organization. However, this study used the convergent parallel design, resulting in qualitative results. Demir and Pişmek (2018) demonstrated that the convergent parallel design conducts the quantitative and qualitative elements in the same phase of the research process while analyzing the components separately but producing concurrent results. Therefore, for the qualitative portion of the study, the researcher used survey-related results to conclude the qualitative elements that coincide with the quantitative elements. Using the convergent parallel design, this combination of results gave the researcher a succinct overview of the study results after implementing the new technology into the supply chain.

Bracketing

Considering this research followed the mixed method design, a discussion of bracketing must occur to eliminate personal bias due to the flexibility. Creswell and Poth (2018) demonstrated that bracketing is when the researcher brackets himself or herself out of the study by discussing their personal experiences with the phenomenon. This allows the researcher to identify their experiences with the phenomenon to partly set them aside to focus on the participants' experiences in the study. For this research, bracketing was applied to the qualitative portion of the study, where the researcher sought to identify the non-quantitative results of implementing the new wearable safety technology. The researcher provided a complete experience of their personal experience of how injury frequency impacts the organization and what other behavioral changes can be attributed to the new technology. This documentation allowed the researcher to understand their personal experiences with the safety-related outcomes but did not allow those experiences to determine the participants' experience.

Role of the Researcher Summary

To conclude, the researcher had a vital role in this research. Given the mixed method design, this role included quantitative and qualitative research. The quantitative research was done remotely, which supported the removal of personal bias from the quantitative data. However, the convergent parallel design combined this quantitative data with qualitative experiences. Therefore, bracketing allowed the researcher to discuss their personal experience with the phenomenon. This combination allowed the researcher to mix the qualitative and quantitative outcomes into one cohesive view of how this new technology helped the finished vehicle logistics organization become safer in the supply chain.

Research Methodology

When building the research outline, the researcher chose the appropriate research design and methodology that suited the individual and the study. Several types of research designs could be used, depending on the type of research being performed and the suitability of each design. These research designs are fixed, flexible, and mixed method. Robson and McCartan (2016) illustrated that the fixed design is typically used with quantitative research designs. These designs are pre-determined before data collection and cannot be changed. While the flexible design is traditionally used with qualitative research, which allows for flexibility during the data collection process. However, the mixed method design combined qualitative and quantitative aspects into one research design. Next, the researcher must decide which research method to use after choosing the design. The researcher could use the convergent parallel, explanatory sequential, or exploratory sequential transformative for the mixed method approach. Finally, the researcher must discuss using triangulation to improve research validity.

Research Designs

This research focused on a mixed method design. Lukenchuk (2017) illustrated that mixed method designs have superiority over single-method research because of the ability to combine qualitative and quantitative research. This study used a mixed method design using qualitative and quantitative methods, specifically convergent parallel research. Two research questions focused on the quantitative measurement of wearable safety technology implementation related to employee-related ergonomic injuries. Brunsdon (2016) illustrated that quantitative research must be rigorously tested and be repeatable by a third party. This part of the research was data-driven and could be replicated by any third party, giving higher data integrity. Simultaneously, the other two research questions focused on the qualitative impacts of this same implementation. Denny and Weckesser (2019) illustrated that qualitative research must focus on understanding a person's experience and providing insights into the research. This methodology was appropriate for the other two research questions as the researcher gained insight into the qualifiable outcomes from the organizational implementation of wearable safety technology.

Research Methods

The mixed method approach, focusing on convergent parallel research, allowed the researcher to examine this problem from qualitative and quantitative aspects. McKim (2017) found that "mixed methods added value by increasing validity in the findings, informing the collection of the second data source, and assisting with knowledge creation" (p. 203). This research aims to inform the organization of all aspects of reducing employee-related ergonomic injuries. According to Demir and Pişmek (2018), "a convergent parallel design entails that the researcher concurrently conducts the quantitative and qualitative elements in the same phase of the research process, weighs the methods equally, analyzes the two components independently, and interprets the results together" (p. 123).

First, the quantitative research questions correlated the wearable safety technology's implementation to the injury frequency. Advanced statistics were used to measure the application of the technology and that correlation. Next, the qualitative research examined the two research questions that sought to learn the organization's subjective impacts after implementing the safety technology. This approach allowed the researcher to use a qualitative approach to explain the effects of the quantitative data and the implementation of wearable safety technology after collecting ample amounts of data.

Research Triangulation

Since this research followed the mixed method approach, with fixed quantitative and flexible qualitative data, triangulation was critical for data and research validity. Gibson (2017) found that "triangulation allows scholars to document consistency in findings using different means of obtaining those findings, increasing our confidence that the findings are not driven by a particular method or data source" (p. 203). The quantitative research questions focused on the quantitative measurement of wearable safety technology implementation related to employee-related ergonomic injuries. At the same time, the qualitative research questions focused on the qualitative impacts of this same implementation. The process of combining these findings is triangulation.

First, considering this research followed the convergent parallel method, both data sets were examined separately. Then, considerations were decided regarding agreement, partial agreement, silence, or dissonance between the qualitative and quantitative data findings. Then, the results were listed together to find convergence from each method, complementary data from each method, and to find any discrepancies. Next, a triangulation protocol was developed, using a coding matrix to display findings that emerge from each part of the study. This matrix and the protocol allowed the researcher to demonstrate the convergent parallel applications of this research between the qualitative and quantitative findings to answer all research questions.

Research Methodology Summary

To conclude, depending on the type of research being performed and the personal beliefs of the researcher, a research study could follow many different designs and methods. For this research, the previous information has shown why the mixed method design combined with the convergent parallel method was the most appropriate. This design also included different forms of research triangulation to guarantee data integrity and validity. This combination allowed the researcher to provide the best information possible to provide results that could help mitigate injuries within the supply chain organization.

Participants

For this research study, there were four different groups of participants. Those groups were site-level leadership, hourly employees, senior leadership, and accountants. Each of these groups of participants played a vital role in their contribution to the research. First, within a supply chain organization, the site-level leadership is the local management team for each facility responsible for the facility's day-to-day operations. The site-level leadership at the finished vehicle logistics facilities is a crucial aspect of helping solve employee-related ergonomic injuries. Kao et al. (2021) demonstrated that the only way to address occupational injuries is for senior leadership to understand their employees' safety behaviors and climate. These behaviors were found to be early predictors of workplace injuries. By understanding these behaviors, leadership can take proactive steps toward improving workplace safety programs. Within global supply chain companies, site-level leadership was crucial in helping to work with the local employees while implementing, measuring, and researching the implemented technology. Also, the local leadership of the sites could see greater employee morale by reducing their individual site’s employee-related ergonomic injuries.

Next, the hourly employees at each finished vehicle logistics site had a crucial role in this research. Employees within a supply chain organization are involved in every aspect of the site's day-to-day operations and were a critical facet of this research. The hourly employees are the individuals responsible for handling the duties issued by the site-level leadership. These employees are the individuals who get injured from ergonomic-related injuries and would benefit if the technology could reduce the frequency of these injuries.

Schnittfeld and Busch (2016) illustrated the growing demand of stakeholders to find sustainable solutions to the everchanging health and safety environment within organizations of all sizes, especially in the supply chain and logistics industry, where much of the work is in manual labor. Similarly, Hughes (2019) illustrated a demand for higher workplace safety standards within supply chain organizations. Therefore, the senior stakeholders of the finished vehicle logistics organization would be vested in this study's outcome. The senior leadership team and the board of directors for the finished vehicle logistics organization had a vested interest in the outcome of this research. Senior leadership is responsible for proactively reducing these injuries while sponsoring the cost of the technology in the hope that it results in lower injury frequency. Also, if the injury frequency rate rises, there could be saving in overall insurance costs and future insurance premiums. This decrease in premiums would directly connect to the final participants, which means the finished vehicle logistics accounting team would also have a vested interest in the study's outcome.

Population and Sampling

Pater (2017) illustrated that the best approach to reducing ergonomic-related injuries is to take a proactive approach instead of rehashing old habits. This study used modern technology to lower the frequency of injuries. However, the researcher also decided on the applicable population, sampling method, frame, and sample size. Finally, the researcher guaranteed that enough information and data were collected to reach full saturation while accessing the sample.

Population

This research study focused on reducing idiopathic musculoskeletal disorders, known as WMSDs. To understand the population for this research, the researcher must first define the population. Taherdoost (2016) illustrated that the research population is the entire group the researcher sought to conclude. Therefore, for this research, the population was the employees within the finished vehicle logistics organization being studied who work in a job function where they could suffer from a WMSD. These individuals would be of either gender or vary in a range of ages, starting at 18. Oakman et al. (2016) found that WMSDs are prevalent in all age groups within the supply chain and logistics industries. However, the predictor of the WMSDs was higher in different age groups. Repetitive motion was the highest cause of a WMSD in the age group of 20 to 35, while awkward job posture was the highest predictor of employees above 50. Therefore, all age groups apply to the study because this research would cover bending, lifting, and twisting movements.

Finally, the size of the eligible population was taken into consideration. This research focused on the finished vehicle logistics facility within the United States. According to Wallenius Wilhelmsen (2022), the organization has 81 facilities worldwide, but only 39 are in the United States. Those facilities range in size of employees anywhere from five employees to 400 employees. Total labor hours for the United States in 2021 were 4,531,489 if employees work 2080 hours in a year, 52 weeks at 40 hours per week, which put the total population for this research at 2,178 employees.

Sampling

Next, the researcher must discuss the appropriate sampling for this research. Creswell and Poth (2018) illustrated that sampling is when the researcher selects the individuals and sites for their study to provide information and an understanding of the research problem and central phenomena. The first step was to decide on the sampling method. The sampling method was a mixed method using the convenience and criterion methods for this research. Given that the technology used in this study is new to the market, along with a shortage of raw materials due to the COVID-19 pandemic, the number of devices available for this study was scarce.

Also, given that this technology was used for the first time to research this phenomenon, the finished vehicle logistics organization allowed the researcher to study only two sites in the United States to demonstrate the technologies applicability. Those sites are Brunswick, Georgia, and Carlisle, Pennsylvania. Therefore, the convenience method was applicable, considering the organization sought to save money until the technology proved viable. Finally, the new technology could only be ordered in quantities of 25 units. Therefore, the total sample size in the United States was 70 employees, with 25 devices at each site, allowing for employee turnover and absences.

Also, the criterion methodology was used, given that all participants in the research were volunteers. Even though this technology only monitors the employees bending, lifting, and twisting, the organization and researcher wanted to guarantee that the employees were not forced into this research study. Therefore, the criterion method was used to present the opportunity to participate in the research to the employees, but only those who would volunteer for the study were chosen as participants.

Given the previous information, the sample frame for this research study was any employee who works at one of the two sites who volunteered for the study. This sample frame is appropriate given the supply chain constraints on manufacturing and the organization’s hesitancy to grow the research further during a proof-of-concept phase. Given employee turnover, call-ins, and sickness, the sample size was 70 hourly employees who used the devices to allow for maximum utilization on a day-to-day basis. For the qualitative section of this research, of 70 employees, 32 responded to the survey. Therefore, the sampling size was 100%. Also, for the leadership employees and the qualitative results, the researcher sent the survey to 60 individuals who were knowledgeable about the implementation of wearable safety technology. Of the 60 individuals selected as the sample size, 22 chose to participate in the survey: seven site leaders, eight senior leaders, and seven accountants.

The researcher gathered close to 6 months' worth of data to allow the new device to be used effectively to guarantee appropriate data saturation. Even though the sample size is small, the data collected over a more extended period provided enough information to successfully conclude the device's applicability towards lowering the frequency of WMSDs.

Finally, given the role of the researcher within the organization, the researcher had full access to the sample and the information. Data were collected and stored within an online database, to which only the researcher and the site-level management had access to that data. Also, the researcher traveled to both sites periodically to check on the progress of the research study.

Population and Sampling Summary

This research demonstrates that modern technology could lower the frequency of WMSDs in a supply chain environment. Given the nature of the research, the study population includes all employees within the finished vehicle logistics organization. However, the organization was hesitant to have every employee wear one of the devices since it is a new technology. Therefore, this study was based on a smaller sample size for this research's initial proof of concept. Also, only employees who volunteered to participate in the study were chosen.

Given this information, all participants who volunteered in either section were used as the sampling methodology. However, given the role of the research, the researcher had full access to travel to the sites to guarantee the efficacy of the study and monitor data collection remotely. The research was conducted for almost a year, so much data were collected to ensure that this research was fully saturated. OSHA, a branch of the U.S. Department of Labor (n.d.), stated that every employer shall provide a place of employment free of recognized hazards that are likely to cause physical harm or death to their employees. This research is the first step in trialing a new technology that helped supply chains lower the frequency of WMSDs.

Data Collection and Organization

Proper organization was the key to success for the researcher during this study. The following section provides a succinct overview of the researcher's plan for collecting, organizing, protecting, and accessing crucial data for this research. The data collection plan provided guidelines to gather all the necessary information to answer the research questions correctly. Simultaneously, the member-checking guidelines provided the integrity needed for the qualitative data. Proper instruments were put into place to gather the data, consisting of archive data and interview guides. Finally, the data organization plan provided the researcher with the proper guidelines and tools to guarantee the integrity of the data collection process. This combination of planning and tools provided the researcher with the proper path for successfully completing this research.

Data Collection Plan

The mixed method design collected qualitative and quantitative data for this research study. For the quantitative portion of this research, the first set of data collected answers to RQ1: Quantitative Research Question: What are the historic injury rates for the U.S. warehousing and distribution industry compared to the organization's historic injury frequency rates? First, the researcher answered RQ1a: What are the organization's historical injury frequency rates? The data were collected from the organization's SharePoint database, which houses all historical safety and employee injuries. The data gave a concise overview of all facilities in the United States and those being studied. Next, the researcher answered RQ1b: What are the organization's historical costs associated with ergonomic injuries? The data were gathered from the organization's SharePoint database. Then, the researcher answered RQ1c: What are the historical injury frequency rates for the U.S. warehousing and distribution sector? This information was collected from the BLS, which provided a concise overview of the U.S. workforce sector related to the organization. Finally, the researcher answered RQ1d: How do the organization's historical injury rates compare to the warehousing and distribution industry's historical injury rates? This comparison was achieved through a comparison of the previous quantitative data.

Next, the researcher focused on the data that answers RQ3: Quantitative Research Question: What is the organization's injury frequency rate and injury costs after implementing the wearable safety technology? Devices were implemented to capture the hourly employee participants' risk profile, translated into a daily safety score. For this study, the technology that the hourly employees wore provided feedback to the employees on their risk profiles, allowing for adjustments in behavior to help lower those risk profiles or raise their daily safety scores. Marras et al. (1992) used an exoskeleton lumbar motion monitor to assess the employee's trunk position, velocity, and acceleration while lifting in a three-dimensional space. That research aimed to determine factors that the exoskeleton lumbar motion monitor read, leading to lower back disorder risk groups. The risk groups were classified as low, medium, and high-risk groups. Motion from each plane was considered when determining the risk group.

After implementing the devices, the researcher answered RQ3a: What are the organization's injury frequency rates after implementing the wearable safety technology? Also, if an injury did occur to an employee wearing a device, the researcher was able to answer RQ3b: What are the organization's injury costs associated with ergonomic injuries after implementing the wearable safety technology? Finally, another quantitative data comparison was performed to answer RQ3c: How do the organization's injury frequency rates compare to those within the warehousing and distribution sector after implementing the wearable safety technology? The previous data provided a succinct overview of the organization's injury frequency and how the devices helped lower the risk of Work-Related Musculoskeletal Disorders (WMSD).

For the qualitative portion of this research, data were collected from interviews, allowing the other participants in this study to provide their observational feedback related to the study. A semi-structured interview guide was used so that the researcher could ask each participant the same questions. These interviews addressed RQ2: Qualitative Research Question: What are the impacts of the injury frequency rate on the organization? Also, the interview addressed RQ4: Qualitative Research Question: What other behavioral changes can be observed positively influencing reducing injury frequency after implementing the wearable safety technology? The instrument section of this paper demonstrates a further discussion of the interview guide, the questions, and the relation to the research questions.

Member Checking

Member checking validated the qualitative data gathered through semi-structured interviews for this research. Candela (2019) illustrated that member checking is a way for the researcher to allow the participants to confirm or deny the accuracy of the data interpretation, which guaranteed an accurate portrayal of the participants' voices. Therefore, adding credibility to the qualitative study. For this research, qualitative data were gathered through semi-structured interviews. However, to guarantee the validity of the information being gathered, the researcher used member checking to allow the participant to confirm or deny the researcher's information. This was done by summarizing the participant's information to guarantee accuracy. Also, the researcher captured the answers provided by the interviewee electronically. At the bottom of the semi-structured interview summation, the researcher had the interviewee sign their name to guarantee the most accurate portrayal of their viewpoint.

Follow-up Interviews

Follow-up interviews were conducted similarly to the initial semi-structured interview but without the previous structured form. If any follow-up questions arise, the researcher would interview the applicable person during the research process. However, that interview would be recorded for data credibility and follow the same member-checking criteria. After reading, memoing, and documenting all the surveys, no follow-up interview was deemed necessary. The information provided by the participants provided a comprehensive overview of their views of the technology implementation.

Instruments

For this research, interview guides were used to gather qualitative data, while archive data were used to gather quantitative data.

Interview Guides

Two interview guides were used for this research. The first, shown in Appendix A, answered RQ2: Qualitative Research Question: What are the impacts of the injury frequency rate on the organization? This semi-structured interview guide provided a concise viewpoint, from all participants, on the current impact of injuries on the organization. The second, shown in

Appendix B, was used to answer RQ4: Qualitative Research Question: What other behavioral changes can be observed positively influencing reducing injury frequency after implementing the wearable safety technology? After implementing the technology, this interview guide followed up with the previous participants and collected their viewpoints on how technology impacted other organizational behavior changes.

Archive Data

Archive data were used to answer the quantitative research questions. First, the organization's SharePoint site was used to collect the data needed to answer the following research questions:

RQ1a: What are the organization's historical injury frequency rates?

RQ1b: What are the organization's historical costs associated with ergonomic injuries?

The data were then combined with historical data from the BLS to compare the organization with the greater supply chain. This answered the following research questions:

RQ1c: What are the historical injury frequency rates for the U.S. warehousing and distribution sector?

RQ1d: How do the organization's historical injury rates compare to the warehousing and distribution industry's historical injury rates?

This combination of SharePoint data and BLS data provided a concise answer to the first research question: RQ1: Quantitative Research Question: What are the historic injury rates for the warehousing and distribution industry compared to the organization's historic injury frequency rates?

Next, the organization's SharePoint site measured injury frequency after implementing the new technology. Also, the technology provider provided access to the previously mentioned employee-related data on their daily safety scores. Finally, the previously collected BLS data compared the organization with the greater supply chain. This combination of data answered the third research question: RQ3: Quantitative Research Question: What is the organization's injury frequency rate and injury costs after implementing the wearable safety technology?

The organization's SharePoint site held all archive data related to work-related injuries worldwide. The local management team uses the site to enter all information about the injuries. At the same time, the local human resources team filled out any protected data within the same SharePoint site. Finally, the costs for individual injuries were also gathered from the insurance providers who cover work-related injuries. Combining this information with the BLS data gave the researcher a concise view of the historical and current work-related injuries.

Data Organization Plan

Given the mixed method design of this research, data organization is crucial for integrity. To optimize the organization and integrity of this research, the research followed the Data Management Plan (DMP) illustrated by the U.S. Geological Survey (n.d.). A DMP was collected for each data repository and included in an appendix of the final research. This DMP is illustrated in Appendix C and Appendix D. Appendix C demonstrates a DMP filled out when gathering existing data, previously illustrated as the archive data. Appendix D demonstrates a DMP that was filled out when new data were. Appendix C DMP applied to historical data from the organization or BLS. However, Appendix D DMP applied to the new information gathered quantitively or qualitatively.

The DMP allowed the researcher to organize the data collected during this research properly. Johnson et al. (2010) illustrated that the quantitative protocol would provide better information about the numbers and proportions of the participants actively involved in the study.

The researcher must properly organize that data on their computer and follow the proper protocols to guarantee the integrity of this study. The primary organizational tool was the Microsoft Office suite for the quantitative data. IBM SPSS was used to analyze the data, but data were initially captured in Excel and housed in password-protected folders on the researcher's computer.

Johnson et al. (2010) found that the qualitative method produces large-scale data to be analyzed. However, this study found that the key to qualitative research is having a well-designed approach to what the research project is expected to accomplish. Given the nature of this research, the researcher was prepared to analyze the qualitative data seamlessly. For example, the baseline qualitative protocol was used to carefully develop an interview schedule, using the interview guide to allow the researcher to be as organized as possible. The individual interviews were stored in a password-protected folder on the researcher's computer for that data. These interviews were then coded to identify emergent themes discussed below.

Summary of Data Collection and Organization

One key to completing this research is the integrity of the data collection process and proper organization techniques. The mixed method design allowed the researcher to see data from both the qualitative and quantitative aspects. However, this produced a significant amount of data, which the researcher had to collect, organize, and protect. Creswell and Poth (2018) found that protocols for data collection are crucial during the qualitative inquiry process. The previously described processes for data collection, interview guides, and member checking provided the researcher with an appropriate path toward success. Also, the information provided through the historical databases of the organization and BLS provided the researcher with essential information to answer the quantitative questions. However, all the data were organized as well. Following the DMP, provided by the U.S. Geological Survey (n.d.), allowed the researcher to stay organized and provide greater integrity to the research. This combination of data collection and organization planning gave the researcher the proper planning to complete the research project successfully.

Data Analysis

Considering this research follows a mixed method, many different forms of data analysis exist. First, qualitative data analysis. Creswell and Poth (2018) illustrated that qualitative data analysis involves coding and organizing themes, representing the data, and interpreting that data. Then, for the quantitative data analysis, Morgan et al. (2013) demonstrated the appropriateness of the different variables and testing methods to be used. This combination of methods allows the researcher to provide a succinct viewpoint of the data analysis process.

Qualitative Emergent Ideas and Coding Themes

For the qualitative section of this research, the first step was to read and memo the emergent ideas taken from the semi-structured interview guides. The researcher followed the path illustrated by Creswell and Poth (2018) to properly code, organize, represent, and interpret the qualitative data. First, the researcher transcribed all the interview guides verbatim into transcripts in NVivo. This transcript allowed for the remaining steps to be easier using NVivo. While transcribing this information, the researcher read all interview guides and used notes in the margins to memo potential emergent ideas. This reflective thinking was the basis for future steps in this process.

Then, the researcher used color to highlight and identify codes within the transcripts. This step allowed the researcher to visualize codes. These initial codes were short names translated into higher-level expanded code names in the codebook. Those expanded codes were applied to a higher-level code directly related to the emergent themes applicable to the qualitative research questions. Finally, the researcher counted the frequency of the code, which allowed the researcher to develop emergent themes and patterns within the transcript. A separate codebook was used as a legend to classify the highlighted code into the emergent theme and identify the number of times the code was highlighted within the transcript.

Qualitative Interpretation

The next step in this qualitative process was for the researcher to translate the previously defined themes into interpretations. The researcher turned those themes into related categories and families, which related the themes to the literature. Creswell and Poth (2018) suggested the researcher should guide their interpretation using the following questions: "What surprising information did you not expect to find? What information is conceptually interesting or unusual to participants and audiences? What are the dominant interpretations, and what are the alternate notions?" (p. 195). These questions provided a solid framework for the researcher to start the interpretation process. Peer feedback was sought from the dissertation chair during the early interpretations, which allowed the researcher to articulate patterns and seek feedback.

Qualitative Data Representation

Next, the researcher represented the data found in the text and codebook in a visual form. A matrix was used to compare and cross-reference categories, which allowed the researcher to establish a visual representation of the data patterns. This matrix was a hierarchical tree diagram, which showed both high and lower levels of abstract information. According to Creswell and Poth (2018), the lower levels of the tree represented the least abstract themes, while the higher level represented the most abstract themes.

Quantitative Variables

For the quantitative section of this research, there are several variables. The first variable was wearable safety technology. Morgan et al. (2013) described this variable as an activity "which is given to a group of participants, within a specified period of time during the study" (p. 02). This variable is an independent variable, and the data type was shown as dichotomous. Some employees wore the technology, and some did not. Therefore, this independent variable was measured with the injury frequency rate dependent variable. The ratio range was either one or zero, given that it was binary and dichotomous since not all employees wore the device. The second variable is the various injury frequency rates. This variable was the previously discussed organizational injury frequency rate, an ordinal data ranging from zero to an infinite number. The third variable is the cost of injuries within the organization, which is nominal data that is dependent. The data are dependent because the cost of injuries is directly related to the number of injuries. The data ranged from zero to infinity.

Quantitative Descriptive Statistics

Descriptive statistics represent large quantitative sums of data in a more straightforward and understood form. This statistic is the lost time incident frequency is the ratio of injuries per hour worked. This ratio was visualized by data from the organization and BLS, which houses the information for the entirety of the supply chain in comparison. The BLS data were shown in the same format but were used to benchmark the organization. For the organizational data, after data collection, these statistics were divided into different distributions, dispersions, tendencies, and any other ratios that allowed the researcher to find patterns and trends in the data. This information was collected into IBM SPSS for data analysis.

Quantitative Hypotheses Testing

Hypotheses testing tested the quantitative research questions' relationship, differences, and descriptives. Several research questions had quantitative hypotheses testing.

RQ1a: What are the organization's historical injury frequency rates? This research question sought to understand the organization's historic injury frequency rate, which was used for future comparisons. This research question used the dependent variable of injury frequency rate. No testing was necessary for this hypothesis because there is no comparison of an independent variable. Descriptive statistics were visualized using IBM SPSS to demonstrate the data set.

RQ1b: What are the organization's historical costs associated with ergonomic injuries? This research question sought to understand the organization's historical cost of injuries, which were used for future comparisons. This research question used the dependent variable of the cost of injuries. No testing was necessary for this hypothesis because there is no comparison of an independent variable. Descriptive statistics were visualized using IBM SPSS to demonstrate the data set.

RQ1c: What are the historical injury frequency rates for the U.S. warehousing and distribution sector? This research question sought to understand the BLS data of the U.S. warehousing and distribution sector. This was data and not a variable in the research. The data were used for comparison purposes later. No testing was necessary for this hypothesis because there was no comparison of an independent variable. Descriptive statistics were visualized using IBM SPSS to demonstrate the data set.

RQ1d: How do the organization's historical injury rates compare to the warehousing and distribution industry's historical injury rates? This research question sought to compare the previous BLS data with the organization's historic injury frequency rate. This compared the dependent variable of injury frequency with the data from the BLS. No testing was necessary for this hypothesis because there is no comparison of an independent variable. Descriptive statistics were visualized using IBM SPSS to demonstrate the data set.

RQ3a: What are the organization's injury frequency rates after implementing the wearable safety technology? This research question sought to test the outcome of the implementation of the new wearable safety technology. This research question used the independent variable of the employees wearing the device and compared it against the dependent variable of the current and historical injury frequency rate. Morgan et al. (2013) demonstrated that chi-square testing would be used for this hypothesis. Chi-square is appropriate due to the large sample size and the even split between the subjects. However, the chi-square test only demonstrated the statistical significance of the data set.

RQ3b: What are the organization's injury costs associated with ergonomic injuries after implementing the wearable safety technology? This research question sought to test the outcome of the implementation of the new wearable safety technology. This research question used the independent variable of the employees wearing the device and compared it against the dependent variable of the current and historical injury costs. Morgan et al. (2013) demonstrated that chi-square testing would be used for this hypothesis. Chi-square was appropriate due to the large sample size and the even split between the subjects. However, the chi-square test only demonstrated the statistical significance of the data set.

RQ3c: How do the organization's injury frequency rates compare to those within the warehousing and distribution sector after implementing the wearable safety technology? This research question sought to benchmark the organization against the greater supply chain. This research question sought to compare the previous BLS data with the organization's injury frequency rate after implementing the new technology. This would compare the dependent variable of injury frequency after implementing the wearable safety technology against the data from the BLS. No testing was necessary for this hypothesis because there is no comparison of an independent variable. Descriptive statistics were visualized using IBM SPSS to demonstrate the data set.

Quantitative Hypotheses Testing Alternatives

Most testing used descriptive statistics to demonstrate the relationship between independent variables given the previous information. However, two research questions used the chi-square test to demonstrate the relationship between an independent and dependent variable. Morgan et al. (2013) illustrated that the one-sample t-test would be the next appropriate test if the data collected did not meet the requirement for the chosen test. Using this test, the researcher would break out the dichotomous data of the individuals who wore the device and those who did not. Then use the one-sample t-test to compare those independent variables against the previous dependent variables. Also, the paired-samples t-test was used if the researcher chose to study the entirety of the independent variables and combine those individuals into the same test.

Finally, if the one-sample t-test was not deemed appropriate, the researcher would use linear multiple regression analysis to test the research site against other sites that were not included in the research. This would allow the researcher to demonstrate a statistically significant correlation between a research site and a non-research site. This correlation would then allow the researcher to demonstrate how the research site would have performed if the new technology was not implemented.

Triangulation

Since this research followed a mixed method approach, with fixed quantitative and flexible qualitative data, triangulation is critical for data and research validity. Gibson (2017) found that "triangulation allows scholars to document consistency in findings using different means of obtaining those findings, increasing our confidence that the findings are not driven by a particular method or data source" (p. 203). The quantitative research questions focused on the quantitative measurement of wearable safety technology implementation related to employee-related ergonomic injuries. At the same time, the qualitative research questions focused on the qualitative impacts of this same implementation. The process of combining these findings was triangulation. First, considering this research followed the convergent parallel method, both data sets were examined separately. Then, the results were listed together to find convergence from each method, complementary data from each method, and to find any discrepancies. Next, a triangulation protocol developed a coding matrix to display findings that emerge from each part of the study. Finally, considerations were decided on agreement, partial agreement, silence, or dissonance between the qualitative and quantitative data findings. This matrix and the protocol allowed the researcher to demonstrate the convergent parallel applications of this research between the qualitative and quantitative findings to answer all research questions.

Summary of Data Analysis

Considering this research followed a mixed method approach, with fixed quantitative and flexible qualitative data, many different means of data analysis were needed. The researcher followed the work of Creswell and Poth (2018) to analyze the qualitative data properly. This qualitative data used transcripts coded into NVivo to create a codebook properly, interpret the data, and represent the data using a matrix tree. Meanwhile, the researcher followed the work of

Morgan et al. (2013) to analyze the quantitative data properly. The data used IBM SPSS to properly analyze the data, either using descriptive statistics or chi-square testing. The data consisted of a few variables, some of which were independent and some that were dependent. This combination of guidance from Creswell and Poth (2018) and Morgan et al. (2013) provided the researcher with the appropriate path to adequately summarize the findings into a concise understanding of the research questions.

Reliability and Validity

For this research, Amadi (2021) stated that mixed method research entails a detailed collection of qualitative and quantitative data concerning the case. In this research study, many measures were taken to ensure that the highest levels of reliability and validity were attained. Measures were taken to ensure reliability and validity to resolve the methodological differences between the approaches. Reliability was achieved through credibility, transferability, dependability, and conformability. At the same time, validity was achieved through bracketing and triangulation. This combination demonstrated a robust methodological approach that ensured the reliability and validity of the study and the researcher's work.

Reliability

Reliability within this mixed method research project was achieved through several different means. Lincoln and Guba (1985) established those means as credibility, transferability, dependability, and conformability, which collectively combine to establish trustworthiness in research. First, in the context of mixed method research, Schoonenboom and Johnson (2017) illustrated that credibility is the notion that the mixed method approach would enhance the integrity of the findings. The mixed method design allowed the researcher to explore all aspects of the phenomenon for this research. The quantitative research explored the statistical findings behind the implementation of wearable safety technology. At the same time, the qualitative research explored the participants' individual experiences affected by work-related injuries. Therefore, qualitative and quantitative research combined a highly credible information source that provided critical insights into lowering work-related injuries within the organization and other sectors.

Transferability is how this research can be applied in other contexts and studies. Burchett et al. (2013) found that the most significant factor contributing to the transferability of research is the study's congruence with the participant's experiences and beliefs. OSHA, a branch of the U.S. Department of Labor (n.d.), stated that every employer should provide a place of employment free of recognized hazards that are likely to cause physical harm or death to their employees. Therefore, given that all organizations must provide a workplace free of hazards, this congruence improved the transferability to other industries or organizations within the warehousing and logistics sector. Work-related injuries happen in every industry worldwide, and this research could help increase knowledge of how organizations can take proactive measures to lower injury frequencies.

Finally, Taheri et al. (2019) illustrated that further credibility could be achieved by adopting the appropriate well-recognized mixed method frameworks. This study demonstrated an in-depth description of all steps taken throughout the research process to allow for the replication of future studies. Dependability is obtained through an in-depth methodological description that allows the study to be repeated. Therefore, achieving higher levels of dependability through future replications. Also, confirmability was achieved by using triangulation to reduce researcher bias. The following section discusses the steps in the triangulation process further.

Validity

The quantitative research questions focused on the quantitative measurement of wearable safety technology implementation related to employee-related ergonomic injuries. At the same time, the qualitative research questions focused on the qualitative impacts of this exact implementation. The process of combining these findings was triangulation. Gibson (2017) found that "triangulation allows scholars to document consistency in findings using different means of obtaining those findings, increasing our confidence that the findings are not driven by a particular method or data source" (p. 203). Since this research followed a mixed method approach, with fixed quantitative and flexible qualitative data, triangulation was critical for data and research validity.

First, considering this research followed the convergent parallel method, both data sets were examined separately. Then, the results were listed together to find convergence from each method, complementary data from each method, and to find any discrepancies. Next, a triangulation protocol developed a coding matrix to display findings that emerged from each part of the study. This matrix and the protocol allowed the researcher to demonstrate the convergent parallel applications of this research between the qualitative and quantitative findings to answer all research questions. Then, considerations were decided on agreement, partial agreement, silence, or dissonance between the qualitative and quantitative data findings. McKim (2017) found that "mixed methods added value by increasing validity in the findings, informing the collection of the second data source, and assisting with knowledge creation" (p. 203).

Bracketing

The final step in the reliability and validity process was for the researcher to take the proper steps to reduce preconceptions related to the research, which increased the rigor of the project. Tufford and Newman (2012) defined these steps as bracketing. Previously, when discussing how the researcher would transcribe emergent ideas, it was stated that the researcher would read all the interview guides and use notes in the margins to memo potential emergent ideas. This memoing of emergent ideas is a form of bracketing in which the researcher can also reflect upon their engagement with the data. To increase the validity and reliability of the study, the researcher also detailed their engagement with the data to allow for the analysis of any preconceived notions. The insights from the notes allowed the researcher to acknowledge and foreground their preconceptions instead of stifling them for objectivity.

Summary of Reliability and Validity

Given the previous methodological approach, this research took many steps to ensure that reliability and validity were at the highest levels. Reliability was achieved through credibility, transferability, dependability, and conformability. At the same time, validity was achieved through bracketing and triangulation. Amadi (2021) illustrated that the best way to achieve reliability and validity in mixed method research is through robustness and methodological research. The previous information and in-depth examples proved that this research has the appropriate methodology to provide the highest levels of reliability and validity, which provided organizations worldwide with information on lowering incident frequencies through modern technology.

Summary of Section 2

As previously demonstrated, there is a desperate need for organizations to take proactive steps to lower ergonomic injuries. These proactive steps are proper for both the finished vehicle logistics organization and the overall global supply chain. The International Organization for Standardization (2018) statistics demonstrate that globally more than 300 million non-fatal workplace injuries happen each year is a tremendous call to research this growing tragedy. As Christian leaders, it is their duty to provide a safe workspace for their employees, and this research provided a roadmap for those safer organizations.

According to Matos et al. (2020), these safety improvements would lead to a more significant overall health, safety, and operational performance. Section one demonstrated all the elements of this study that provided new information on solving ergonomic injuries within a finished vehicle logistics organization. The researcher demonstrated all the information needed to lower this incident frequency ratio in Section 2.

First, the researcher's role was defined, demonstrating how the convergent parallel method would greatly benefit this study. Then, the researcher demonstrated the application of the mixed method research design to this research study. Following Lukenchuk's (2017) work, the mixed method designs would demonstrate superiority by combining qualitative and quantitative research. However, research triangulation must be demonstrated to increase confidence in the findings. Next, the researcher demonstrated the four different groups of participants in the study, ranging from lower-level hourly employees to senior leadership. Also, the researcher demonstrated how the population would be decided and the sampling techniques used for this study.

At the same time, a succinct plan demonstrated the data collection, organization, instruments, and analysis. According to Creswell and Poth (2018), setting the protocols for these steps during the qualitative inquiry process would demonstrate higher validity and reliability in the study. This is achieved through rigor in the research and following the DMP provided by the U.S. Geological Survey (n.d.). A separate plan was also established to code the emergent ideas in the qualitative data while interpreting the quantitative variables. This separation goes along with the mixed method research and the previous illustration of research triangulation for the convergent parallel design. Finally, the work of Lincoln and Guba (1985) helped to establish credibility, transferability, dependability, and conformability to the study. This combination of means is the basis of the researcher's trustworthiness in the study. Section two demonstrated all the information that is the key to using wearable safety technology and lowering employee-related ergonomic injuries within supply chains and the finished vehicle logistics organization.

According to the International Organization for Standardization (2018), every 15 seconds a worker dies from a work-related injury or disease, and 153 experience a work-related injury. The growing trend within lean management and productivity instead of safety has led to this global crisis of workplace safety. Within the U.S. transportation and warehousing industry, the BLS (2019, Table 2) illustrated that in 2019 more than 38 million injuries occurred from overexertion and bodily reactions. Section one of this research demonstrated the growing workplace crisis of workplace-related employee injuries. In that section, the researcher demonstrated how organizations could combat employee-related injuries. However, many of those steps are reactive to the already occurring injuries, which are lagging indicators. Koh et al. (2019) stated that the only way to solve these ergonomic injuries is with a proactive approach to employee safety. Therefore, organizations must not only work on reactive measures to combat these injuries but also take proactive steps to counteract the lagging indicator, which is WMSDs. Section two of this research defined a potential technology adoption that would support the reduction of workplace injuries within supply chains globally.

Section 2 of this research illustrated that this research aimed to determine the quantitative impact of wearable safety technology on the organization’s injury frequency rate and the qualitative impacts that can also impact the injury frequency rate. The researcher sought to implement modern technology devices that proactively alerted employees of improper ergonomic posture, which could reduce work-related injuries. This research focused on a pragmatic approach combined with a mixed method design, which Lukenchuk (2017) has superiority over single-method research because of the ability to combine qualitative and quantitative research. The results were combined using the convergent parallel approach. Section two also demonstrated that proper techniques were taken to ensure IRB guidelines were followed while still making strides to prove beneficial to the organization for reducing employee-related ergonomic injuries. Also, proper techniques were demonstrated in all facets of the research methodology, including but not limited to the role of each participant, how the population was gathered, and all steps related to the validity and reliability of data within this study. Finally, this section demonstrated how reliability and validity were upheld during the study. This information combined into a succinct overview of the research needed to demonstrate whether wearable safety technology benefited the organization and the global supply chain.

To conclude, the previous section has demonstrated the growing crisis of injuries within organizations, specifically in the supply chain and logistics industries. These injuries affect all facets of the organization and cannot be appropriately combatted without proactive steps toward lowering the number of injuries. Many techniques can lower those injuries, but most are reactive and do not proactively solve the issue. This research demonstrated a way to use modern technology to proactively take steps to reduce the number of injuries within a supply chain organization. In the next section of this study, the researcher demonstrated the research findings, the application to professional practice, further study recommendations, and reflections.

Section 3: Application to Professional Practice

Globally, the International Organization for Standardization (2018) stated that every 15 seconds a worker dies from a work-related injury or disease, and 153 experience a work-related injury. That translates into nearly 5,700 work-related fatalities daily and 374 million non-fatal injuries each year. In section one, the researcher has demonstrated the growing need for organizations to take steps toward counteracting the growing workplace crisis of employee safety within supply chain organizations. In Section 2, the researcher demonstrated the need to research the use of wearable safety technology to potentially lower WMSDs within an organization. This section will demonstrate the implementation of that technology, along with the quantitative and qualitative results. Also, through triangulation, this section will demonstrate the convergence of the two methods. Finally, the researcher will demonstrate this research's application to professional practice, potential future applications, and recommendations for further study.

Overview of the Study

The purpose of this study was to address the lack of data to substantiate the potential usage of wearable safety technology at finished vehicle logistics facilities in the U.S. to reduce employee-related ergonomic injuries, possibly resulting in decreasing the organization's injury frequency rate. Like many other supply chain and logistics organizations, the finished vehicle logistics subsect also has challenges with work-related injuries. According to Hughes (2019), leadership must meet a higher workplace safety standard within a supply chain organization. However, the organization treated these injuries as a trailing indicator and was not taking proactive measures to counteract these injuries. To potentially solve this problem, Pater (2017) recommended that a proactive approach to reducing ergonomic-related injuries is the best solution instead of organizations rehashing old habits. Therefore, this research study used proactive wearable technology to analyze the potential decrease in injuries and associated costs.

Research Background

The researcher followed the pragmatic research paradigm to provide the most relevant information for future practice. According to Creswell and Poth (2018), individuals who follow the pragmatic methodology develop meaning from their experiences. In this instance, the sought experience is employee-related ergonomic injuries, which is correlated to the meaning of why those injuries happen and what can be done to help prevent them. Then, the researcher had to decide which research design to follow. For the most significant future research implications, the researcher followed the mixed method approach, focusing on convergent parallel research. This approach allowed the researcher to examine this problem from qualitative and quantitative aspects. McKim (2017) found that “mixed methods added value by increasing validity in the findings” (p. 203). Finally, the researcher used triangulation to develop one succinct final analysis and recommendation to better understand the convergence of the quantitative and qualitative research. Gibson (2017) found that “triangulation allows scholars to document consistency in findings using different means of obtaining those findings, increasing our confidence that the findings are not driven by a particular method or data source” (p. 203).

Quantitative Research

Now that the background of the study is understood, one can understand the research performed. First, the researcher started with quantitative research. Hourly employees at two sites within the finished vehicle logistics organization volunteered to wear the technology device from June 2021 to April 2022. During this timeframe, the technology measured the employee's ergonomics as they bent, lifted, and twisted. The device provided haptic feedback to the employee if they made one of these motions improperly, along with a safety score at the end of the day. Koh et al. (2019) demonstrated that new technology could be implemented that helps supply chains ensure process safety. The researcher and the organization hoped that behavioral modification, through the haptic feedback and safety score, would potentially lead to fewer ergonomic injuries. Lessening these ergonomic injuries would potentially decrease the number of injuries, lower the incident frequency, and lower the cost of claims within the sites that participated. A total of 50 devices were implemented for the study, with 25 at each site. However, there were a total of 70 participants in the study to allow full daily utilization of the devices due to employee absences.

In May of 2022, the devices were removed to allow the researcher to start the quantitative and qualitative research, which included in-person semi-structured interviews that will be discussed later. First, the researcher pulled historical data from Wallenius Wilhelmsen (2022) and the BLS. The data were used to provide a historical perspective of the organization and overall warehousing and transportation sector of the United States. The data allowed the researcher to develop benchmarks against itself and the industry to measure the outcome of the quantitative research correctly. The information is demonstrated fully in research question one, what are the historic injury rates for the warehousing and distribution industry compared to the organization's historic injury frequency rates?

Then, the researcher was tasked with answering research question three, what is the organization's injury frequency rate and injury costs after implementing the wearable safety technology? This information would be gathered from data received from the devices and used to benchmark against the previous historical organization and BLS data. First, the researcher sought to understand the organization's injury frequency after implementing the new technology. Also, how do those injuries compare to the BLS benchmark? This understanding was achieved by pulling data from Wallenius Wilhelmsen (2022) and comparing it to the most recent BLS data. The outcome of the data is fully documented in research questions 3a and 3c. Finally, the researcher sought to understand if the costs associated with ergonomic injuries were lowered after implementing the technology. The outcome of the data is fully documented in research question 3b.

Finally, the researcher tested both hypotheses to complete the quantitative section of this research. First, hypotheses one, there is no statistically significant relationship between the implementation of wearable safety technology and the organization's incident frequency rate. After several different tests to demonstrate statistical significance, the researcher found that linear multiple regression analysis was the most appropriate test. This test found that one site had a statistically significant relationship for injury frequencies with Brunswick, Georgia, which was Brussels, Belgium. This portion of the study resulted in a statistically significant positive correlation between the Brunswick, Georgia site incident frequencies and the Brussels, Belgium site, $r\ (41) = .528$, $p = <.001$, and the effect size of $r = .528$ is considered large.

Given that Brunswick, Georgia did not have any incidents during the implementation of the wearable safety technology, IBM SPSS would not allow for a multiple regression model to determine statistical significance due to no data for the dependent variable. However, during the wearable safety technology implementation phase, the correlated site in Brussels, Belgium experienced two injuries during approximately 20,000 working hours, giving an incident frequency of 19.17. The site in Brussels, Belgium did not demonstrate this new technology. Therefore, given the large correlation between the two statistically significant sites, it can be assumed that if Brunswick, Georgia had not implemented the new technology, there would have been several injuries at the site. Following the same incident ratio, the Brunswick, Georgia site would have experienced approximately 10 injuries during that same time.

Next, the researcher performed the same secondary alternative hypothesis testing for the Carlisle, Pennsylvania facility. However, there is insufficient data to compute a secondary alternative hypothesis testing for this site. As stated previously, the organization acquired the site only a few years ago. Therefore, insufficient historical data are present to compute a positive correlation with statistical significance to another site.

To conclude, this hypothesis is null because statistical significance was determined for wearable safety technology lowering the frequency of injuries at the Brunswick, Georgia facility. Unfortunately, insufficient data were present to compute this same statistical significance for the Carlisle, Pennsylvania facility. Therefore, the result of this hypothesis calls for the future reduction of injuries through wearable safety technology.

Then the researcher sought to answer hypotheses one; there is no statistically significant relationship between the implementation of wearable safety technology and the organization's cost of injuries. For the site in Brunswick, Georgia, since there have been no injuries since implementing the wearable safety technology, no tests can be run to demonstrate statistical significance. The site cannot be compared against itself or the entire U.S. organization. Then, the researcher used multiple methods to compare the site in Carlisle, Pennsylvania.

To conclude, due to the lack of information from the organization, Hypotheses 2_0 is confirmed; statistical significance cannot be demonstrated that the implementation of wearable safety technology lowered the cost of injuries within the finished vehicle logistics organization. However, one can see that one of the facilities dramatically reduced incidents when the technology was implemented.

Qualitative Research

After the quantitative research was concluded, the researcher started the qualitative research. While the data were being analyzed during the quantitative research, the researcher conducted semi-structured interviews for the qualitative research. Two interview guides were used, which covered the four participant groups: senior leadership, site-level leadership, accountants, and hourly employees.

The first interview was conducted with the leadership employees, the first three of the four participant groups. As illustrated by Creswell and Poth (2018), this interview provides information and an understanding of the research problem and central phenomena. This interview was offered to 75 individuals who were knowledgeable about the implementation of wearable safety technology. Of the 75 individuals selected as the sample size, 19 chose to participate in the interview: six site leaders, seven senior leaders, and six accountants. The themes discovered from their answers are below. The researcher asked the participants three questions related to their job function and the impact of work-related injuries. The results of this interview were broken up into five high-level themes, which in order from greatest to least are: the headcount impact of injuries, the financial impact of injuries, the productivity impact of injuries, the safety impact of injuries, and the morale impact of injuries.

Next, the researcher analyzed the interview data from the second interview group offered to the hourly employees. The total population for that group is 74 employees who used wearable safety technology. Of those 74 employees, 29 agreed to participate in the interviews. The results of this interview were broken up into two high-level themes, which in order from greatest to least, are: the holistic impact of the technology and the personal impact of the technology.

To conclude, the outcomes of the two interviews were vastly different, but the researcher dived further into theories to understand this phenomenon. Upon further research, Robinson et al. (2018) identified this trait as the theory of organization identification, in which visible group dynamics are formed and create an in-group bias and out-group discrimination. The in-group biases create a feeling of connectedness and belonging to the organization. Cirjaliu and Draghici (2016) demonstrated that organizations have elevated productivity above safety within the workplace. The leadership interview results demonstrated that these employees had put profits and productivity above morale and safety. Combining the references of the financial impact, personal productivity, and site productivity (headcount) account for 76% of the comprehensive references in the interviews. However, the employees did not focus on their personal experience with the trial, and most respondents focused on the organization's collective experience.

Convergence of the Research

The final step in the process was for the researcher to triangulate the research outcomes and find agreement, partial agreement, or dissonance between the findings. The researcher chose to analyze the outcomes of the two quantitative research questions against the outcomes of the two qualitative research questions. There was a total of 47 possible relationships; there were 10 relationships that had an agreement, two that had a partial agreement, and 37 that had dissonance. These relationships are demonstrated in Tables 46-49, and this reference is further demonstrated by the severe dissonance between this research's quantitative and qualitative outcomes. Cirjaliu and Draghici (2016) illustrated that lean manufacturing forces organizations to push productivity to achieve the organization's goals, but this shift has led to ergonomic issues in the workplace. Leadership focused more on lean management and financial outcomes, while hourly employees focused on their holistic group.

Presentation of the Quantitative Findings

Work-related ergonomic injuries were previously defined as a trailing indicator of a severe problem in the United States. Saruchera (2020) illustrated that many safety precautions must be taken when transporting cargo in-port and operating the logistics centers that integrate inland and maritime transportation. The following research will provide details into a detailed mixed method study attempting to understand how technology can help potentially reduce work-related injuries. This reduction is potentially achieved by equipping employees with wearable safety technology. The quantitative section of this research focused on the statistics behind benchmarked injury frequencies, injury costs, and how the implementation of wearable technology impacts a finished vehicle logistics organization. The qualitative section of this research focused on the impacts and behavioral changes observed within the same organization. López-García et al. (2019), ergonomic injuries affected workers' health and safety and production-related aspects, and those musculoskeletal injuries were the most common injuries in the United States. This research provides insight into future research on how wearable safety technology can reduce employee work-related injuries.

Descriptive Statistics

In this section, the researcher will discuss descriptive statistics, the pre-tests performed for research questions one and three, and the results in this section. For many of the research questions, descriptive statistics will answer those questions. However, the next section will discuss any results needing hypotheses testing and analytics using IBM SPSS.

Research Question 1

What are the historic injury rates for the U.S. warehousing and distribution industry compared to the organization's historic injury frequency rates?

For this question, the researcher sought to gather a broader understanding of the organization's incident frequency rate and costs of injuries. Also, the researcher sought to understand how the entire scope of the United States is performing in similar quantifiable variables. This understanding is achieved by reviewing the incident rate, the standard rate used by the BLS. Finally, the researcher will compare the incident frequency rate of the organization against the BLS data.

Research Question 1a

What are the organization's historical injury frequency rates?

For this question, the researcher will define historical as January 2018 until the date of the implementation of the wearable safety technology, which was June 2021. Table 2 demonstrates all data investigated to cohesively answer this research question, which is archive data from Wallenius Wilhelmsen (2022). The incident rate is calculated by multiplying the number of injuries multiplied by 200,000 and dividing by the total direct and indirect hours. This calculation will give the organization a rate of injury per 100 full-time employees. This incident rate is the standard rate used by the BLS. This rate allowed for future benchmarking against BLS rates for future research questions. Also, a recordable injury is defined by the U.S. Department of Labor (n.d.) as an injury that results in "death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness" (pp. 01). These recordable injuries are not limited to ergonomic injuries, which are detailed in the next research question.

2018 Historical Injury Frequency. In 2018, Table 2 demonstrates that the organization's facilities in the United States had 112 recordable injuries compared to approximately 4.9 million working hours, giving an incident frequency of 4.48 injuries per 100 full-time employees. In Brunswick, Georgia, the facility had six recordable injuries with approximately 230,000 working hours, giving an incident frequency of 5.17 injuries per 100 full-time employees. The facility in Carlisle, Pennsylvania was acquired during this timeframe. Therefore, no data exists for recordable injuries during 2018. However, worker's compensation data on injury amounts are available and will be given in future research questions.

2019 Historical Injury Frequency. In 2019, Table 2 demonstrates that the organization's facilities in the United States had 96 recordable injuries compared to approximately 3.7 million working hours, giving an incident frequency of 5.17 injuries per 100 full-time employees. In Brunswick, Georgia, the facility had five recordable injuries with approximately 146,000 working hours, giving an incident frequency of 6.84 injuries per 100 full-time employees. In Carlisle, Pennsylvania, the facility had seven recordable injuries with approximately 72,000 working hours, giving an incident frequency of 19.43 injuries per 100 full-time employees.

2020 Historical Injury Frequency. In 2020, Table 2 demonstrates that the organization's facilities in the United States had 63 recordable injuries compared to approximately 4.1 million working hours, giving an incident frequency of 3.01 injuries per 100 full-time employees. In Brunswick, Georgia, the facility had two recordable injuries with approximately 132,000 working hours, giving an incident frequency of 3.02 injuries per 100 full-time employees. The facility in Carlisle, Pennsylvania, had five recordable injuries with approximately 67,000 working hours, giving an incident frequency of 14.90 injuries per 100 full-time employees

2021 Historical Injury Frequency. From January to May of 2021, before the wearable safety technology was implemented, Table 2 demonstrates that the organization's facilities in the

United States had 30 recordable injuries compared to approximately 1.9 million working hours, giving an incident frequency of 3.15 injuries per 100 full-time employees. In Brunswick, Georgia, the facility had one recordable injury with approximately 61,000 working hours, giving an incident frequency of 3.24 injuries per 100 full-time employees. In Carlisle, Pennsylvania, the facility had four recordable injuries with approximately 25,000 working hours, giving an incident frequency of 31.56 injuries per 100 full-time employees.

Overall Historical Injury Frequency. Overall, for the period being measured as historical information, Table 2 demonstrates that the organization's facilities in the United States had 301 recordable injuries compared to approximately 14.8 million working hours, giving an incident frequency of 4.07 injuries per 100 full-time employees. In Brunswick, Georgia, the facility had 14 recordable injuries with approximately 572,000 working hours, giving an incident frequency of 4.89 injuries per 100 full-time employees. In Carlisle, Pennsylvania, the facility had 16 recordable injuries with approximately 164,000 working hours, giving an incident frequency of 19.45 injuries per 100 full-time employees.

Research Question 1b

What are the organization's historical costs associated with ergonomic injuries?

Ergonomic injuries and idiopathic injuries are interchangeable for this portion of the research. Oranye and Bennett (2018) defined idiopathic injuries as injuries that occur from repetitive strains. Also, historical was previously defined as 2018 until June 2021. Finally, the data will demonstrate injuries that resulted in a worker's compensation claim, which would have a monetary cost to the organization. Previous data demonstrated all injuries in the organization, but the data will be filtered to those injuries that occur from strain or repetitive motion.

2018 Historical Injury Costs. For 2018, Table 3 demonstrates 17 injuries resulting from a strain or repetitive motion across all facilities in the United States that resulted in a worker's compensation claim. The total for these claims was $510,455.25, with a minimum of $9.80, a maximum of $431,743.74, and an average of $30,026.78. None of the previously defined six recordable injuries in Brunswick, Georgia resulted in a worker's compensation claim. Table 4 demonstrates the worker's compensation injuries in Carlisle, Pennsylvania during this period. That facility experienced five worker's compensation injuries, with a total for these claims was $2,158.49, with a minimum of $9.80, a maximum of $907.81, and an average of $431.70.

2019 Historical Injury Costs. For 2019, Table 5 demonstrates that 56 injuries resulting from a strain or repetitive motion across all facilities in the United States resulted in a worker's compensation claim. The total for these claims was $1,104,489.67, with a minimum of $10.15, a maximum of $161,572.60, and an average of $19,723.03. Table 6 demonstrates the worker's compensation injuries in Brunswick, Georgia during this period. That facility experienced two worker's compensation injuries, with a total for these claims was $5,069.86, with a minimum of $242.73, a maximum of $4,827.13, and an average of $2,534.93. Table 7 demonstrates the worker's compensation injuries in Carlisle, Pennsylvania during this period. That facility experienced three worker's compensation injuries, with a total for these claims was $11,487.38, with a minimum of $193.89, a maximum of $10,421.55, and an average of $3,829.13.

2020 Historical Injury Costs. For 2020, Table 8 demonstrates 30 injuries resulting from a strain or repetitive motion across all facilities in the United States that resulted in a worker's compensation claim. The total for these claims was $549,279.83, with a minimum of $10.50, a maximum of $209,327.20, and an average of $18,309.33. Of the previously defined two recordable injuries in Brunswick, Georgia, none of those resulted in a worker's compensation claim. Table 9 demonstrates the worker's compensation injuries in Carlisle, Pennsylvania, during this period. That facility experienced two worker's compensation injuries, with a total for these claims being $21.00 because both claims were for $10.50.

2021 Historical Injury Costs. From January to May of 2021, before the wearable safety technology was implemented, Table 10 demonstrates 12 injuries resulting from a strain or repetitive motion across all facilities in the United States that resulted in a worker's compensation claim. The total for these claims was $20,116.33, with a minimum of $115.55, a maximum of $8,832.76, and an average of $1,676.36. Table 11 demonstrates the worker's compensation injuries in Brunswick, Georgia during this period. That facility experienced two worker's compensation injuries, with a total for these claims was $488.70, with a minimum of $243.98, a maximum of $244.72, and an average of $244.35. Table 12 demonstrates the worker's compensation injuries in Carlisle, Pennsylvania during this period. That facility experienced two worker's compensation injuries, with a total for these claims was $7,027.20, with a minimum of $197.32, a maximum of $6,829.88, and an average of $3,513.60.

Overall Historical Injury Costs. Overall, for the period being measured as historical information, Table 13 demonstrates that 115 injuries resulting from a strain or repetitive motion across all facilities in the United States resulted in a worker's compensation claim. The total for these claims was $2,184,341.08, with a minimum of $9.80, a maximum of $431,743.74, and an average of $18,994.27. Table 14 demonstrates the worker's compensation injuries in Brunswick, Georgia during this period. That facility experienced four worker's compensation injuries, with a total for these claims was $5,558.56, with a minimum of $242.73, a maximum of $4,827.13, and an average of $1,389.64. Table 15 demonstrates the worker's compensation injuries in Carlisle, Pennsylvania during this period. That facility experienced 12 worker's compensation injuries, with a total for these claims was $20,694.07, with a minimum of $9.80, a maximum of $10,421.55, and an average of $1,724.51.

Research Question 1c

What are the historical injury frequency rates for the U.S. warehousing and distribution sector?

For this portion of the research, the researcher pulled archive data from the BLS for the transportation and warehousing industry, identified by NAICS codes starting with 48 through 49. The data will show incident rates and the number of cases for all U.S. industries in the warehousing and transportation sector, which aligns with the organization being studied.

2018 U.S. Historical Injury Data. For 2018, Table 16 demonstrates that the transportation and warehousing sector of the United States experienced a total incident frequency of 4.5 incidents per 100 full-time employees. That incident frequency rate was broken down into 2.1 incidents per 100 full-time employees who experienced an injury requiring days away from work, 1.2 incidents per 100 full-time employees who experienced an injury requiring a job transfer or restriction, and 1.2 incidents per 100 full-time employees who experienced some other kind of recordable injury.

Similarly, Table 17 demonstrates that the transportation and warehousing sector of the United States experienced approximately 221,000 recordable injuries in 2018. Those injuries are broken down into approximately 103,000 injuries requiring days away from work, approximately 60,000 injuries requiring a job transfer or restriction, and approximately 57,000 injuries classified as some other kind of recordable injury.

2019 U.S. Historical Injury Data. For 2019, Table 18 demonstrates that the transportation and warehousing sector of the United States experienced a total incident frequency of 4.4 incidents per 100 full-time employees. That incident frequency rate was broken down into 2.0 incidents per 100 full-time employees who experienced an injury requiring days away from work, 1.2 incidents per 100 full-time employees who experienced an injury requiring a job transfer or restriction, and 1.2 incidents per 100 full-time employees who experienced some other kind of recordable injury.

Similarly, Table 19 demonstrates that the transportation and warehousing sector of the United States experienced approximately 227,000 recordable injuries in 2019. Those injuries are broken down into approximately 103,000 injuries requiring days away from work, approximately 62,000 injuries requiring a job transfer or restriction, and approximately 61,000 injuries classified as some other kind of recordable injury.

2020 U.S. Historical Injury Data. For 2020, Table 20 demonstrates that the transportation and warehousing sector of the United States experienced a total incident frequency of 4.0 incidents per 100 full-time employees. That incident frequency rate was broken down into 1.9 incidents per 100 full-time employees who experienced an injury requiring days away from work, 1.1 incidents per 100 full-time employees who experienced an injury requiring a job transfer or restriction, and 1.0 incidents per 100 full-time employees who experienced some other kind of recordable injury.

Similarly, Table 21 demonstrates that the transportation and warehousing sector of the United States experienced approximately 206,000 recordable injuries in 2020. Those injuries are broken down into approximately 99,000 injuries requiring days away from work, approximately 57,000 injuries requiring a job transfer or restriction, and approximately 50,000 injuries classified as some other kind of recordable injury. Finally, given that BLS data are a lagging indicator, no information is available for 2021 or 2022 to use for comparison at the time of this research.

Overall U.S. Historical Injury Data. Given the previous information about calculating an incident frequency rate, the researcher can reverse calculate the number of hours worked in the transportation and warehousing sector of the United States since the variables of injury rate and the number of injuries are known. This reverse calculation allowed the researcher to summarize the injury rate and total injuries for the previously shown BLS data for 2018 through 2020. Table 22 demonstrates that the average incident frequency rate between 2018 and 2020 was 4.30 incidents per 100 full-time employees. Also, Table 22 demonstrates that cases with days away from work have an average incident rate of 2.00 per 100 full-time employees, cases with days of a job transfer or restriction have an average incident rate of 1.17 per 100 full-time employees, and other recordable cases have an average incident rate of 1.13 per 100 full-time employees. One can see that the number of injuries continues to drop as the years progress, as the number of hours rises. Simply, the transportation and warehousing sector of the United States is a growing sector that continues to become safer each year.

Research Question 1d

How do the organization's historical injury rates compare to the U.S. warehousing and distribution industry's historical injury rates?

For this portion of the research, the researcher will compare the organization's injury frequency rate with the transportation and warehousing sector of the United States. This comparison is achieved by reviewing the injury frequency rate previously defined in RQ1a with the BLS data from RQ1c. Table 23 demonstrates the numerical comparison of the BLS data versus the Wallenius data for injury frequency rates. While Table 24 creates a graphical representation of the data presented in Table 23.

2018 Comparison. For 2018, Table 23 shows that the BLS injury frequency rate was 4.5 injuries per 100 full-time employees, while the organization's entire U.S. scope had an injury frequency rate of 4.48 injuries per 100 full-time employees. Therefore, comparing the organization's scope with the BLS data, the entire organization has an injury frequency per 100 full-time employees of .02 less than the average for the United States. The facility in Brunswick, Georgia, had an injury frequency of 5.17 injuries per 100 full-time employees. Therefore 0.67 higher than the average for the United States. Injury frequency data for Carlisle, Pennsylvania is unavailable for 2018 due to the acquisition.

2019 Comparison. For 2019, Table 23 shows that the BLS injury frequency rate was 4.4 injuries per 100 full-time employees, while the organization's entire U.S. scope had an injury frequency rate of 5.17 injuries per 100 full-time employees. Therefore, comparing the organization's scope with the BLS data, the entire organization has an injury frequency per 100 full-time employees of .77 higher than the average for the United States. The facility in Brunswick, Georgia, had an injury frequency of 6.84 injuries per 100 full-time employees, therefore 2.44 higher than the average for the United States. While the facility in Carlisle, Pennsylvania, had an injury frequency of 6.84 injuries per 100 full-time employees, 19.43 incidents per 100 full-time employees were higher than the average for the United States.

2020 Comparison. For 2020, Table 23 shows that the BLS injury frequency rate was 4.0 injuries per 100 full-time employees, while the organization's entire U.S. scope had an injury frequency rate of 3.01 injuries per 100 full-time employees. Therefore, comparing the organization's scope with the BLS data, the entire organization has an injury frequency per 100 full-time employees of .99 lower than the average for the United States. The facility in Brunswick, Georgia had an injury frequency of 3.02 injuries per 100 full-time employees, therefore .98 lower than the average for the United States. While the facility in Carlisle, Pennsylvania, had an injury frequency of 14.90 injuries per 100 full-time employees. Therefore 10.90 incidents per 100 full-time employees are higher than the U.S. average.

2021 Comparison. For 2021, information from the BLS is not available. Given that BLS information is a lagging indicator, the benchmark is the most recent information available, which is 2020 incident frequencies. Therefore, Table 23 shows that the BLS injury frequency rate was 4.0 injuries per 100 full-time employees, while the organization's entire U.S. scope had an injury frequency rate of 3.15 injuries per 100 full-time employees. Therefore, comparing the organization's scope with the BLS data, the entire organization has an injury frequency per 100 full-time employees of .85 lower than the average for the United States. The facility in Brunswick, Georgia had an injury frequency of 3.24 injuries per 100 full-time employees, therefore .76 lower than the average for the United States. While the facility in Carlisle, Pennsylvania had an injury frequency of 31.55 injuries per 100 full-time employees. Therefore 27.55 incidents per 100 full-time employees are higher than the U.S. average.

Pre-Implementation Comparison of Injury Frequency. Table 24 demonstrates the visual correlation of the information presented previously. In 2018 the overall organization had an injury frequency that was very close to the average for the United States, which was given by the BLS data. However, in 2019 the frequency rose slightly, which can be attributed to acquiring a new organization, which included more sites outside of Carlisle, Pennsylvania, which is the one being studied. However, in 2020 the organization's incident frequency started to normalize and dropped significantly below the average for the United States. Finally, in 2021, the organization rose slightly but continued to be under the benchmark of BLS.

Research Question 1 Summary

Pater (2017) found that a proactive approach to reducing employee-related ergonomic injuries is the best solution to this trailing indicator issue. This research question defines the call to action to take a proactive approach to solving the issue of injuries within the organization. 2018 demonstrated that the organization was on the right track to being on par with the remainder of its industry sector. However, 2019 was a bad year for the organization, which saw many more injuries occur, some of which can be due to the acquisition of another organization and getting that organization onboarded to the safety programs that the organization had created. Then, 2020 and 2021 produced great years for injury frequencies, even though the two studied sites had higher injury frequency rates than the entire organization.

Similar results were seen when comparing the cost of injuries before implementing the new wearable safety technology. Table 25 shows that for the period of historical data being studied, the average cost of an ergonomic injury for the entire organization was approximately $18,994. While the facility in Brunswick, Georgia averaged approximately $1,390, and the facility in Carlisle, Pennsylvania averaged approximately $1,725. Table 26 demonstrates that the entire organization experienced an average of 29 ergonomic injuries that resulted in a worker's compensation case for the same period. In contrast, Brunswick, Georgia experienced an average of one per year, and Carlisle, Pennsylvania experienced three per year.

The previous information calls to action to research this growing problem of ergonomic injuries within a supply chain organization. In the following sections, the organization applies the previously defined wearable safety technology to a group of employees within the Carlisle and Brunswick facilities. Table 27 demonstrates the percentage comparison of the previously defined ergonomic injuries to the recordable injuries. For the organization in the United States, ergonomic injuries were 38% of all injuries during the historical period. This trial demonstrated any statistical significance of implementing this wearable safety technology and potentially demonstrated a call for further research into how this new technology could potentially lower injury frequencies within supply chain organizations.

Research Question 3

What is the organization's injury frequency rate and injury costs after implementing the wearable safety technology?

For this question, the researcher sought to understand how the implementation of wearable safety technology compares to the previous quantitative data. The wearable safety technology was implemented in June 2021 and removed in April 2022. Previous data were measured from January 2018 until May 2021. The data represented in this section will be from June 2021 until April 2022. The 11-month period in which the technology was being trialed demonstrates a feasibility study to which the organization could prove if the technology proved beneficial. Also, if the technology proves beneficial and statistically significant, this research could potentially call for further research into wearable safety technology within supply chains.

Research Questions 3a and 3c

What are the organization's injury frequency rates after implementing the wearable safety technology?

How do the organization's injury frequency rates compare to those within the warehousing and distribution sector after implementing the wearable safety technology?

For this portion of the research, the researcher sought to understand the injury frequency of the organization after implanting the wearable safety technology. This information will then be used to compare the organization's injury frequency rate with the transportation and warehousing sector of the United States. After implementation, this comparison is achieved by testing the statistical significance of the incident frequency rate against the BLS injury frequency rate.

2021 Post-Implementation Injury Frequency. Starting in June of 2021, after the wearable safety technology was implemented, Table 28 demonstrated that the organization's facilities in the United States had 37 recordable injuries compared to approximately 2.6 million working hours, giving an incident frequency of 2.84 injuries per 100 full-time employees. In Brunswick, Georgia, the facility had no recordable injuries with approximately 79,000 working hours, giving an incident frequency of zero injuries per 100 full-time employees. In Carlisle, Pennsylvania, the facility had four recordable injuries with approximately 38,000 working hours, giving an incident frequency of 20.88 injuries per 100 full-time employees.

2022 Post-Implementation Injury Frequency. For the remainder of the implementation until March 2022, Table 28 demonstrated that the organization's facilities in the United States had 21 recordable injuries compared to approximately 1.2 million working hours, giving an incident frequency of 3.47 injuries per 100 full-time employees. In Brunswick, Georgia, the facility had no recordable injuries with approximately 31,000 working hours, giving an incident frequency of zero injuries per 100 full-time employees. In Carlisle, Pennsylvania, the facility had two recordable injuries with approximately 14,000 working hours, giving an incident frequency of 27.53 injuries per 100 full-time employees.

Post-Implementation Comparison of Injury Frequency. Table 29 demonstrates the visual correlation of the information presented previously. This table compares the incident frequencies before and after implementing the wearable safety technology. One can see that the overall United States continues to be lower than the BLS benchmark. The facility in Brunswick, Georgia has not had an incident since implementing the wearable technology. While the facility in Carlisle, Pennsylvania had fewer incidents, it remains above the BLS frequency benchmark. This frequency ratio is because that facility has few employees, leading to higher frequencies, even though fewer incidents happened. This section continues to rely on descriptive statistics to analyze the information presented. The next section will use IBM SPSS to test these analytics further.

Research Question 3b

What are the organization's injury costs associated with ergonomic injuries after implementing the wearable safety technology?

For this portion of the research, the researcher will compare the organization's cost of ergonomic injuries before and after implementing the wearable safety technology. This comparison is achieved by testing the statistical significance of the cost of ergonomic injuries before and after implementing wearable safety technology.

2021 Post-Implementation Injury Costs. For the remainder of 2021, which started in June 2021, after the wearable safety technology was implemented. Table 30 demonstrates 17 injuries resulting from a strain or repetitive motion across all facilities in the United States that resulted in a worker's compensation claim. The total for these claims was $61,364.79, with a minimum of $267.21, a maximum of $61,364.79, and an average of $11,682.51. As demonstrated previously, the location in Brunswick, Georgia had no injuries during the implementation period. However, Table 31 demonstrates the worker's compensation injuries in Carlisle, Pennsylvania during this period. That facility experienced three worker's compensation injuries, with a total for these claims was $13,058.16, with a minimum of $267.12, a maximum of $6,784.63, and an average of $4,352.72.

2022 Post-Implementation Injury Costs. The devices were implemented in 2022 until March. Table 32 demonstrates five injuries resulting from a strain or repetitive motion across all facilities in the United States that resulted in a worker's compensation claim. The total for these claims was $5,105.33, with a minimum of $181.11, a maximum of $2,535.21, and an average of $1,021.07. As demonstrated previously, the location in Brunswick, Georgia had no injuries during the implementation period. Also, the Carlisle, Pennsylvania facility did not experience an injury during this period that resulted in a worker's compensation injury. Therefore, all five injuries are associated with other facilities in the United States.

Post-Implementation Comparison of Injury Costs. Table 33 demonstrates the average injury cost for the two sites compared to the overall organization. In 2018, 2019, and 2020 the average cost of an ergonomic injury at the chosen facilities was significantly lower than the average cost of the same injury within the entire organization. However, the trend of these injuries lowering costs across the United States has continued from 2018 through the implementation in June 2021. One can see that the average cost of an ergonomic injury in the United States in 2018 was slightly more than $30,000, while right before the implementation, this number lowered to approximately $1,600. The two sites being studied had an average cost of an ergonomic injury much lower than the remainder of the organization during this timeframe, except when the organization significantly experienced a lowering of costs in the pre-implementation timeframe of 2021. After implementing wearable safety technology, the United

States experienced a slight jump to approximately $11,000, while the two facilities continued to be lower than the U.S. average. Finally, in 2022 this trend continued with the two sites having no injuries that resulted in an ergonomic worker's compensation injury while the entire organization had an average of approximately $1,000. The next section on hypotheses testing will use IBM SPSS to test these analytics further.

Quantitative Hypotheses Testing

In this section, the researcher will expand upon the previous descriptive statistics to use IBM SPSS to test the quantitative hypothesis.

Hypotheses 1_0

There is no statistically significant relationship between the implementation of wearable safety technology and the organization's incident frequency rate.

Initially, the researcher assumed the chi-square test would be appropriate to demonstrate the statistical significance of implementing wearable safety technology. However, this assumption was taken before researching the data behind this quantitative research. After researching the data, the outcome for the data was significantly smaller and had smaller values, as shown in Table 34. According to Morgan et al. (2013), Fisher's exact test would be the appropriate test in this circumstance.

After the data were entered into IBM SPSS, testing was done for chi-square and Fisher's exact test. However, not enough data were present within this research portion to demonstrate the statistical significance of implementing wearable safety technology against the BLS incident frequency rate benchmark. This lack of statistical significance is because there is only one data point for each section of time to compare against the singular data point of the BLS data. Fisher's exact test would not populate within IBM SPSS due to the lack of data. This is due to 100% of the data having a count higher than five, which excludes the chi-square test from demonstrating statistical significance.

Next, Morgan et al. (2013) illustrated that the one-sample t-test would be the next appropriate test for the first alternative hypothesis testing. This information was entered into IBM SPSS to see if the one-sample t-test would demonstrate statistical significance. The testing value entered for the one-sample comparison was the mean of 4.07 incident rate pre-implementation. Table 35 demonstrates this test, and from that information, it can be concluded that p = .359. Therefore, the sample (M = 3.684) is not significantly different from the population mean of 4.07. Similarly, the one-sample t-test confirmed hypothesis $H1_0$. There is no statistically significant relationship between the implementation of wearable safety technology and the organization’s incident frequency rate.

However, the researcher applied a linear multiple regression analysis of the research sites for secondary alternative hypothesis testing against other sites. First, the researcher tested the site in Brunswick, Georgia against all other global sites that perform the same job function. The researcher used a linear multiple regression model to test the dependent site, Brunswick, Georgia against in injury frequency of 41 other sites as the independent variable. This test found that one site had a statistically significant relationship for injury frequencies with Brunswick, Georgia, which was Brussels, Belgium. The linear multiple regression model, which can be seen in Table 36, found that when comparing the historical incident frequencies of the two sites. This study resulted in a statistically significant positive correlation between the Brunswick, Georgia site incident frequencies and the Brussels, Belgium site, r (41) = .528, p = <.001, and the effect size of r = .528 is considered large.

The statistically significant positive correlation of the historical injury frequency between Brunswick, Georgia, and Brussels, Belgium, was then used to determine if the implementation of the wearable safety technology could be deemed statistically significant during the post-implementation timeframe. Given that Brunswick, Georgia did not have any incidents during the implementation of the wearable safety technology, IBM SPSS would not allow for a multiple regression model to determine statistical significance due to no data for the dependent variable.

However, Table 37 demonstrates that during the wearable safety technology implementation phase, the correlated site in Brussels, Belgium experienced two injuries during approximately 20,000 working hours, giving an incident frequency of 19.17. The site in Brussels, Belgium did not demonstrate this new technology. Therefore, given the large correlation between the two statistically significant sites, it can be assumed that if Brunswick, Georgia had not implemented the new technology, there would have been several injuries at the site. Following the same incident ratio, the Brunswick, Georgia, site would have experienced approximately 10 injuries during that same time.

Therefore, given the large correlation of statistical significance between the two sites and that Brunswick, Georgia experienced zero injuries during the implementation period, it can be stated that the implementation of the wearable safety technology had a positive statistical correlation to lowering the injury frequency during the time it was worn in Brunswick, Georgia.

Next, the researcher performed the same secondary alternative hypothesis testing for the Carlisle, Pennsylvania facility. However, there is insufficient data to compute a secondary alternative hypothesis testing for this site. As stated previously, the organization acquired the site only a few years ago. Therefore, insufficient historical data are present to compute a positive correlation with statistical significance to another site.

To conclude, this hypothesis is null because statistical significance was determined for wearable safety technology lowering the frequency of injuries at the Brunswick, Georgia facility. Unfortunately, insufficient data were present to compute this same statistical significance for the Carlisle, Pennsylvania facility. Therefore, the result of this hypothesis calls for the future reduction of injuries through wearable safety technology.

Hypotheses 2_0

There is no statistically significant relationship between the implementation of wearable safety technology and the organization's cost of injuries.

Unlike the previous hypothesis, the researcher has access to the entirety of the data instead of singular data points per year provided by the BLS. For this comparison, the researcher will compare the costs of ergonomic injuries. For the site in Brunswick, Georgia, since there have been no injuries since implementing the wearable safety technology, no tests can be run to demonstrate statistical significance. The site cannot be compared against itself or the entire U.S. organization.

For the site in Carlisle, Pennsylvania, the researcher first compared the site's information against its own. After implementation, all injuries were compared to all the injuries pre-implementation. This comparison uses the chi-square testing, shown in Table 38. Unfortunately, not enough cases were valid to meet the conditions to run this test. Also, Fisher's exact test would not populate within IBM SPSS due to the lack of data. While 100% of the data had a count higher than five, which excludes the chi-square test from demonstrating statistical significance. Next, the researcher ran the same test to compare the site against the United States. However, due to only three injuries during the post-implementation phase, the same results as Table 38 populated.

Next, for alternative hypothesis testing, Morgan et al. (2013) illustrated that the one-sample t-test would be the next appropriate test. This information was entered into IBM SPSS to see if the one-sample t-test would demonstrate statistical significance. These tests were run for the site in Carlisle, Pennsylvania only, considering that Brunswick, Georgia had no injuries during this timeframe. The testing value entered for the one-sample comparison was the mean of $1,725, which is the average cost of injuries in Carlisle, Pennsylvania pre-implementation. Table 39 demonstrates this test, and from that information, it can be concluded that $p = .329$. Therefore, the sample (M = $4,352.72) is not significantly different from the population mean of $1,275. Finally, the researcher used the one-sample t-test to compare Carlisle, Pennsylvania to the entire organization with a testing value for the average of the entire organization of $18,994. This can be seen in Table 40, which has a lower statistical significance. In this table, it is demonstrated that comparing Carlisle, Pennsylvania has a $p = .019$. Therefore, the sample (M = $4,352.72) is not significantly different from the population mean of $18,994. Therefore, hypothesis $H2_0$ is confirmed. There is no statistically significant relationship between the implementation of wearable safety technology and the organization's cost of injuries.

To conclude, due to the lack of information from the organization, Hypotheses 2_0 is confirmed; statistical significance cannot be demonstrated that the implementation of wearable safety technology lowered the cost of injuries within the finished vehicle logistics organization. However, one can see that one of the facilities dramatically reduced incidents when the technology was implemented. This information, visualized in Tables 41 and 42, calls for future research to demonstrate whether statistical significance can be demonstrated between the cost of injuries and the implementation of wearable safety technology.

Summary of Hypotheses Testing

From the previous information presented, this research has demonstrated statistical significance in implementing wearable safety technology at a finished vehicle logistics facility in Brunswick, Georgia, which potentially has reduced work-related ergonomic injuries. However, there was insufficient data to prove the same statistical significance for the Carlisle, Pennsylvania, site. Also, statistically significant data were not determined to lower the cost of injuries. Following the work of Pater (2017), the organization took a proactive approach to reducing ergonomic injuries. The facility in Brunswick, Georgia has seen a significant reduction in these injuries, while the facility in Carlisle, Pennsylvania did not see a significant change. The quantitative section of this research proves that future research is needed to prove if this implementation could potentially call for further research into this topic.

Quantitative Relationship of the Findings

In this section, the researcher will demonstrate how the previous quantitative information related to the research questions, the theoretical framework, the literature, and the problem being studied.

Quantitative Relationship to the Research Questions

In this section, the researcher will summarize the previous information related to each research question. This information will provide a succinct overview of how the previous quantitative research answered each research question.

Research Question 1a

What are the organization's historical injury frequency rates?

For this research question, the researcher demonstrated Table 2, which gives an overview of the organization's injury frequency rates. For this overview, historical is defined as January

2018 until May 2021. The descriptive statistics section of this research gives an in-depth overview of the data associated with this research question, which has been fully addressed.

Research Question 1b

What are the organization's historical costs associated with ergonomic injuries?

For this research question, the researcher demonstrated Table 3 through Table 15, which gives a detailed view of all costs associated with injuries in the United States and breaks those costs down for the two sites being studied. All those costs were put into IBM SPSS for data analysis, giving descriptive statistics for each table. The descriptive statistics section of this research gives an in-depth overview of the data associated with this research question, which has been fully addressed.

Research Question 1c

What are the historical injury frequency rates for the U.S. warehousing and distribution sector?

For this research question, the researcher demonstrated Table 16 through Table 22, which gives data from the BLS on all the injuries for organizations within the warehousing and transportation sector of the United States. The data provide a critical benchmark for future research questions and allows the organization to measure its progress through the years. Unfortunately, this information is a lagging indicator, so no new data are available from the BLS for 2021. However, the industry practice is to use the most current information available. Therefore, 2020 data are used as the benchmark for 2021 and 2022 until more current information is available. The descriptive statistics section of this research gives an in-depth overview of the data associated with this research question, which has been fully addressed.

Research Question 1d

How do the organization's historical injury rates compare to the warehousing and distribution industry's historical injury rates?

For this portion of the research, the information from the organization is compared to the benchmark from the BLS. This information allowed the researcher to benchmark how the organization was doing against the greater supply chain. Table 23 compared the data from the two, while Table 24 provided a graphical representation of that comparison for visual purposes. Given the small amounts of data, no descriptive statistics could be run. This section relied on the subjective opinion of the relative ratio of organizational data versus the BLS benchmark data. However, the descriptive statistics section of this research gives an in-depth overview of the data associated with this research question, which has been fully addressed.

Research Question 1 Summary

What are the historic injury rates for the warehousing and distribution industry compared to the organization's historic injury frequency rates?

The previous four sub-research questions provide a succinct overview of the first research question. This research question provides historical information for the organization and BLS to allow future researcher questions to provide more statistical analysis once the wearable safety technology has been implemented. Other tables were developed for comparison purposes, Tables 25 through 27. For some of the questions, the researcher used IBM SPSS to provide descriptive statistics of the problem. However, some of the other research questions relied on the subjective opinion of the researcher to provide information on whether the site was doing well based on the objective data as a benchmark from the BLS. This research question was fully answered in this research's previous descriptive statistic section.

Research Questions 3a and 3c

What are the organization's injury frequency rates after implementing the wearable safety technology?

How do the organization's injury frequency rates compare to those within the warehousing and distribution sector after implementing the wearable safety technology?

For this research question, the researcher demonstrated in Tables 28 and 29 the injury frequency for the organization and BLS during the wearable safety technology implementation period. Descriptive statistics correlate this information, but statistical significance is determined later within previous sections. The descriptive statistics section of this research gives an in-depth overview of the data associated with this research question, which has been fully addressed.

Research Question 3b

What are the organization's injury costs associated with ergonomic injuries after implementing the wearable safety technology?

For this research portion, the researcher demonstrated Tables 30 through 35. The first tables measure the future hypothesis testing, while the latter shows the descriptive statistics behind the collected data. Unfortunately, statistical significance was not available after running three different tests, but the data provided shows that future research is needed to implement wearable safety technology to potentially lower the frequency of injuries within supply chains. This research question was fully answered in this research's previous descriptive statistic section.

Research Question 3 Summary

What is the organization's injury frequency rate and injury costs after implementing the wearable safety technology?

The previous three sub-research questions provide a succinct overview of the third research question. This research question provides post-implementation information for the organization and BLS to allow future researcher questions to provide more statistical analysis once the wearable safety technology has been implemented. Other tables were developed for comparison purposes, Tables 28 through 35. For some of the questions, the researcher used IBM SPSS to provide descriptive statistics of the problem. However, some of the other research questions relied on the subjective opinion of the researcher to provide information on whether the site was doing well based on the objective data as a benchmark from the BLS. This research question was fully answered in this research's previous descriptive statistic section.

Summary of the Quantitative Relationship to the Research Questions

The previous section illustrated the relationship between the quantitative research and two of the research questions. Research question one asks, what are the historic injury rates for the warehousing and distribution industry compared to the organization's historic injury frequency rates? This research question is broken down into four sub-questions that detail the specifics of the original research question. Tables 2 through 23, along with the previous section, detail how this research question was answered. First, the researcher documented the historical injury frequency of the organization, which answers research question 1a. Then, the researcher documented the historical costs of ergonomic injuries within the organization, which answers research question 1b. Next, the researcher illustrated the frequency of similar injuries within the U.S. warehousing and transportation sector. That information was pulled from the BLS, which was used as a benchmark later and answered research question 1d. Finally, the historical injury frequency is compared against the benchmark of BLS data, which answers research question 1d. These four sub-questions combine to give one succinct overview of the organization's injuries, injury costs, and benchmark BLS data. Then compares the organization to the BLS to provide a benchmark for future measurement after the technology is implemented.

Next, the researcher answered research question three, what is the organization's injury frequency rate and injury costs after implementing the wearable safety technology? This research question is broken down into three sub-questions that detail the specifics of the original research question as it relates to the quantitative research post-implementation. Tables 28 through 35, along with the previous section, detail how this research question was answered. First, the researcher documented the organization's injury frequency rate after implementing the wearable technology, which answers research question 3a. Then, the researcher benchmarked that injury frequency against the previous BLS data to show changes in the benchmark post-implementation. This information answers research question 3c. Finally, the researcher documented the cost of any ergonomic injuries after implementing the technology, which answered research question 3b. These three sub-questions provide great insight into how the organization's ergonomics changed after implementing wearable technology. The combination of both research questions gives the researcher a holistic quantitative overview of how wearable safety technology impacted the organization.

Quantitative Relationship to the Theoretical Framework

The following will be a discussion on the research framework design. This discussion will focus on how the quantitative discoveries relate to the research design's theories, participants, concepts, constructs, and variables.

Research Theories

Figure 1 demonstrates the research framework design. In this table, the first research theory is agency theory. Ross (1973) stated that this theory seeks to minimize the goal-incongruence effect due to humans being self-interested individuals. The agency theory applied in this research because the organization's and employees' goals must be aligned for a successful implementation. The quantitative findings of this theory prove that a successful implementation of wearable safety technology could lower work-related injuries and claims across those sites in the United States. However, this research's qualitative findings will prove more valuable in demonstrating the agency theory. The qualitative findings will prove if the hourly employees at the site were interested in lowering these claims or if it was only the site's leadership.

Next, the innovation diffusion theory was described by Dearing and Cox (2018) as "innovation that is communicated through certain channels over time among members of a social system" (p. 183). This theory describes how innovations are adopted within the population of potential adopters. The hourly employees will be the adopters, and the innovation diffusion theory will help explain the adoption of the new technology to be implemented at the finished vehicle logistics facilities. Like the agency theory, the quantitative research proved that wearable safety technology lowered the number of claims and injuries at the sites. However, the qualitative research will be able to demonstrate the value of this research further as it compares to the innovation diffusion theory. The qualitative research will demonstrate if the hourly employees accepted wearing the technology as it diffused through the organization.

Finally, Ajzen (1991) illustrated that the theory of planned behavior is a theory that proposes behaviors based on the individual's intention regarding that behavior, which is a function of their attitude toward that behavior. This theory was able to be proved through quantitative research. The theory proposes that employee-related ergonomic injuries are behaviors that need modification, and the technology seeks to provide information to change those behaviors. Through the successful implementation of wearable safety technology, the number of injuries and cost of claims was reduced across the sites in the United States. The devices work by providing haptic feedback and safety scores to the individuals. As the study progressed, the number of injuries and the cost of the claims were reduced. Therefore, the technology was able to modify the individual's behavior to become more aware of their ergonomic safety.

Research Participants

Figure 1 shows four types of participants in this research: site-level leadership, hourly employees, senior leadership, and accountants. The quantitative research solely focused on the data from the hourly employees, which are the employees who were injured before and during the research study. However, the future qualitative discussion will detail the participants' feedback on implementing wearable safety technology. Therefore, the qualitative research will successfully answer this portion of the research study on how the outcome from the participants interconnects with the theoretical framework.

Research Concepts

Figure 1 shows that there are four different research concepts within this study. The first two concepts will be able to be demonstrated through quantitative research, while the second two will relate to qualitative research. The first quantitative research concept states that wearable safety technology could possibly reduce employee-related ergonomic injuries. This concept was proven true through previous quantitative research. Furthermore, one of the sites demonstrated statistical significance in reducing the number of injuries while implementing wearable safety technology.

The second quantitative research concept states that reducing employee-related injuries could increase the organization's injury frequency rate. This concept was also proven true during the quantitative research portion of this study. Comparing Table 2 with Table 28 shows that both facilities reduced injuries when implementing wearable safety technology. Table 29 gives a visual representation of the injury frequency rate and shows how this reduction in injuries compensates for the injury frequency rate. Therefore, this concept was valid at the sites that implemented wearable safety technology.

Research Constructs and Variables

Figure 1 shows that there are five research constructs or variables. First, there are three concepts: wearable safety technology, the injury frequency rate, and the cost of the injuries. All these concepts were used in the quantitative section of this research. The wearable safety technology was implemented at two sites with hourly employees. The injury frequency rate was measured before and during the implementation of the wearable safety technology. Finally, the cost of the injuries was measured before and during the implementation of the wearable safety technology. Next, this research has two constructs: the impact of injury frequency and behavioral changes. Both concepts will be measured during the qualitative research portion.

Quantitative Relationship to the Literature

Many similarities exist between the previous research and the literature previously demonstrated. For example, Pater (2017) found that a proactive approach to reducing employee-related ergonomic injuries is the best solution to this trailing indicator issue. The previous research demonstrates how the researcher and the organization have taken the advice of Pater in trialing a new technology. Antwi-Afari et al. (2019) found that many technologies exist in the market that are designed to improve an organization's occupational health and safety programs, resulting in lower workplace injuries. The wearable safety technology builds off the previous literature illustration and proves that this technology was valuable to the organization and future research, even though one of the facilities was not statistically significant. Finally, Gruchmann et al. (2021) found that the supply chain and logistics sectors suffer from a shortage of skilled labor and that the blue-collar workers in these industries are more likely to suffer work-related injuries. The finished vehicle logistics sector relies heavily on blue-collar labor, and this research could potentially provide a path to lowering those injuries while providing a safe work environment for the scarcity of those employees who remain.

During the quantitative section of this research, no differences were found between the research and the literature. However, there may be differences when the qualitative section is discussed further in this research. For example, Ozorhon and Karahan (2017) illustrated that these technologies could lead to numerous safety and non-safety benefits within manufacturing, construction, and supply chain organizations. The quantitative section will be able to demonstrate if any non-safety benefits were found within the organization after implementing the wearable safety technology.

Quantitative Relationship to the Problem

The quantitative portion of this study specifically targets the problem statement for this research problem. First, Pagell et al. (2016) found that in 2014 OSHA recorded 2.8 million non-fatal occupational injuries across all industries. Since OSHA is the defining benchmark for occupational injuries in the United States, these benchmarks were used to compare the organization’s injuries before and after the implementation of wearable safety technology. Then, Kao et al. (2021) illustrated that to address these occupational injuries, an organization must understand employees' safety behaviors and the safety climate of the organization, which are predictors of workplace injuries. The qualitative section of this study will understand the safety climate and behaviors observed during this study to answer how the study focused on this portion of the research question.

Next, Antwi-Afari et al. (2019) illustrated that many technologies exist that improve an organization's occupational health and safety programs, which can result in lower workplace injuries. The quantitative section of this research focused on precisely that recommendation. Wearable safety technology was implemented to potentially improve the organization’s health and safety program, which proved statistically significant in lowering injuries at one of the facilities. Finally, Schnittfeld and Busch (2016) found that organizational stakeholders demand a sustainable response to the changing health and safety challenges. The organization has demonstrated a sustainable response to the everchanging health and safety climate by taking a proactive step in implementing new technology, which proved statistically significant in lowering work-related injuries. Although not proven statistically significant in the quantitative section of this research, the cost of the claims was also reduced during this study. Therefore, this study's quantitative section demonstrates significant strength between the research study and the problem statement.

Summary of Quantitative Findings

The previous section of this research study demonstrates significant value in future research using wearable safety technology. Previously, Nath et al. (2017) performed a similar study using cell phones to track employees’ ergonomic movements related to injuries in the workplace. That study illustrated that these musculoskeletal disorders have many impacts on the workplace outside of the direct worker’s compensation costs and the most common injuries are sprains, strains, and tendonitis. Two finished vehicle logistics sites in the United States used wearable safety technology for almost a year to demonstrate if this technology could potentially reduce work-related injuries and the cost of those injuries.

First, a benchmark comparison was made using the historical injury rates of the organization compared to the BLS. This comparison looked at the organization's entire footprint in the United States, a site in Brunswick, Georgia, and a site in Carlisle, Pennsylvania. This historical research was done to answer research question 1 and provide a succinct understanding of the impact of work-related injuries on the organization before implementing wearable safety technology. Tables 2, 23, and 24 highlights the historical benchmark's understanding.

Next, research question 3 sought to understand the same information after implementing wearable safety technology. First, the site in Brunswick, Georgia was studied before and after the implementation of wearable safety technology. Table 26 demonstrates that with the implementation of wearable technology, between 2018 and 2021, the site would average one ergonomic injury per year. Also, Table 25 demonstrates that the claim would cost, on average, $1,390. However, Table 28 demonstrates that after the implementation of the new technology, that same site experienced no injuries, which resulted in no costs to the organization. The research into this site proved statistically significant for $H1_0$ where the organization was proven to have a reduced incident frequency rate. This statistical significance was found using a multiple-regression model, which bounded statistical significance between the site in Brunswick, Georgia, and a site in Brussels, Belgium. The site in Brussels was on track with its original progression of injuries, while the site in Brunswick, Georgia had zero injuries. Unfortunately, statistical significance was not demonstrated for $H2_0$ where the researcher sought to understand if the cost of these injuries was reduced. However, it can be subjectively seen by the research through the quantitative data provided.

First, the site in Carlisle, Pennsylvania was studied before and after implementing wearable safety technology. Table 26 demonstrates that with the implementation of wearable technology, between 2018 and 2021, the site would average three ergonomic injuries per year. Also, Table 25 demonstrates that the claim would cost, on average, $1,725. However, Table 28 demonstrates that after implementing the new technology, that site experienced six additional injuries. Those injuries resulted in an additional cost to the organization of $4,352. Unfortunately, unlike the previous site, the research into this site did not prove statistically significant for $H1_0$. The researcher used the same testing for the Carlisle, Pennsylvania site to find statistical significance with another site, but no other sites proved a statistically significant correlation. Also, this site did not demonstrate statistical significance for $H2_0$ where the researcher sought to understand if the cost of these injuries was reduced.

Then, the researcher demonstrated the significance of the previous research to the theoretical framework, literature, and problem statement. First, focusing on the theoretical framework, two of the three research theories could be validated through quantitative research, while one will be validated through qualitative research. However, the participant data will be validated during the qualitative research. Also, two of the four research concepts could be validated during quantitative research, while the remaining two will be validated during qualitative research. Finally, all three concepts for the theoretical framework were validated during the quantitative research, while the two variables will be validated during the qualitative research.

Next, the researcher demonstrated how the quantitative implementation of wearable safety technology applied to the previous literature studied. For example, Ozorhon and Karahan (2017) illustrated that these technologies could lead to numerous safety and non-safety benefits within manufacturing, construction, and supply chain organizations. This demonstration is seen through the quantitative research previously demonstrated.

Finally, the researcher demonstrated how the quantitative implementation of wearable safety technology applied to the previous problem statement. For example, Antwi-Afari et al. (2019) illustrated that many technologies exist that improve an organization's occupational health and safety programs, which can result in lower workplace injuries. This demonstration is seen through the quantitative research previously demonstrated.

To conclude, this study's previous quantitative research portion has proven the value of future research behind wearable safety technology, its benefits to potentially lowering work-related injuries, and the costs of those injuries. Statistical significance was demonstrated for some of the studies, while the portion that did not prove statistically significant was subjectively demonstrated to improve safety while lowering injury frequency and the cost of those injuries. Then, demonstrate the value of the theoretical framework, literature, and problem statement. The previous quantitative research provides a robust framework for future research into the feasibility of this technology. In the next section, the researcher will demonstrate the qualitative research behind the wearable safety technology, which will answer the remaining research questions, and hypothesis and potentially provide more value to the previous research.

Presentation of the Qualitative Findings

Nath et al. (2017) found that proactive information gathering about the positioning of the employees could be used better to relay proper posture and ergonomic-related behaviors to the employees. Now that the quantitative findings have been presented, the researcher must investigate the qualitative findings before seamlessly triangulating those results into one succinct and holistic view of the outcome of wearable safety technology within a finished vehicle logistics organization. In this section, the researcher will present the qualitative findings from two groups of employees. First, the leadership employees are comprised of site-level leadership, senior leadership, and accountants. Second, the hourly employees who wore the wearable technology at the two sites implemented in the United States. Those employees were interviewed based on a semi-structured interview guide, which allowed the researcher to gain a greater perspective on the participant's viewpoint, while the researcher listened carefully to what the participants were saying. Based on those interviews, follow-up questions were asked if more information was needed. Then, those viewpoints are gathered and coded in NVivo into higher and lower-level themes. Finally, those themes are interpreted into emergent ideas and correlated to the research questions, conceptual framework, literature, and anticipated themes. This qualitative research allowed the researcher to fully understand the perspective of all associated parties within the organization to understand better the impact of wearable safety technology within a finished vehicle logistics organization.

Qualitative Themes Discovered

The researcher will present the themes discovered during the interviews in the following section. First, the researcher will discuss the themes discovered for the leadership interviews. Then, the researcher will discuss the themes discovered for the hourly interviews.

Themes Discovered – Leadership Participants

The researcher will discuss the themes discovered during the interviews with the Leadership Employees (LE) in this first section. This interview, which is demonstrated in Appendix A, was used for three of the four participant groups, as demonstrated in Figure 1: site-level leadership, senior leadership, and accountants. The total population eligible for this interview was approximately 75, given the three eligible different participant groups. Creswell and Poth (2018) illustrated that sampling is when the researcher selects the individuals and sites for their study to provide information and an understanding of the research problem and central phenomena. Therefore, for the appropriate sampling, the researcher asked those 75 individuals, who were knowledgeable about the implementation of wearable safety technology, to participate in the interview. Of the 75 individuals selected as the sample size, 19 chose to participate in the interview: six site leaders, seven senior leaders, and six accountants. The themes discovered from their answers are below.

The interview with the organization's leadership asked three questions related to their job function and the impact of work-related injuries. After the interviews were completed, the researcher started by transcribing all interviews into NVivo verbatim. Then, the researcher took detailed notes during the transcription process to memo emergent ideas. Codes were applied to all similar patterns in the transcribed interviews, allowing the researcher to develop lower, less abstract, and higher-level themes. After all lower-level themes were coded, the researcher had a more significant discovery of the themes from the leadership interviews. Five highest-level themes were discovered, which are discussed below, in order from greatest to least. These themes can be seen in Table 43.

The Headcount Impact of Injuries

The headcount impact of injuries was discussed during the leadership interviews 52 times. Twenty-three of those times, participants of the leadership interviews discussed how injuries lead to increased staffing to replace injured individuals. For example, LE18 stated that increased injuries would lead to “more replacements” (Leadership Interviews, 2022). Twenty-five of those times, participants of the leadership interviews discussed how injuries lead to increased training to replace the injured individual. For example, LE17 stated that increased injuries would lead to “more training costs” (Leadership Interviews, 2022). Four of those times, participants of the leadership interviews discussed how injuries lead to increased working hours if either of the two previous references were not an option. For example, LE13 stated that increased injuries would lead to “more hours worked” (Leadership Interviews, 2022).

The Financial Impact of Injuries

The financial impact of injuries was discussed during the leadership interviews 48 times. Fourteen of those times, participants of the leadership interviews discussed how injuries affected profits, balance sheets, profit and loss statements, or other objective financial measures. For example, LE1 stated that the “profit and loss statement would worsen” (Leadership Interviews, 2022). Seven times, participants of the leadership interviews discussed how injuries affected future business. For example, LE8 stated in a follow-up question that “many customers require certain standards of safety” (Leadership Interviews, 2022). Fourteen of those times, participants of the leadership interviews discussed how injuries affected healthcare costs, premiums, or other objective costs related to healthcare. For example, LE2 referenced “insurance premiums would rise” (Leadership Interviews, 2022).

The Productivity Impact of Injuries

The productivity impact of injuries was discussed during the leadership interviews 48 times. These references refer to the work those individuals must contribute when injuries occur. Ten of those 48 times, participants of the leadership interviews discussed how injuries lead to an increase or decrease in accident investigations. For example, LE11 stated, "I would spend more time investigating accidents” (Leadership Interviews, 2022). Two of those times, participants of the leadership interviews discussed how injuries lead to increased or decreased injury prevention measures. For example, LE9 stated that “a reduction in injuries would allow me to focus on the future instead of preventing past injuries" (Leadership Interviews, 2022). Nineteen of those times, participants of the leadership interviews discussed how injuries lead to an increase or decrease in the work that must be put into the related claims. For example, LE7 stated that a reduction in injuries would "allow me to have less calls with the insurance carriers" (Leadership Interviews, 2022). Two participants in the leadership interviews discussed how injuries increase root cause analysis from the injury. For example, LE5 stated, "I have to spend time investigating the root cause of an accident" (Leadership Interviews, 2022). One of those times, participants of the leadership interviews discussed how injuries lead to an increase or decrease in the travel related to injuries, which would be individuals traveling to the site where the injury occurred to work with the local team on numerous post-incident measures. For example, LE16 stated, "I have to travel to sites to perform investigations" (Leadership Interviews, 2022). Fourteen of those times, participants of the leadership interviews discussed how injuries lead to an increase or decrease in the general workload that occurs when injuries happen. For example, LE10 stated that "a decrease in injuries would decrease my injury-related workload" (Leadership Interviews, 2022).

The Safety Impact of Injuries

The safety impact of injuries was discussed during the leadership interviews 24 times. Sixteen of those times, participants of the leadership interviews discussed how injuries affected the safety score. This is a reference to the lost-time injury frequency that was discussed earlier in this research. For example, LE15 stated that increased injuries would lead to "a lower safety score" (Leadership Interviews, 2022). Eight of those times, participants of the leadership interviews discussed how injuries affected sustainability metrics. For example, LE10 explained in a follow-up question that "the European Union has strict guidelines for social governance metrics, which coincides with injury metrics" (Leadership Interviews, 2022).

The Morale Impact of Injuries

The morale impact of injuries was discussed during the leadership interviews 23 times. All of those 23 references discussed how injuries impact the morale of local and global organizations. For example, LE14 stated that increased injuries would lead to "lower morale" (Leadership Interviews, 2022).

Themes Discovered – Hourly Employee Participants

In this first section, the researcher will discuss the themes discovered during the leadership interviews. These interviews, demonstrated in Appendix B, were given to the final participant group. That final group is the hourly employees, which is demonstrated in Figure 1. The total population for that group was 74 employees who used wearable safety technology. Of those 74 employees, 29 agreed to participate in the interviews. Therefore, the sampling size is 100% of the respondents. The themes discovered from their answers are below.

The interviews with the hourly employees of the organization asked three questions related to their job function and the impact of work-related injuries. After the interviews were completed, the researcher started by transcribing all interviews into NVivo verbatim. Then, the researcher took detailed notes during the transcription process to memo emergent ideas. Codes were applied to all similar patterns in the transcribed interviews, allowing the researcher to develop lower, less abstract, and higher-level themes. After all lower-level themes were coded, the researcher had a more significant discovery of the themes from the leadership interviews. Two highest-level themes were discovered, which are discussed below, in order from greatest to least. These themes can be seen in Table 44.

The Holistic Impact of the Technology

The interviews with the Hourly Employees (HE) focused on their subjective views of implementing the wearable safety technology. The overall holistic impact on the organization was discussed 73 times, 81% of the overall coded themes from the interviews. Twenty of those times, the hourly employees discussed how communication improved during the trial of the wearable safety technology. For example, HE4 stated that “people are talking more about safety” (Hourly Interviews, 2022). Twenty-nine other times the hourly employees discussed how overall safety improved during the trial of the wearable safety technology. For example, HE1 stated that “the devices helped us all to be safer” (Hourly Interviews, 2022). Nine of those times, the hourly employees discussed how the employees at the site were more cognizant of the group's posture during the trial of the wearable safety technology. For example, HE20 stated, "we talked more about how to bend and lift” (Hourly Interviews, 2022). Another seven times, the hourly employees discussed how employees at the site were more aware of how to prevent ergonomic injuries during the trial of the wearable safety technology. For example, HE14 stated that “people were paying more attention to their bodies” (Hourly Interviews, 2022). Finally, eight times the hourly employees discussed how the work environment improved during the technology trial. For example, HE29 stated that “management spent money fixing safety issues” (Hourly Interviews, 2022).

The Personal Impact of the Technology

The interviews sent to the hourly employees focused on their subjective views of implementing wearable safety technology. The personal impact on the employee was discussed 17 times, 19% of the overall coded themes from the interviews. Eleven of those times, the hourly employee discussed how they were more aware or cognizant of their personal safety. For example, HE22 stated, "I was safer" (Hourly Interviews, 2022). Three of those times, the hourly employee discussed how they made modifications to their working environment to be safer during the trial of the wearable safety technology. For example, HE3 stated, "I am paying more attention to how safe I am working" (Hourly Interviews, 2022). Finally, three people discussed being more cognizant of their posture during the trial. For example, HE1 stated in a follow-up question that "the device told me when I was being bad, so I adjusted so it would not go off" (Hourly Interviews, 2022).

Qualitative Interpretation of the Themes

Now that the previous themes have been discovered, the researcher must interpret the previous themes. The researcher focused on the dominant interpretations of each of the previous themes while discussing what information is conceptually interesting or unusual given to the participants.

Theme Interpretation - Leadership

The dominant theme was the leadership participants who discussed the headcount impact of injuries. Fifty-two of the 195 references in the coding were related to the headcount impact that injuries have on a site. Twenty-three of those 52 times, leadership participants discussed the added headcount a site must incur to combat those injuries. When an employee gets injured, they may not be able to return to work or sometimes must switch job functions. However, that job still needs to be completed, which leads to an additional headcount to backfill for the injured employees. Another 23 times, leadership participants discussed the added training a site must incur after those injuries. For example, LE11 stated that increased injuries would lead to "higher replacement costs and most training" (Leadership Interviews, 2022). This training is a reference to the last headcount because the additional employees that must be present must also be trained to perform their new work duties. Finally, four times leadership participants discussed additional working hours that the site must incur. Similarly, if an additional headcount is unavailable, the existing headcount must work additional hours to compensate for the lack of headcount to complete the job tasks. Like the previous theme, all previous references also have a financial impact. Additional headcount, training, and working hours all cause the site to be less profitable.

The second dominant theme from the interviews was that those leadership participants discussed the financial impact of injuries more than any other theme. Forty-eight of the 195 references were related to the financial impact of injuries on a site. For example, LE8 stated that increased injuries would lead to “increased global costs” (Leadership Interviews, 2022). Given that the participants in this group come from site-level leadership, senior leadership, and accountants, this dominant theme is not surprising. Cirjaliu and Draghici (2016) illustrated that lean manufacturing forces organizations to push productivity to achieve the organization's goals, but this shift has led to ergonomic issues in the workplace. This literature reference is seen through the most dominant theme from the leadership participants. Profits have become the objective measure that benchmarks the organization’s sites against each other. Therefore, when discussing injuries, which impact many aspects of the organization, profits were the most dominant and highly discussed theme.

The next dominant theme was those leadership participants discussed the productivity impact of injuries. Forty-eight of the 195 references were related to the productivity impact of injuries on a site. Unlike the following reference, where headcount is the productivity of the overall site, this productivity reference is related to that person’s productivity. For example, LE14 stated that a decrease in injuries would lead to “being able to focus on the day-to-day operations” (Leadership Interviews, 2022). Fourteen of the 48 times, leadership participants discussed how they would have to take time to perform an accident investigation after the injury occurred. The organization mandates that no matter how large or small an accident is, an accident investigation occurs to attempt to keep this similar injury from occurring in the future. Part of the accident investigation is a root-cause analysis, which was discussed once. Similarly, injury prevention measures are discussed nine times in the accident investigation. Also, many of the interviewed individuals directly correlated to the claim produced for the insurance agency after the accident occurred. This claim was discussed 19 times. Finally, a general increase in workload was discussed 12 times. From the previous themes, these leadership employees are also intrinsically concerned with the amount of work they incur when an injury happens. All the previous sub-themes deal with the personal workload of a leadership employee after an injury occurs.

The second to the least dominant theme found during the interviews was that those leadership participants discussed the safety impact of injuries more than any other theme. Twenty-four of the 195 references in the coding were related to the organization's overall safety. Sixteen references were related to the safety score, which is the lost-time injury frequency. For example, LE17 stated that increased injuries would lead to a “lower global safety score” (Leadership Interviews, 2022). This frequency is a global standard that the organization reports to benchmark its safety against other organizations. This frequency was the predominant measure demonstrated in this research's quantitative section. Next, safety as a sustainability metric was discussed eight times, while an unsafe work environment was discussed five times.

The final theme, the least dominant, discussed the morale impact of injuries more than any other theme. Twenty-three of the 195 references were related to the impact that injuries have on morale on the site. Given the questions in these interviews, the impact of morale count is positive or negative. Participants discussed a decrease in morale when injuries occur while referencing an increase in morale if injuries were to be reduced. For example, LE18 stated that increased injuries would lead to “lower morale” (Leadership Interviews, 2022). The employees within the organization work side-by-side daily, so morale is a vital part of any organization. When an injury occurs to a co-worker, many employees start to ponder if that injury could occur and how that would affect their life and work. Therefore, it is understood that morale would be a vital theme discussed in this research.

To conclude, modern leadership within the organization has put profits and productivity above morale and safety. Cirjaliu and Draghici (2016) demonstrated that organizations have elevated productivity above safety within the workplace. However, employers are responsible for paying for the cost of these injuries and the downtime the employee experiences after an injury. This theme is also represented in the qualitative portion of this research focuses on the organization's leadership. Combining the references of the financial impact, personal productivity, and site productivity (headcount) account for 76% of the comprehensive references in the interviews. Therefore, given the themes discovered from the leadership interviews, it can be determined that leadership has put profits and their workload above the safety and well-being of the hourly employees at the location.

Theme Interpretation – Hourly

The most dominant theme during the interviews was those hourly participants who discussed how the holistic organization had changed. Unlike the leadership participants, the hourly employees focused on others and the collective change within the organization. Seventy-three of the ninety references used words like “we” or “us” to reference themselves and their fellow employees. For example, HE24 stated, “we were safer in how we moved” (Hourly

Interviews, 2022). The employees focused mainly on how communication and safety improved within the collective site. The second theme found that only 17 of the 90 references during the interviews focused on their personal safety, work environment, or cognizance during the technology trial. For example, HE17 stated in a follow-up question, "I would try to work safer" (Hourly Interviews, 2022). No references were made to an employee personally getting injured, while the employees discussed holistic injuries seven times.

To conclude, the hourly employees involved in this technology trial did benefit from the implementation and reduction of injuries. However, the employees did not focus on their personal experience with the trial, and most respondents focused on the organization's collective experience. For example, HE1 stated, “we all tried to be as safe as possible” (Hourly Interviews, 2022). Robinson et al. (2018) identified this trait as the theory of organization identification, in which visible group dynamics are formed and create an in-group bias and out-group discrimination. The in-group biases create a feeling of connectedness and belonging to the organization. This theory can also be seen within the leadership employees but differently. Within the organization, leadership is held accountable for the quantifiable of their site. Quantifiable metrics such as profit, safety scores, headcount versus productivity, and healthcare costs are measured by each site monthly. These quantifiable variables are then compared site-by-site while leadership discusses how to improve those metrics amongst each other.

Therefore, the theory of organizational identification leads to an in-group bias between leadership around the county based on these metrics. However, the hourly employees are not held to those same metrics as the leadership employees. The leadership employees focus more on production output, individual safety, and other related metrics. Therefore, the theory of organizational identification explains why the leadership interviews mostly discussed quantitative metrics while the hourly employee interviews mainly discussed the holistic communication, injuries, and safety of the site.

Qualitative Relationship of the Findings

In this section, the researcher will demonstrate how the previous qualitative information related to the research questions, the theoretical framework, the literature, and the problem being studied.

Qualitative Research Questions

In this section, the researcher will summarize the previous information related to each research question. This information will provide a succinct overview of how the previous qualitative research answered each research question.

Research Question 2

What are the impacts of the injury frequency rate on the organization?

For this portion of the research, the emergent themes from the previous qualitative research provide a cohesive understanding to answer this research question. To answer this research question correctly, the researcher must understand the qualitative and subjective perspectives of the leadership employees, who are more directly correlated to the injury frequency rate. The hourly perspective is considered in research question four.

First, from the leadership perspective, the injury frequency rate significantly impacts the organization's financials. This impact can also be seen within quantitative research, where the number of injuries causes a rise in claims and overall costs to the organization. This emergent theme was the second most dominant reference within the interview's coding, with 48 of the one 195 references. Next, the emergent theme of headcount and productivity were the first and third-most dominant references, respectively. The coding themes within the interview were 52 and 48, respectively, of the 195 references. Like the financial impact, when an employee is injured, there is an indirect financial correlation between the injury and productivity or headcount. This indirect impact is seen in productivity through time spent investigating the accident, root-cause analysis, travel, and other indirect costs. While for headcount, this indirect impact is seen through additional headcount, additional training, or additional working hours.

Finally, the least dominant themes were safety and morale, respectively. These themes were discussed 24 and 23 times per the 195 references. Going back to the previous reference by Robinson et al. (2018), it is understood that given the in-group biases of the leadership employees, the direct and indirect financial implications would be a more emergent trait than traits like morale and safety. The leadership employees are more focused on the overall quantifiable metrics of their sites, which leads to these themes being more higher references.

To conclude, the direct and indirect financial implications impact the injury frequency rate within the organization. Whether it is the direct impact of the cost of an injury or an indirect impact of training and increased headcount, the qualitative research cohesively correlates that the most significant impact of the injury frequency on the organization is the direct and indirect financial implications.

Research Question 4

What other behavioral changes can be observed positively influencing reducing injury frequency after implementing the wearable safety technology?

For this portion of the research, the emergent themes from the previous qualitative research provide a cohesive understanding to answer this research question. To answer this research question correctly, the researcher must understand the qualitative and subjective perspective of the hourly employees, who are more directly correlated to the behavioral impact after implementing the technology.

First, the organization's holistic group was considered the most dominant emergent theme from the hourly employee's perspective. Robinson et al. (2018) attributed this to the in-group biases of the theory of organizational identification. The researcher summarized this emergent theme as a holistic impact of the technology on the organization, given that the employees discussed the holistic group 81% of the time. Forty-nine times each, the hourly employees discussed how the implementation of wearable technology helped to improve communication or overall safety within the site. For example, HE17 stated, "my manager would talk to me about my safety score" (Hourly Interviews, 2022). While another nine times, the employees discussed how the collective site was more cognizant about their posture, or 15 times they discussed an overall improvement in the working environment or injuries.

A slight few of the employees did reference the emergent idea that the implementation helped them personally to become safer. Eleven times personal safety was discussed, three times modifications to their work environment were discussed, and three people discussed how they were more cognizant of their posture. For example, HE11 stated in a follow-up question that "the device graded us on a daily basis, and I was always trying to beat my score" (Hourly Interviews, 2022). However, the most dominant theme is that the holistic organization communicated more and became safer.

To conclude, several behavioral changes can be positively influenced by reducing injury frequency after implementing wearable safety technology. First, communication within the site was significantly improved after implementing the technology. Next, the overall safety of the site was also improved. Finally, the collective group of hourly employees' cognizance of their working posture was positively influenced. To conclude, the theory of organizational identification helps the researcher better understand the perspective of the hourly employees who participated in the interviews and the meaning behind their results.

Summary of the Qualitative Relationship to the Research Questions

The previous section illustrated the relationship between the qualitative research and two of the research questions. Research question two asks, what are the impacts of the injury frequency rate on the organization? This research question was answered predominantly through interviews with the leadership employees. Those employees showed that injuries affect the site's finances, productivity, and headcount. Those impacts represented 148 of the 195 references from the leadership interviews. Research question four asks, what other behavioral changes can be observed positively influencing reducing injury frequency after implementing the wearable safety technology? This research question was answered predominantly through interviews with hourly employees. Those employees showed that communication was significantly improved within the site during the technology implementation. Also, the overall safety of the site was improved from their viewpoint. Finally, the collective group of employees felt more were working to improve their posture to reduce work-related ergonomic injuries.

Qualitative Relationship to the Theoretical Framework

The following will be a discussion on the research framework design. This section continues the previous quantitative relationship to the theoretical framework. This discussion will focus on how the qualitative discoveries relate to the research design's theories, participants, concepts, constructs, and variables.

Research Theories

Figure 1 demonstrates the research framework design. In this table, the first research theory is agency theory. Ross (1973) stated that this theory seeks to minimize the goal-incongruence effect due to humans being self-interested individuals. The agency theory will apply in this research because the organization's and employees' goals must be aligned for a successful implementation. The previous quantitative findings of this theory prove that a successful implementation of wearable safety technology could lower work-related injuries and claims across those sites in the United States. However, for this section, the researcher focused on the qualitative aspects of this research in correlation to this research theory. Given the previous emergent themes, this theory did not prove true during the qualitative research. The leadership's goals versus the hourly employees' goals remained incongruent. The leadership employees were more focused on the financial aspects of the injuries, while the hourly employees were more focused on the behavioral impact of the technology. Also, the hourly employees were not self-interested but biased toward their collective group. For example, HE3 stated that "everyone is paying more attention to safety" (Hourly Interviews, 2022).

Next, the innovation diffusion theory was described by Dearing and Cox (2018) as "innovation that is communicated through certain channels over time among members of a social system" (p. 183). This theory describes how innovations are adopted within the population of potential adopters. The hourly employees will be the adopters, and the innovation diffusion theory will help explain the adoption of the new technology to be implemented at the finished vehicle logistics facilities. However, for this section, the researcher focused on the qualitative aspects of this research in correlation to this research theory. Like the agency theory, the quantitative research proved that wearable safety technology lowered the number of claims and injuries at the sites.

The previous coding of emergent themes focused on the positive sentiment from both groups. However, the conversation to relate this research theory to the completed research focused on the negative sentiments found during the coding. The leadership employees did not correlate negative sentiments toward implementing wearable safety technology. However, three negative sentiments were coded during the transcription of the hourly employee interviews. Those employees stated that they did not see any positive behavioral impacts from implementing wearable technology within the organization. Even though leadership and hourly employees had incongruent goals from the implementation, the innovation theory proved true during the qualitative research. One of the most significant themes discovered during the interviews was how communication increased while implementing the technology. This communication was a direct correlation between the incongruent goals of the leadership and hourly employees but still led to adopting the technology. Given that only three negative sentiments were recorded about the implementation of the technology, it can be confidently stated that this research theory proved true during the research.

Finally, Ajzen (1991) illustrated that the theory of planned behavior is a theory that proposes behaviors based on the individual's intention regarding that behavior, which is a function of their attitude toward that behavior. This theory was able to be proved through quantitative research.

Research Participants

Figure 1 shows four types of participants in this research: site-level leadership, hourly employees, senior leadership, and accountants. The quantitative research solely focused on the data from the hourly employees, which are the employees who were injured before and during the research study. The previous emergent themes fully documented the research participants' qualitative perspectives.

Research Concepts

Figure 1 shows that there are four different research concepts within this study. The first two concepts were demonstrated through quantitative research, while the second two will relate to qualitative research. The third concept is other safety-related behavior changes. Given the previous emergent themes, this concept can be correlated to several of the emergent themes. The greatest emergent theme correlated with this research concept is increased communication. Abubakar et al. (2020) found that a measure of an organization's safety climate is communication, and this research proved that communication was improved through the implementation of the technology. Therefore, the increase in communication positively correlates with safety-related behavioral change after implementing the new technology. For example, HE5 stated that "we talked more about safety" (Hourly Interviews, 2022). Several other emergent themes, such as cognizance of posture, an adaptation to the working environment, and a perception of a safer work environment, can also be positively correlated with this research concept.

The fourth concept is other non-safety-related behavioral changes. Given the outcome of the previous research, the impact of injuries on the organization touched many financial and non-financial perspectives. From an increase in headcount, improved communication, or increases in training, implementing this technology proved viable for many organizational aspects. However, for this research concept, no other non-safety-related behavioral changes were witnessed during this research.

Research Constructs and Variables

Figure 1 shows that there are five research constructs or variables. All the research variables were demonstrated during the quantitative research, while the concepts are demonstrated in the quantitative section of this research. First, the construct of the impact of injury frequency can be correlated to the emergent themes from the leadership interviews and research question two. These two sections directly demonstrate and correlate injury frequency's impact on the organization. Second, the construct of the behavioral changes can be correlated to the emergent themes from the hourly interviews and research question four. These two sections directly demonstrate and correlate the behavioral changes observed after implementing the new technology.

Quantitative Relationship to the Anticipated Themes

Several anticipated themes were demonstrated during the initial investigation of this research. Now that the implementation of the technology is completed, the researcher will demonstrate if there is a correlation between the anticipated themes and the outcome of the research.

First, it was hypothesized that the employees would become safer through behavioral modification by adjusting their behaviors after obtaining feedback from the safety technology. This anticipated theme was proven true during this research's quantitative and qualitative sections. During the quantitative section, statistical significance was determined for wearable safety technology lowering the frequency of injuries at the Brunswick, Georgia facility. Unfortunately, insufficient data were present to compute this same statistical significance for the Carlisle, Pennsylvania facility. Therefore, the use of the technology proved that employees were safer after implementing the wearable safety technology. This theme is not demonstratable with the qualitative results but was transferable to future themes.

The next anticipated theme was that the behavior modification would translate to other non-ergonomic related safety injuries. This anticipated theme is also evident from the previous quantitative and qualitative results. Comparing the pre-and post-implementation data when comparing all recordable injuries, not just those for ergonomic-related injuries, demonstrates a decline in all injuries within the sites. This reduction in non-ergonomic related injuries can be correlated to the qualitative results where hourly employees observed an increase in safety communication and overall safety of the site.

The final anticipated theme was that the proactive steps taken by the organization would lead to a reduction in injury frequency, costs, and premiums. This anticipated theme is directly correlated to the outcome of the quantitative results. It was demonstrated that the technology implementation led to a positive and sometimes statistically significant outcome at all the sites where it was implemented. Therefore, calling for future expansion of this research to more sites across the supply chain.

Quantitative Relationship to the Literature

During the quantitative section of this research, no differences were found between the research and the literature. The researcher will discuss the literature with the qualitative results in this section. First, Ozorhon and Karahan (2017) illustrated that these technologies could lead to numerous safety and non-safety benefits within manufacturing, construction, and supply chain organizations. The quantitative section of this research could correlate that many safety and non-safety-related benefits were observed during the technology implementation. For example, the increase in communication about safety during the technology implementation can be attributed to both safety and non-safety related.

Also, during the literature review, it was summarized that leadership professionals must focus efforts and resources on making safety improvements and then be effective change agents of the new safety efforts. This was cohesively demonstrated by the goal incongruence of the agency theory. The leadership employees were more focused on the financial aspects of the injuries, while the hourly employees were more focused on the behavioral impact of the technology. Also, the hourly employees were not self-interested but biased toward their collective group.

Similarly, Gruchmann et al. (2021) found that the supply chain and logistics sectors suffer from a shortage of skilled labor. This finding directly correlates to the outcome of the qualitative results of the leadership interviews. The site leadership was significantly concerned with the training or additional headcount of the skilled labor when needing to backfill for an employee that suffered from an injury. It was demonstrated that the headcount discussed 50 of the 212 references in the coding of the leadership interviews.

Finally, Seçkiner and Ünal (2021) found that designing the appropriate Personal Protective Equipment (PPE) for employees' job tasks is demanding but required to design an effective workplace safety program. This study suggested that employers must go above and beyond when evaluating their employee’s PPE instead of buying something “off-the-shelf” that could not be suitable for the job. This reference is an exact correlation to the research that was implemented. The wearable safety technology was treated as a proof of concept for a new form of PPE. The organization went above and beyond to trial a new form of PPE to determine its viability for further implementation at its other sites. This trial has successfully proven that the organization should further develop the wearable safety technology program and that future research is needed to continue the quantitative and qualitative correlation between this technology and injuries.

Qualitative Relationship to the Problem

The quantitative section provided an excellent statistical correlation between the problem statement and the research. The qualitative section of this research provides greater context and depth to the original correlation from the quantitative section. Antwi-Afari et al. (2019) illustrated that many technologies exist that improve an organization's occupational health and safety programs, which can result in lower workplace injuries. The qualitative section of this research proved that even though goal incongruence was determined during the implementation of the technology, the leadership and hourly workforce benefited from the use of the technology. Also, Schnittfeld and Busch (2016) found that organizational stakeholders demand a sustainable response to the changing health and safety challenges. This entire technology demonstration can now be directly proven as a sustainable response to the changing health and safety challenges. The quantitative section of this research proved statistical value in implementing the technology, while the qualitative section proved that both leadership and hourly employees perceived the value. Therefore, providing a sustainable response to ergonomic injuries.

Summary of Qualitative Findings

The previous section of this research study demonstrates significant value in future research using wearable safety technology. Organizations have elevated productivity above safety within the workplace (Cirjaliu & Draghici, 2016). However, employers are responsible for paying for the cost of these injuries and the downtime the employee experiences after an injury.

The qualitative section of this study proves a cohesive understanding of the behavior impact after implementing wearable safety technology within a finished vehicle logistics organization.

First, the researcher analyzed the data behind the interviews with leadership employees, including site-level leadership, senior leadership, and accountants. To the researcher's surprise, the leadership employees mainly focused on the financial and non-financial implications of the injuries, which was a goal incongruence with the hourly employees. For example, 64 of the 212 references were related to the financial impact of injuries on a site. Cirjaliu and Draghici (2016) illustrated that lean manufacturing forces organizations to push productivity to achieve the organization's goals, but this shift has led to ergonomic issues in the workplace. This literature reference is seen through the most dominant theme from the leadership participants

Then, the following dominant themes from the leadership interviews were the productivity and headcount implications behind the injuries. Leadership discussed productivity 51 and headcount 50 times. Like the previous theme, the leadership employees were more focused on the workload implications they must deal with when an injury happens, followed by the additional headcount impact that an injury has on a site. Combining the references of the financial impact, personal productivity, and site productivity (headcount) account for 76% of the comprehensive references in the interviews. Therefore, given the themes discovered from the leadership interviews, it can be determined that leadership has put profits and their workload above the safety and well-being of the hourly employees at the location.

Next, the researcher analyzed the data from the interviews conducted with the hourly employees. Surprisingly, the hourly employees were more focused on others and the collective change within the organization. Seventy-three of the ninety references used words like “we” or “us” to reference themselves and their fellow employees. For example, HE18 stated, "it seemed like we talked more about how to prevent injuries" (Hourly Interviews, 2022). After further scholastic research into this revelation, the researcher found that Robinson et al. (2018) identified this trait as the theory of organization identification, in which visible group dynamics are formed and create an in-group bias and out-group discrimination. However, many positive site-wide attributes were discussed during the interviews of hourly employees. First, the hourly employees found that communication was improved within the site. Also, overall safety was improved within the site. The hourly employees involved in this technology trial did benefit from the implementation and reduction of injuries. Instead, the employees did not focus on their experience with the trial, and most respondents focused on the organization's collective experience.

According to the International Organization for Standardization (2018), every 15 seconds a worker dies from a work-related injury or disease, and 153 experience a work-related injury. The growing trend within lean management and productivity instead of safety has led to this global crisis of workplace safety. To conclude, leadership within the organization is held to a different standard than the hourly employees of the site, and this goal incongruence was demonstrated through the qualitative section of this research. However, before a more significant impact on the organization can be seen, leadership and hourly employees must fix the goal incongruence that was demonstrated and has the same outcome in mind. The outcome of the qualitative section of this research has a positive potential for future advancement in wearable safety technology and its impact on safety and non-safety-related behaviors.

Convergence of Research Findings

The final step to fully understanding the previous mixed method research is a discussion of the convergence of the two methods using research triangulation. Gibson (2017) found that “triangulation allows scholars to document consistency in findings using different means of obtaining those findings, increasing our confidence that the findings are not driven by a particular method or data source” (p. 203). The researcher's first step to guaranteeing data validity and reliability was to analyze the two research methods separately. This separation can be seen in the previous information due to separating the sections, which is the order in which the researcher analyzed the data. Next, the triangulation protocol was used to develop a coding matrix that displays the findings that emerge from the two methods. This matrix and the protocol allowed the researcher to demonstrate the convergent parallel applications of this research between the qualitative and quantitative findings to answer all research questions. This can be seen in the upcoming tables. Finally, considerations are decided regarding agreement, partial agreement, silence, or dissonance between the qualitative and quantitative data findings.

Given the large amount of data that is present in the triangulation coding, a separate codebook and matrix were created for the outcome of each quantitative research question to relate that research question to the outcomes of the overall qualitative research questions. First, Table 45 demonstrates the legend used for the triangulation coding. In that table, a solid line represents an agreement, a dotted line represents a partial agreement, and no connection represents dissonance. The following sections will discuss each quantitative research question's outcomes and their triangulation to the qualitative research questions.

Convergence of RQ1a and RQ3a

Research question 1a asks, what are the organization’s historical injury frequency rates? Research question 3a asks, what are the organization’s injury frequency rates after implementing the wearable safety technology? The coding matrix for these triangulations can be seen in Tables 46 and 48, respectively. For both research questions, the quantitative outcome had four qualitative emergent themes that had an agreement. First, the theme of the leadership emergent theme of the financial impact of injuries. This agreement is because as the injury frequency fluctuates, the financials that the leader is responsible for will also fluctuate. As demonstrated in the qualitative research, leadership is highly concerned with the financial impact of injuries within the organization. Therefore, an agreement is made between these two research outcomes. Second, the theme of the leadership emergent theme of the productivity impact of injuries. This agreement is because as the injury frequency fluctuates, the leadership workload will also correspondingly fluctuate. Therefore, an agreement is made between these two research outcomes. The third is the emergent leadership theme of the headcount impact of injuries. This agreement is because as the injury frequency fluctuates, the additional training and headcount within the site will also correspondingly fluctuate. Therefore, an agreement is made between these two research outcomes. Fourth is the theme of the hourly emergent theme of the holistic impact of injuries. As the qualitative research shows, hourly employees are more concerned with the collective organization than themselves. This agreement is because as the injury frequency fluctuates, the response from the hourly employees will fluctuate. Therefore, an agreement is made between these two research outcomes.

Next, this quantitative outcome had two qualitative emergent themes with a partial agreement for both research questions. First, the theme of the leadership emergent theme of the morale impact of injuries. This partial agreement is because leadership was not as highly concerned with the morale at the site versus the financials. However, the morale will still fluctuate correspondingly with the injury frequency rate. Therefore, a partial agreement is made between these two research outcomes. Second, the theme of the leadership emergent theme of the safety impact of injuries. This partial agreement is because leadership was not as highly concerned with the site's overall safety versus the financials. However, the overall safety will still fluctuate correspondingly with the injury frequency rate. Therefore, a partial agreement is made between these two research outcomes.

Finally, for both research questions, the quantitative outcome had one qualitative emergent theme that had dissonance. That theme is the hourly emergent theme of the personal impact of injuries. The leadership interviews demonstrated that the personal impact of an injury on an employee was not considered. Therefore, the dissonance is made between these two research questions.

Convergence of RQ1b and RQ3b

Research question 1b asks, what are the organization's historical costs associated with ergonomic injuries? Research question 3b asks, what are the organization's injury costs associated with ergonomic injuries after implementing the wearable safety technology? The coding matrix for these triangulations can be seen in Tables 48 and 50, respectively. For both research questions, the quantitative outcome had one qualitative emergent theme that had agreement. The most emergent theme of the leadership interviews was the financial impact of injuries. This agreement is because as the costs associated with ergonomic injuries fluctuate, the financials that the leader is responsible for will also fluctuate. As demonstrated in the qualitative research, leadership is highly concerned with the financial impact of injuries within the organization. Therefore, an agreement is made between these two research outcomes.

Given that this question focuses on injury costs and not the frequency of injuries, a partial agreement was not found with any other qualitative outcomes. The remaining qualitative outcomes all represented dissonance between these two research questions. Yes, it can be stated that as injury costs rise, the injury frequency would also rise, which would allow for agreement, but that same agreement was covered in the last research question. Therefore, the dissonance is made between the remaining six research questions.

Convergence of RQ1c, RQ1d, and RQ3c

These three questions demonstrate the dissonance between qualitative and quantitative research. Research question 1c asks, what are the historical injury frequency rates for the U.S. warehousing and distribution sector? Research question 1d asks, how do the organization's historical injury rates compare to the warehousing and distribution industry's historical injury rate? Research question 3c asks, how do the organization's injury frequency rates compare to those within the warehousing and distribution sector after implementing the wearable safety technology? This research question was asked to gain further insight into how the organization performs against the associated industry. This information was used as a benchmark for the organization for future research comparisons. No table was made for the dissonance of this research question.

Summary of the Convergence of Research Findings

Seven quantitative research outcomes could potentially correlate to the seven qualitative research outcomes. Those correlations could have been either agreement, partial agreement, or dissonance. Given the previous information, 10 relationships had an agreement, two had a partial agreement, and 37 had dissonance. These findings further demonstrate the incongruence between the goals of the organization's leadership and the employees who perform blue-collar work within the sites. Leadership focuses more on lean management and financial outcomes, while hourly employees focus on their holistic group. Cirjaliu and Draghici (2016) illustrated that lean manufacturing forces organizations to push productivity to achieve the organization's goals, but this shift has led to ergonomic issues in the workplace. This reference is further demonstrated by the severe dissonance between this research's quantitative and qualitative outcomes.

However, this research does demonstrate a pathway to correcting this incongruence for the benefit of future research and the site. Robinson et al. (2018) demonstrated that organization identification is the in-group bias represented by the hourly employees and the out-group discrimination towards leadership. This is further recognized by Ross (1973), where agency theory seeks to minimize the goal-incongruence effect due to humans being self-interested individuals. The agency theory will apply in this research because the organization's and employees' goals must be aligned for a successful implementation. The outcome of the qualitative research has potential for future research that could potentially demonstrate that wearable safety technology can be used to lower incident rates and reduce costs associated with ergonomic injuries. However, qualitative research demonstrates that all parties associated with the research must have the same outcome. Yes, communication was improved during the trial period of this technology, but that communication was not enough to overcome the goal incongruence between the hourly and leadership employees. Nevertheless, this research gives an excellent pathway to further research on both subjects.

Application to Professional Practice

The previous research provides a powerful application to professional practice. Globally, the International Organization for Standardization (2018) stated that every 15 seconds a worker dies from a work-related injury or disease, and 153 experience a work-related injury. That translates into nearly 5,700 work-related fatalities and 374 million non-fatal injuries yearly. The only way to solve this growing organizational problem is to counteract the problem with new proactive measures, senior leadership support, and harnessing the power of new technologies to solve this crisis potentially. Following this research will give other supply chain organizations a pathway to proactively lower the number of their safety incidents.

Improving General Business Practices

The previous literature review detailed many different technologies that could be used to proactively lower accidents and injuries within supply chains. However, this research is one of the first trials of a wearable safety device that also informs the employee when performing their job function unsafely. The application of this specific research will be discussed in the next section. This section will focus on general business practices that can be improved from the outcome of this research.

First, the most significant general business practice that can be applied from this research is that organizations must try new proactive safety technologies to combat the lagging indicator of safety incidents. Pater (2017) also illustrated that a proactive approach to reducing ergonomic-related injuries is the best solution instead of organizations rehashing old habits. Many different safety technologies that can help proactively solve work-related injuries are demonstrated during the literature review of this research. Yes, tools such as after-action reports, root-cause analysis, and incident evaluations can give a business a better understanding of why an injury happened and how to keep it from happening. However, general business practices should be modified to proactively solve these injuries instead of reactively solving the lagging indicator.

Second, Cirjaliu and Draghici (2016) illustrated that lean manufacturing forces organizations to push productivity to achieve the organization's goals, but this shift has led to ergonomic issues in the workplace. This shift is evident through the findings of this research that the leadership of sites must value safety as equally as production and productivity. Yes, the measured organization has a lower incident frequency than the BLS benchmark. However, the

Wallenius Wilhelmsen (2022) safety policy states that all accidents and injuries are preventable. Schulman (2020) illustrated that safety would penetrate down to all employee-related job functions. To improve general business practices, organizations should use this research to understand that safety cannot be a second priority and that push for safety will penetrate all job functions. Ultimately, a more significant push for a safer work environment by leadership will translate into safer employees.

Third, Ross (1973) stated that agency theory seeks to minimize the goal-incongruence effect due to humans being self-interested individuals. This theory is proven applicable in this research because the organization's and employees' goals must be aligned for a successful implementation. This research demonstrated that leadership focused more on injuries' financial, headcount, and productivity impact. While via the organizational identification theory, the hourly employees participating in this research were more focused on the holistic group. Communication about safety was proved to improve during the demonstration of the technology, but a severe goal incongruence remained. Another general business practice that can be improved is that before setting out on a new journey, all parties must be on the same page and understand the desired outcome of the journey.

Finally, the last business practice to be improved from this research is that leadership of an organization must look at both the subjective and objective of all parties after the results of any business process are changed. Matos et al. (2020), these safety improvements will lead to a more significant overall health, safety, and operational performance. However, are those improvements considering the viewpoints of all employees affected by ergonomic injuries? This study proved fiscally viable for implementing the technology via the quantitative results. However, further examination of the qualitative results showed a large incongruence between the outcomes. Combining all the previous general business practices demonstrates to leadership that the outcome of a project is greater than the quantitative and financial results. Yes, injuries in Brunswick were lowered, but the goal incongruence of leadership and hourly employees was highly evident from this research. Therefore, that leads one to question the implementation's overall success when considering all participant's viewpoints.

Potential Application Strategies

Given all aspects of the previous research, the following is the researcher's viewpoint of a proposed application strategy that organizations can use to leverage the findings of this study. Like the previous research, this application strategy focused on implementing new technology into a supply chain and logistics organization. This application strategy focused on the four-step Plan Do Check Act (PDCA) cycle. Husby and Hamilton (2017) illustrated that this cycle is a four-step model for carrying out change. However, given that a circle has no end, this cycle is also endless.

The first step in the PDCA cycle is the plan. Organizations must come up with a solid plan for the implementation of any new process and technology. The researcher recommends that organizations must apply proper change management principles. Harrington (2018) proposed a strategy for change management that focuses on cultural and project change management. As the previous section recommends, this change management process considers the cultural aspect, such as the individual organization's beliefs, behaviors, and assumptions. Also, the project change management aspect considers the organization's viewpoints to successfully implement the application with minimal impact on the organization's social, organizational, or process aspects. Therefore, the first step to implementing new technology within a supply chain and logistics organization is to apply proper change management strategies beforehand.

The next step of the application strategy is the do, which can only be achieved by having all implementation members highly involved with the day-to-day implementation. One of the reasons the quantitative results were successful with the project is that both the researcher and the site-level leadership had a vested interest in the project's outcome. McLoughlin and Miura (2017) explained that the only way to truly understand your organization's ongoings is to be present within the organization's inner workings. This project would not have been successful without proper shopfloor management techniques and presence on the shop floor. All parties involved in this project were there to help the employees with any difficulties with the technology, training, communication, and overall success of the technology trial.

The next step of the application strategy is to check the results, and it is recommended that organizations use a mixed method implementation process that considers both the quantitative and qualitative perspectives. Lukenchuk (2017) illustrated that mixed method designs have superiority over single-method research. Therefore, the project management team must adequately set up the quantitative and qualitative research behind this implementation for future technology implementations within supply chains. This research demonstrates that although the quantitative outcome may be statistically significant, the qualitative outcome may have higher than expected dissonance from the anticipated results. Therefore, all statistical viewpoints must be considered for a successful implementation of new technology or process within a supply chain and logistics organization.

Finally, the last step of the PDCA cycle is to act upon the results. In this instance, the researcher started with a proof of concept with 50 devices across two sites in the United States. The results have proven viable for further implementation only if the qualitative section's results are considered. The researcher will present the results from this research study to senior leadership to get approval for the implementation of wearable safety technology to be broadened. However, the quantitative results will prove lessons learned for the researcher for future implementations. Similarly, other supply chain and logistics organizations that follow this application strategy should do the same. Once all the application results are summarized, those organizations should act upon the results.

Summary of the Application to Professional Practice

The previous research demonstrates the use of wearable safety technology to potentially lower the impact of ergonomic injuries on an organization's injury frequencies and costs. The previous section demonstrated how an organization could apply this research to improve general business practices and an application strategy for implementing any new technology in their business. Organizations must remember that, according to the International Organization for Standardization (2018) stated that every 15 seconds a worker dies from a work-related injury or disease. This proactive approach to improving the lagging indicator of safety incidents can help organizations improve their overall safety.

Recommendations for Further Study

The previous section details recommendations by the researcher for improving general business practices and potential application strategies based on this research. Building on those sections, the researcher will now demonstrate recommendations for further areas that should be studied based on this study's findings.

Other Supply Chain and Logistics Organizations

The previous study applies to numerous areas within the supply chain and logistics realm but focused singularly on a fished vehicle logistics organization. Koh et al. (2019) demonstrated that new technology could help supply chains ensure process safety and promote social sustainability. In this section, the researcher will demonstrate several different realms of the supply chain and logistics world that could benefit from this study.

The previous research compared the finished vehicle logistics organization against the BLS benchmark of the transportation and warehousing industry. This industry is classified by the NAICS codes 48-49. According to the U.S. Bureau of Labor and Statistics (2020), that industry had 4.4 recordable injuries per 100 full-time employees in 2020. The following are several other areas of the supply chain and logistics management realm, along with their NAICS code and recordable injuries per 100 full-time employees, to which the researcher recommends further implementation of this research.

Manufacturing. Schwerha et al. (2020) illustrated that ergonomics must be introduced into lean manufacturing facilities to reduce injuries and improve effectiveness. Upon further research of the data from the U.S. Bureau of Labor and Statistics (2020), many different areas of the manufacturing realm seem prone to recordable injuries and would benefit from the previous research. The following are several examples of those manufacturing sectors. Food manufacturing, identified as NAICS code 311, had 5.1 recordable injuries per 100 full-time. Animal slaughtering and processing, identified as NAICS code 31161, had 6.7 recordable injuries per 100 full-time. Wood product manufacturing, identified as NAICS code 321, had 4.7 recordable injuries per 100 full-time. Ferrous metal foundries, identified as NAICS code 31151, had 6.4 recordable injuries per 100 full-time.

Like the finished vehicle logistics industry, these manufacturing industries rely heavily on manual blue-collar labor that is prone to ergonomic injuries within the workplace. The lessons learned and the outcome of this research can be applied to the manufacturing world to help those organizations lower the number of work-related injuries by proactively introducing new technology.

Logistics. Another recommended area of focus is that further logistics sector research uses this to benefit their organizations. Oakman et al. (2016) found that work-related ergonomic injuries are prevalent in all age groups within the supply chain and logistics industries. Upon further research of the data from the U.S. Bureau of Labor and Statistics (2020), many different areas of the logistics realm seem prone to recordable injuries and would benefit from the previous research. The following are several examples of those logistics sectors. Household and office goods moving, identified as NAICS code 48421, had 4.7 recordable injuries per 100 full-time. Urban transit systems, identified as NAICS code 4851, had 6.1 recordable injuries per 100 full-time. Couriers and messengers, identified as NAICS code 492, had 6.8 recordable injuries per 100 full-time.

Like the previous recommendation, logistics organizations are prone to work-related injuries due to the manual labor involved. These organizations can also benefit significantly from the previous research by applying proactive technology within their organizations.

Correlation Between Theories

One of the surprising findings from this research was the correlation between agency theory and the theory of organizational identification. Ross (1973) stated that agency theory seeks to minimize the goal-incongruence effect due to humans being self-interested individuals. Robinson et al. (2018) identified this trait as the theory of organization identification, in which visible group dynamics are formed and create an in-group bias and out-group discrimination. The in-group biases create a feeling of connectedness and belonging to the organization.

Based on the findings of this research, it is recommended that further study should look at the correlation between these theories. In this research, agency theory was identified early as one of the research theories that would support the framework of this research. In this instance, agency theory was identified as the goal incongruence between the goals of the leadership employees, which was seen as improving the financials of their site, with the goals of the hourly employees, which was seen as improving the holistic well-being of all employees within the site. The discovery of the holistic viewpoint of the hourly employees led the researcher to discover the theory of organizational identification and its application to this research. For this research, both theories were in direct correlation with each other. However, it is recommended for further research to demonstrate if these theories will always be in direct correlation with each other. The correlation outcome could help organizations better identify how to properly implement change management practices, using both theories to reduce the possibility of goal incongruence.

Reflections

The previous research has demonstrated how wearable safety technology can be used to benefit not only a fished vehicle logistics organization but also other supply chain and logistics organizations in the future. The basis of this research is that trialing a new technology can be beneficial through proactive safety measures versus organizations rehashing old habits and not making any progress. Similarly, through this research, the researcher has also grown through proactive steps in their education: the following documents the researcher's personal and professional growth and a biblical perspective of Christian integration.

Personal and Professional Growth

One of the first assignments that Liberty University assigns to doctoral candidates is to research doctoral persistence. Rockinson-Szapkiw (2019) illustrated that doctoral persistence plagues higher education institutions due to the student's need for a growth mindset and the influence of persistence. The researcher did not understand the implications of this research until starting on the dissertation journey of this doctoral program. After completing the previous 200-plus pages of research, the researcher understands why students do not complete their doctoral journey and the persistence needed to complete this journey successfully.

First, the researcher fully understands that this journey cannot be completed alone. One must rely heavily on the people influencing their lives positively to complete this journey successfully. Late nights, extended weekends, and lots of typing are involved in this journey, and it would not be possible unless the students have a good support structure to continue to push that student's drive to finish. Also, the researcher fully understands that one must be selfish to complete the doctoral journey successfully. Yes, selfish is a word with negative connotations, but in this example, the researcher means telling others that he or she cannot participate in extracurricular activities because the student has to focus on completing tasks due each weekend. However, this can be extra difficult when entering the dissertation phase of this journey, which does not have assignments due each weekend. The student has to understand that this selfishness is for the future betterment of themselves and their family, and those moments for extracurriculars will come around again.

Finally, the researcher has had much professional growth during this doctoral journey. First, during the doctoral journey, the researcher was promoted to a senior-level position within the organization. The successful completion of an MBA and the doctoral journey allowed the researcher the insight and knowledge needed for this promotion. Second, the researcher could also take all the insights gained from the courses and dissertations of this doctoral journey and apply those to their new position. However, the insights gained from this research have given the researcher a better insight into solving work-related ergonomic injuries. Also, the research has given a better insight into solving the goal incongruence from agency theory, the theory of organizational identification, and how to use change management to achieve future technology implementations properly.

Biblical Perspective

Many different business functions were explored in this research, and all can benefit from a biblical perspective of how to integrate them with the Christian worldview. Keller and Alsdorf (2014) stated that the word vocation comes from the Latin word vocare, which means to call. First, all leaders of an organization must remember that their profession is a calling and not just work. The Bible reminds managers that they must

> walk in a manner worthy of the calling to which you have been called, with all humility and gentleness, with patience, bearing with one another in love, eager to maintain the unity of the Spirit in the bond of peace. (Ephesians 4:1-2, Today's New International Version)

The way to serve God as a leader within an organization is through the gospel and the use of morals as a compass. In this research, it was demonstrated that there was a significant goal incongruence between the leadership and hourly employees located within the site. However, the site's leadership can learn from the previous passage to view their role as a calling instead of just a job.

Also, the Bible explains that as employers, we are to treat our workers fairly and that "Masters, do the same to them, and stop your threatening, knowing that he who is both their Master and yours is in heaven and that there is no partiality with him" (Ephesians 6:9). If the previous researcher demonstrated that leadership was more prone to work-related injuries than the hourly employees, there would be a higher calling for safety within the workplace. However, this research demonstrated that injuries are expected within the workplace. The previous passage tells one that this is unacceptable, and that leadership must be more proactive in solving the crisis of work-related injuries within supply chains. Christian leaders to not be ashamed of doing the right thing. The Bible tells these leaders to “do your best to present yourself to God as one approved, a worker who does not need to be ashamed and who correctly handles the word of truth” (2 Timothy 2:15). Christian leaders are to walk in the way of God and follow the scripture in our daily lives. When presented with these circumstances, Christian leaders should follow the gospel and do the right thing.

Then, through this research, it can be demonstrated that the pragmatic worldview is beneficial to leadership within supply chain organizations. The Bible tells us to “test everything; hold fast what is good” (1 Thessalonians 5:21). Leadership that aligns with the pragmatic view will align closely with the Christian worldview. These leaders must take everything for face value and what works for each person and cannot have a one-size-fits-all approach to leadership. However, for those managers to connect with their employees, they must lead by example. Boardman (2004) stated that “getting managers out of their corporate offices was promoted as a leadership style intended for managers to connect with, communicate with, and relate to all levels of employees” (p. 48). Similarly, the Bible reminds leaders that God is “the way, the truth, and the life. No one comes to the Father except through me” (John 14:6). Leadership should never forget that carrying the Christian worldview is a representation of their leadership style and interactions with their employees. A leader must be present on the floor representing the organization and the Christian worldview.

Finally, it was demonstrated through this leadership that a proactive approach is the best approach to solving any crisis, mainly one dealing with employee safety and ergonomics. Leadership must never forget that the Bible guides by stating, “fight the good fight of the faith. Take hold of the eternal life to which you were called when you made your good confession in the presence of many witnesses” (1 Timothy 6:12). Leadership must take on all of the challenges that come to them with the Christian worldview in mind.

Summary of the Reflections

The previous section documents how this research can be continued to allow for further research into wearable safety technology within the supply chain and logistics realm. Koh et al. (2019) demonstrated that new technology could help supply chains ensure process safety and promote social sustainability. The most significant reflection from this section is that organizations must use a proactive approach to solving the lagging indicator of work-related injuries. Several areas of the supply chain and logistics world were illustrated that could benefit from implementing safety technology. Also, the researcher has demonstrated the need for further research between agency theory and organizational identification theory. Then, the researcher demonstrated personal and professional growth during this research. Doctoral persistence was tested during this research, but the research was able to overcome the trials and tribulations to complete this research successfully. Finally, a biblical perspective was brought into this research to demonstrate how the Christian worldview can be applied to this research.

Summary of Section 3

According to the International Organization for Standardization (2018), every 15 seconds, a worker dies from a work-related injury or disease, and 153 experience a work-related injury. The final section of this research demonstrates the implementation, research, and analysis behind wearable safety technology at two finished vehicle logistics facilities in the United States, which could potentially combat the growing crisis of ergonomic injuries within supply chain organizations. Those technologies were implemented in Brunswick, Georgia, and Carlisle, Pennsylvania. The technology was worn by hourly employees performing various blue-collar jobs within the supply chain world of finished vehicle logistics. The quantitative section of the results focused on the data from implementing these devices compared to the benchmark of the BLS and against other sites. Statistical significance was demonstrated for some of the studies, while the portion that did not prove statistically significant was subjectively demonstrated to improve safety while lowering injury frequency and the cost of those injuries. The outcome of the quantitative research has provided significant value to future research into wearable safety technology.

Next, the qualitative research focused on the subjective viewpoints of two groups of employees. First, the leadership employees are comprised of site-level leadership, senior leadership, and accountants. Second, the hourly employees who wore the wearable technology at the two sites implemented in the United States. The researcher performed a round of in-person semi-structured interviews to gather these viewpoints and combine them into higher and lower levels themes. The leadership employees mainly focused on the financial and non-financial implications of the injuries, which was a goal incongruence with the hourly employees. Combining the references of the financial impact, personal productivity, and site productivity (headcount) account for 76% of the comprehensive references in the interviews. However, the hourly employees were more focused on others and the collective change within the organization. Seventy-three of the ninety references used words like “we” or “us” to reference themselves and their fellow employees.

Then, the researcher triangulated the previous sections to find any agreement between the quantitative and qualitative research. The outcome of this triangulation was that 10 relationships had an agreement, two had a partial agreement, and 37 had dissonance. However, this research does demonstrate a pathway to correcting this incongruence for the benefit of future research and the site. Robinson et al. (2018) demonstrated that organization identification is the in-group bias represented by the hourly employees and the out-group discrimination towards leadership. Leadership focuses more on lean management and financial outcomes, while hourly employees focus on the safety and well-being of their holistic group. This is further recognized by Ross (1973), where agency theory seeks to minimize the goal-incongruence effect due to humans being self-interested individuals. The agency theory will apply in this research because the organization's and employees' goals must be aligned for a successful implementation.

Finally, the researcher demonstrated how this researcher could be applied to other applications, recommendations for further study, reflections, and the biblical perspective of this research. This research could be applied to many other industries, especially within the supply chain and logistics realm. The researcher gave a high-level overview of how an organization could apply this research to improve general business practices and an application strategy for implementing new technology in their business. Also, several industries were given that could be potential candidates for future research into implementing wearable safety technology. While reflecting on this research, doctoral persistence was essential during this journey. This dissertation journey provided many highs and lows, along with several stumbles. However, the doctoral persistence that the researcher showed has allowed for the successful completion of this journey. Finally, a biblical perspective was given to allow readers to correlate this research with the Christian worldview.

Overall, this section has demonstrated how wearable safety technology could potentially be applicable for many industries to lower work-related ergonomic injuries, especially within the supply chain and logistics sectors. However, solely implementing the technology will not solve this crisis. Leaders within the organizations must prioritize safety while communicating the organization's goals with the employees to lower the goal-incongruence. Finally, those leaders must remember that t the Bible explains that as employers, we are to treat our workers fairly and that “Masters, do the same to them, and stop your threatening, knowing that he who is both their Master and yours is in heaven and that there is no partiality with him” (Ephesians 6:9). Following this research will give other researcher and organizations great insight into potentially reducing these injuries, while also demonstrating how to provide safer workspaces that follow the Christian worldview potentially.

Conclusion

As Christian leaders, it is one’s duty to provide the safest workspace possible for employees. Also, according to the U.S. Department of Labor (n.d.-b), within the general duty guidelines of OSHA, every employer shall provide a place of employment free of recognized hazards that are likely to cause physical harm or death to their employees. Commonly, organizations take reactive steps to solve the lagging indicator of injuries. Modern times call for a more proactive approach to solving this crisis, demonstrated by Pater (2017), who stated that a proactive approach to reducing ergonomic-related injuries is the best solution instead of organizations rehashing old habits. Therefore, this research demonstrated wearable safety technology within a finished vehicle logistics organization to provide a proactive way to combat work-related injuries.

The mixed method approach, focusing on convergent parallel research, allowed the researcher to examine this problem from qualitative and quantitative aspects. McKim (2017) found that "mixed methods added value by increasing validity in the findings, informing the collection of the second data source, and assisting with knowledge creation" (p. 203). This approach allowed the researcher to potentially solve this problem from both the quantitative and qualitative aspects. The quantitative research examined wearable safety technology's implementation to the injury frequency. At the same time, the qualitative research examined the two research questions that seek to learn the organization's subjective impacts after implementing the safety technology.

The outcome of this research has demonstrated several items for further research. First, wearable safety technology did have a statistically significant correlation to a reduction in injuries at one of the sites in Brunswick, Georgia. This information can examine future applications of similar technologies to allow for continued research. Also, the wearable safety technology did demonstrate a subjective reduction in injuries and costs, as benchmarked against the BLS. However, not enough data were available to prove statistical significance. This information can also be used for future research into the proactive use of wearable safety technology. Finally, this research demonstrated a severe goal incongruence between the qualitative outcomes between the hourly and leadership employees. This incongruence was summarized by Robinson et al. (2018) as the theory of organization identification, in which visible group dynamics are formed and create an in-group bias and out-group discrimination. Further research is needed on the pre-implementation strategies of organizations when different groups within the organization have incongruent expectations of the outcome.

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Appendices

Appendix A: Interview Guide 1

Semi-Structured Interview Guide 1

Implementation of wearable safety technology to potentially lower work-related injuries

Question 1:

Given your role within the organization, how do work-related injuries impact your day-to-day activities?

Question 2:

How would reducing the number of workplace injuries impact your job function?

Question 3:

How would a rise in the number of workplace injuries impact your job function?

Question 4:

How do work-related injuries impact the local organization?

Question 5:

How do work-related injuries impact the global organization?

Interview Guide 1. For all participants, this interview guide answered all questions related to RQ2: Qualitative Research Question: What are the impacts of the injury frequency rate on the organization?

Appendix B: Interview Guide 2

Semi-Structured Interview Guide 2

Implementation of wearable safety technology to potentially lower work-related injuries

Question 1:

Given your role within the organization, have you observed any changes within the organization after the wearable safety technology was implemented?

Question 2:

How would you describe the impact of the wearable safety technology within the organization?

Question 3:

Other than injury frequency, have you observed any other behavioral impacts within the organization since the wearable safety technology was implemented?

Interview Guide 2. For all participants, this interview guide answered all questions related to RQ4: Qualitative Research Question: What other behavioral changes can be observed positively influencing reducing injury frequency after implementing the wearable safety technology?

Appendix C: DMP for Existing Data

1	[Enter Name of Existing Collection]
Description:	Describe the information that will be used, including its characteristics, temporal scope and scale, and geographic scope and scale, when available.
Source:	Identify the source for the data; include a link and digital object identifier (DOI) if available.
Restrictions:	Identify any limitations on access or reuse (e.g., sensitive data, restricted data, software with license restrictions, etc.) and provide justification for restriction. Provide citation or documentation describing limitations if due to policies or legal reasons.
Format:	Identify the formats in which the data are maintained and made available.
Fees:	Identify any fees associated with acquiring the data.
Quality Checks:	Identify the procedural steps used to evaluate the existing data, including verification, validation, and an assessment of usability.
Data Processing & Scientific Workflows:	Describe any data processing steps or provide a scientific workflow you plan to use to manipulate the data, as appropriate.
Backup & Storage:	Describe the approach for backup and storage of the information associated with the research project during the project.
Volume Estimate:	Estimate the volume of information that will be generated: megabyte (MB), GB, TB, or PB.
Citation:	Provide citation for data product. If the data product can be found online, provide a URL.

DMP for Existing Data. This DMP is applied to all existing data.

Appendix D: IRB Approval

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

June 6, 2022

Andrew Prior
Scott Dickenson

Re: IRB Exemption - IRB-FY21-22-973 Ergonomic Safety in Supply Chains

Dear Andrew Prior, Scott Dickenson,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(iii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by §46.111(a)(7).

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,
G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

Appendix E: DMP for New Data

1	**[Provide a brief name to describe new data collection]**
Description:	Describe the information that will be collected, including its characteristics, temporal scope and scale, and geographic scope and scale, when available.
Data Management Resources:	Describe the proposal resources allocated for data management activities for the new data collected as a level of effort, total dollars allocated, or as a percentage of the total project's cost. Resources could include people's time or proposal funding.
Exclusive Use:	Project data and associated products should be available publicly at the end of the project. If a request to limit access for a period of time after project completion is needed, please identify the length of time and the reason for the extension. (Request cannot be more than one year.)
Restrictions:	Identify any limitations on access or reuse (e.g., threatened or endangered species, tribal or indigenous data, sensitive data, restricted data, software with license restrictions, etc.) and provide justification for restriction. Describe any Memoranda of Understanding/Agreements (MOU/A), if relevant. Provide citation or documentation describing limitations if due to policies or legal reasons (such as IRB approval restrictions). Consider the CARE Principles for Indigenous Data Governance in deliberation over tribal or indigenous data sensitivities.
Format:	Identify the formats/file type in which the data will be generated, maintained, and made available. Data format must be non-proprietary. Data must be in accordance with the FAIR Guiding Principles for scientific data management and stewardship.
Protocols:	Identify any standard protocols or methodologies that will be used to collect the data, if available.
Quality Checks:	Identify the procedural steps for ensuring data quality.
Data Processing & Scientific Workflows:	Describe data processing steps or provide a scientific workflow you plan to use to manipulate the data, as appropriate.
Metadata:	Identify the metadata standard that will be used to describe the document (FGDC CSDGM or ISO must be used)
Volume Estimate:	Estimate the volume of information generated: megabyte (MB), GB, TB, or PB.
Backup & Storage:	Describe the approach for backup and storage of the information associated with the research project to be used during the project.
Repository for Data:	In addition to identifying the CASC repository (ScienceBase), identify any other repositories where you plan to share your data. Indicate if data will be integrated into an existing collection or offered as a new collection.

DMP for New Data. This DMP is applied to all new data.

Table 1

Incidents Categorized by Accident Source.

Accident Source	Number of Injuries	Total Cost of Injuries	Average Cost of Injuries
Bodily Reaction	20	$ 279,729.17	$ 13,986.46
Burn	8	$ 8,738.43	$ 1,092.30
Continual Noise	13	$ 367,072.69	$ 28,236.36
Laceration	32	$ 22,125.42	$ 691.42
Pinch or Crush	20	$ 37,489.19	$ 1,874.46
Repetitive Motion	165	$ 3,326,760.37	$ 20,162.18
Slip, Trip, or Fall	157	$ 4,790,872.31	$ 30,515.11
Struck by object	133	$ 899,161.81	$ 6,760.62
Vehicle Accident	51	$ 3,921,082.77	$ 76,883.98
Total	599	$ 13,653,032.16	$ 22,793.04

This table shows all injuries at the finished vehicle logistics organization incurred workers' compensation claims between 2018 and 2020, as demonstrated by Wallenius Wilhelmsen (2022).

Table 2

Pre-implementation Number of Hours and Recordable Injuries.

	United States Total					
	Year	Direct	Indirect	Total Hours	Recordable Injuries	Incident Rate
	2018	4,587,467	409,600	4,997,067	112	4.48
	2019	3,380,019	337,012	3,717,031	96	5.17
	2020	3,729,516	455,937	4,185,453	63	3.01
Jan - May	2021	1,692,234	210,979	1,903,213	30	3.15
	Total	13,389,236	1,413,528	14,802,764	301	4.07
	Brunswick, Georgia					
	Year	Direct	Indirect	Total Hours	Recordable Injuries	Incident Rate
	2018	208,879	23,040	231,919	6	5.17
	2019	129,028	17,163	146,191	5	6.84
	2020	115,645	16,816	132,461	2	3.02
Jan - May	2021	52,103	9,535	61,638	1	3.24
	Total	505,655	66,554	572,209	14	4.89
	Carlisle, Pennsylvania					
	Year	Direct	Indirect	Total Hours	Recordable Injuries	Incident Rate
	2019	50,234	21,824	72,058	7	19.43
	2020	48,384	18,720	67,104	5	14.90
Jan - May	2021	16,681	8,668	25,349	4	31.56
	Total	115,299	49,212	164,511	16	19.45

This table demonstrates all hours worked and recordable injuries within the United States from January 2018 to May 2021, as demonstrated by Wallenius Wilhelmsen (2022).

Table 3

2018 Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	17	$9.80	$431,743.74	$510,455.25	$30,026.7794
Valid N (listwise)	17				

This table demonstrates all worker's compensation claims for the United States in 2018, as demonstrated by Wallenius Wilhelmsen (2022).

Table 4

2018 Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	5	$9.80	$907.81	$2,158.49	$431.6980
Valid N (listwise)	5				

This table demonstrates all worker's compensation claims for Carlisle, Pennsylvania, in 2018, as demonstrated by Wallenius Wilhelmsen (2022).

Table 5

2019 Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	56	$10.15	$161,572.60	$1104489.67	$19,723.0298
Valid N (listwise)	56				

This table demonstrates all worker's compensation claims for the United States in 2019, as demonstrated by Wallenius Wilhelmsen (2022).

Table 6

2019 Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	2	$242.73	$4,827.13	$5,069.86	$2,534.9300
Valid N (listwise)	2				

This table demonstrates all worker's compensation claims for Brunswick, Georgia, in 2019, as demonstrated by Wallenius Wilhelmsen (2022).

Table 7

2019 Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean
Amount	3	$193.89	$10,421.55	$11,487.38	$3,829.1267
Valid N (listwise)	3				

This table demonstrates all worker's compensation claims for Carlisle, Pennsylvania, in 2019, as demonstrated by Wallenius Wilhelmsen (2022).

Table 8

2020 Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean
Amount	30	$10.50	$209,327.20	$549,279.83	$18,309.3277
Valid N (listwise)	30				

This table demonstrates all worker's compensation claims for the United States in 2020, as demonstrated by Wallenius Wilhelmsen (2022).

Table 9

2020 Ergonomic Injuries Resulted in a Worker's Compensation Ergonomic Injuries.

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean
Amount	2	$10.50	$10.50	$21.00	$10.5000
Valid N (listwise)	2				

This table demonstrates all worker's compensation claims for Carlisle, Pennsylvania, in 2020, as demonstrated by Wallenius Wilhelmsen (2022).

Table 10

January to May 2021, Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	12	$115.55	$8,832.76	$20,116.33	$1,676.3608
Valid N (listwise)	12				

This table demonstrates all worker's compensation claims for the United States in 2021 from January to May, as demonstrated by Wallenius Wilhelmsen (2022).

Table 11

January to May 2021, Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	2	$243.98	$244.72	$488.70	$244.3500
Valid N (listwise)	2				

This table demonstrates all worker's compensation claims for Brunswick, Georgia, in 2021 from January to May, as demonstrated by Wallenius Wilhelmsen (2022).

Table 12

January to May 2021, Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	2	$197.32	$6,829.88	$7,027.20	$3,513.6000
Valid N (listwise)	2				

This table demonstrates all worker's compensation claims for Carlisle, Pennsylvania, in 2021 from January to May, as demonstrated by Wallenius Wilhelmsen (2022).

Table 13

All Historical Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean
Amount	115	$9.80	$431,743.74	$2184341.08	$18,994.2703
Valid N (listwise)	115				

This table demonstrates all worker's compensation claims for the United States from January 2018 to May 2021, as demonstrated by Wallenius Wilhelmsen (2022).

Table 14

Brunswick's Historical Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean
Amount	4	$242.73	$4,827.13	$5,558.56	$1,389.6400
Valid N (listwise)	4				

This table demonstrates all worker's compensation claims for Brunswick, Georgia, from January 2018 to May 2021, as demonstrated by Wallenius Wilhelmsen (2022).

Table 15

Carlisle's Historical Ergonomic Injuries Resulted in a Worker's Compensation Claim.

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean
Amount	12	$9.80	$10,421.55	$20,694.07	$1,724.5058
Valid N (listwise)	12				

This table demonstrates all worker's compensation claims for Carlisle, Pennsylvania, from January 2018 to May 2021, as demonstrated by Wallenius Wilhelmsen (2022).

Table 16

2018 Injury Frequency Rates for the U.S. Transportation and Warehousing Sector.

Industry[2]	NAICS code[3]	Total recordable cases	Cases with days away from work, job restriction, or transfer			Other recordable cases
			Total	Cases with days away from work[4]	Cases with days of job transfer or restriction	
Transportation and warehousing[9]	48-49	4.5	3.3	2.1	1.2	1.2

This table demonstrates the injury frequency rate for all recordable injuries in the U.S. transportation and warehousing sector, demonstrated by the U.S. Bureau of Labor Statistics. (2018-a).

Table 17

2018 Number of Cases for the U.S. Transportation and Warehousing Sector.

Industry[1]	NAICS code[2]	Total recordable cases	Cases with days away from work, job restriction, or transfer			Other recordable cases
			Total	Cases with days away from work[3]	Cases with days of job transfer or restriction	
Transportation and warehousing[9]	48-49	221.4	164.1	103.6	60.5	57.3

This table demonstrates the number of cases for all recordable injuries in the U.S. transportation and warehousing sector, demonstrated by the U.S. Bureau of Labor Statistics. (2018-b).

Table 18

2019 Injury Frequency Rates for the U.S. Transportation and Warehousing Sector.

Industry[2]	NAICS code[3]	Total recordable cases	Cases with days away from work, job restriction, or transfer			Other recordable cases
			Total	Cases with days away from work[4]	Cases with days of job transfer or restriction	
Transportation and warehousing[10]	48-49	4.4	3.2	2.0	1.2	1.2

This table demonstrates the injury frequency rate for all recordable injuries in the U.S. transportation and warehousing sector, demonstrated by the U.S. Bureau of Labor Statistics. (2019-a).

Table 19

2019 Number of Cases for the U.S. Transportation and Warehousing Sector.

Industry[1]	NAICS code[2]	Total recordable cases	Cases with days away from work, job restriction, or transfer			Other recordable cases
			Total	Cases with days away from work[3]	Cases with days of job transfer or restriction	
Transportation and warehousing[10]	48-49	227.9	166.2	103.6	62.6	61.7

This table demonstrates the number of cases for all recordable injuries in the U.S. transportation and warehousing sector, demonstrated by the U.S. Bureau of Labor Statistics. (2019-b).

Table 20

2020 Injury Frequency Rates for the U.S. Transportation and Warehousing Sector.

Industry[2]	NAICS code[3]	Total recordable cases	Cases with days away from work, job restriction, or transfer			Other recordable cases
			Total	Cases with days away from work[4]	Cases with days of job transfer or restriction	
Transportation and warehousing[10]	48-49	4	3	1.9	1.1	1

This table demonstrates the injury frequency rate for all recordable injuries in the U.S. transportation and warehousing sector, demonstrated by the U.S. Bureau of Labor Statistics. (2020-a).

Table 21

2020 Number of Cases for the U.S. Transportation and Warehousing Sector.

Industry[1]	NAICS code[2]	Total recordable cases	Cases with days away from work, job restriction, or transfer			Other recordable cases
			Total	Cases with days away from work[3]	Cases with days of job transfer or restriction	
Transportation and warehousing[10]	48-49	206.9	156.8	99.8	57	50.1

This table demonstrates the number of cases for all recordable injuries in the U.S. transportation and warehousing sector, demonstrated by the U.S. Bureau of Labor Statistics. (2020-b).

Table 22

2018-2020 Number of Cases and Injuries Frequency for the U.S. Transportation and Warehousing Sector.

Year	Type	Total recordable cases	Total	Cases with days away from work	Cases with days of job transfer or restriction	Other recordable cases
2020	Incident Rates	4	3	1.9	1.1	1
2020	Number	206,900	156,800	99,800	57,000	50,100
2020	Hours	10,345,000,000	10,453,333,333	10,505,263,158	10,363,636,364	10,020,000,000
2019	Incident Rates	4.4	3.2	2.0	1.2	1.2
2019	Number	227,900	166,200	103,600	62,600	61,700
2019	Hours	10,359,090,909	10,387,500,000	10,360,000,000	10,433,333,333	10,283,333,333
2018	Incident Rates	4.5	3.3	2.1	1.2	1.2
2018	Number	221,400	164,100	103,600	60,500	57,300
2018	Hours	9,840,000,000	9,945,454,545	9,866,666,667	10,083,333,333	9,550,000,000
Total	Incident Rates	4.30	3.16	2.00	1.17	1.13
Total	Number	656,200	487,100	307,000	180,100	169,100
Total	Hours	30,544,090,909	30,786,287,879	30,731,929,825	30,880,303,030	29,853,333,333

This table demonstrates the number of cases for all recordable injuries and injury frequency in the U.S. transportation and warehousing sector, demonstrated by the U.S. Bureau of Labor Statistics. (2018-a; 2018-b; 2019-a; 2019-b; 2020-a; 2020-b).

Table 23

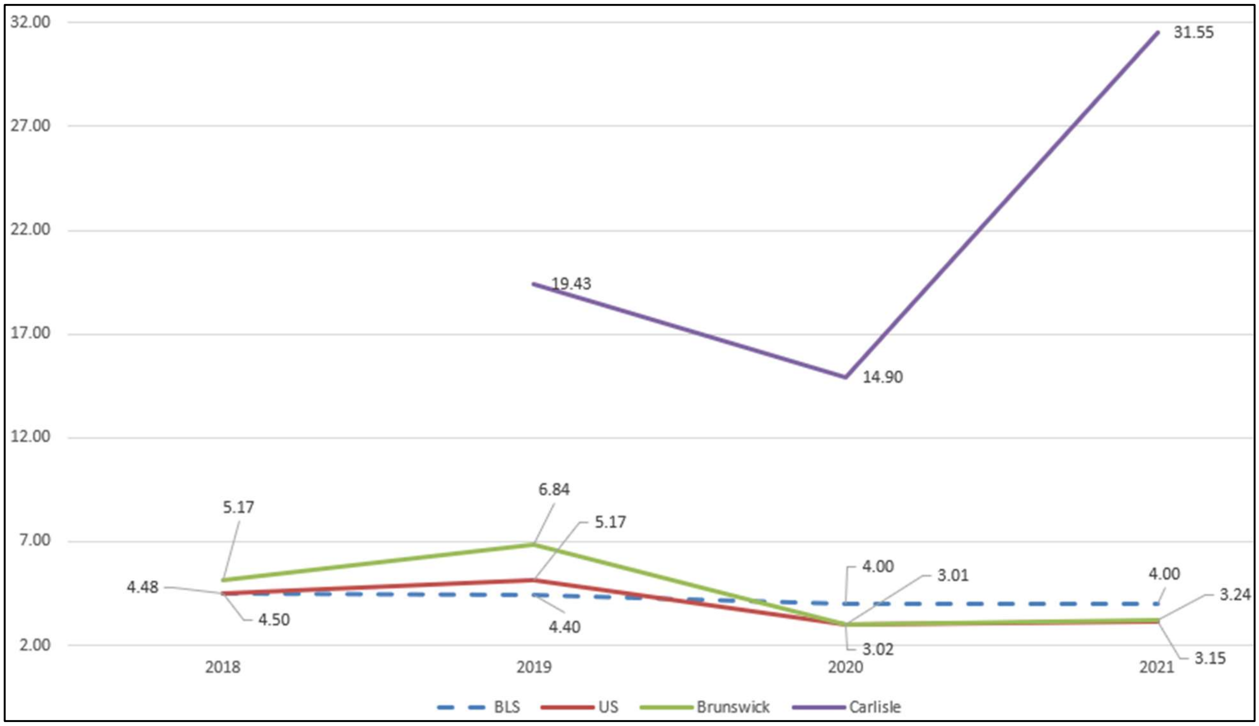
2018-May 2021 Comparison of Injury Frequency Rate.

		Incident Rates			
		BLS	US	Brunswick	Carlisle
Year	2018	4.50	4.48	5.17	
	2019	4.40	5.17	6.84	19.43
	2020	4.00	3.01	3.02	14.90
	2021	4.00	3.15	3.24	31.55

This table compares the injury frequency rate between the BLS data and the Wallenius data, demonstrated by the U.S. Bureau of Labor Statistics. (2018-a; 2018-b; 2019-a; 2019-b; 2020-a; 2020-b) and Wallenius Wilhelmsen (2022).

Table 24

2018-2020 Visual Representation of Table 23.



This graph demonstrates a visual representation of Table 23, which demonstrates the injury frequency rate between the BLS data and the Wallenius data, as demonstrated by the U.S. Bureau of Labor Statistics. (2018-a; 2018-b; 2019-a; 2019-b; 2020-a; 2020-b) and Wallenius Wilhelmsen (2022).

Table 25

2018-2020 January 2018 to May 2021 Cost of Ergonomic Injuries Resulted in a Worker's Compensation Claim.

		Average Injury Cost		
		US	Brunswick	Carlisle
Year	2018	$ 30,026.78	$ -	$ 431.70
	2019	$ 19,723.03	$ 2,534.93	$ 3,829.13
	2020	$ 18,309.33	$ -	$ 10.50
	2021	$ 1,676.36	$ 244.35	$ 3,513.60
	Average	$ 18,994.00	$ 1,390.00	$ 1,725.00

This table compares all worker's compensation claims for the United States from January 2018 to May 2021, as demonstrated by Wallenius Wilhelmsen (2022).

Table 26

2018-2020 January 2018 to May 2021 Total Amount of Ergonomic Injuries Resulted in a Worker's Compensation Claim.

		Total Injuries		
		US	Brunswick	Carlisle
Year	2018	17	0	5
	2019	56	2	3
	2020	30	0	2
	2021	12	2	2
	Average	29	1	3

This table compares all worker's compensation claims for the United States from January 2018 to May 2021, as demonstrated by Wallenius Wilhelmsen (2022).

Table 27

2018-2020 January 2018 to May 2021 Ergonomic Injury Percentage.

		Ergonomic Injury %		
		US	Brunswick	Carlisle
Year	2018	15%	0%	
	2019	58%	40%	43%
	2020	48%	0%	40%
	2021	40%	200%	50%
	Average	38%	29%	44%

This table compares the percentage of ergonomic-related injuries that resulted in a worker's compensation claim compared to the total amount of recordable injuries demonstrated by Wallenius Wilhelmsen (2022).

Table 28

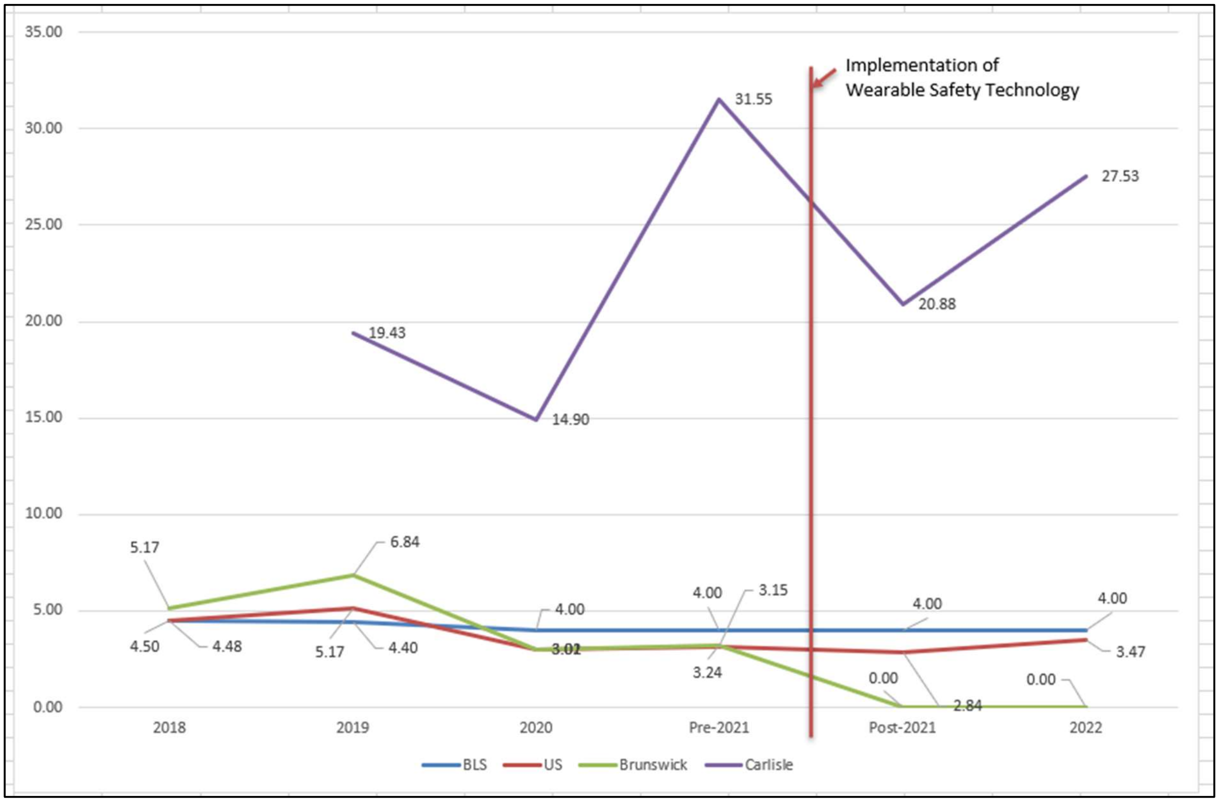
Post-Implementation Number of Hours and Recordable Injuries.

	All United States Hours					
	Year	Direct	Indirect	Total Hours	Recordable Injuries	Incident Rate
Jun - Dec	2021	2,305,825	295,926	2,601,751	37	2.84
Jan - Mar	2022	1,078,801	131,060	1,209,861	21	3.47
	Brunswick Hours					
	Year	Direct	Indirect	Total Hours	Recordable Injuries	Incident Rate
Jun - Dec	2021	66,294	13,349	79,643	0	0.00
Jan - Mar	2022	25,796	5,721	31,517	0	0.00
	Carlisle Hours					
	Year	Direct	Indirect	Total Hours	Recordable Injuries	Incident Rate
Jun - Dec	2021	26,184	12,135	38,319	4	20.88
Jan - Mar	2022	9,331	5,201	14,532	2	27.53

This table demonstrates all hours worked and recordable injuries within the United States from January June 2021 to March 2022, as demonstrated by Wallenius Wilhelmsen (2022).

Table 29

2018-2022 Visual Representation of Table 23 and Table 28.



This graph demonstrates a visual representation of Table 23 and Table 28, demonstrating the injury frequency rate between the BLS data and the Wallenius data, demonstrated by the U.S. Bureau of Labor Statistics. (2018-a; 2018-b; 2019-a; 2019-b; 2020-a; 2020-b) and Wallenius Wilhelmsen (2022).

Table 30

June to December 2021 Ergonomic Injuries that Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	17	$267.21	$61,364.79	$198,602.72	$11,682.5129
Valid N (listwise)	17				

This table demonstrates all worker's compensation claims for the United States in 2021 from June to December, as demonstrated by Wallenius Wilhelmsen (2022).

Table 31

June to December 2021 Ergonomic Injuries that Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	3	$267.21	$6,784.63	$13,058.16	$4,352.7200
Valid N (listwise)	3				

This table demonstrates all worker's compensation claims for Carlisle, Pennsylvania, in 2021 from June to December, as demonstrated by Wallenius Wilhelmsen (2022).

Table 32

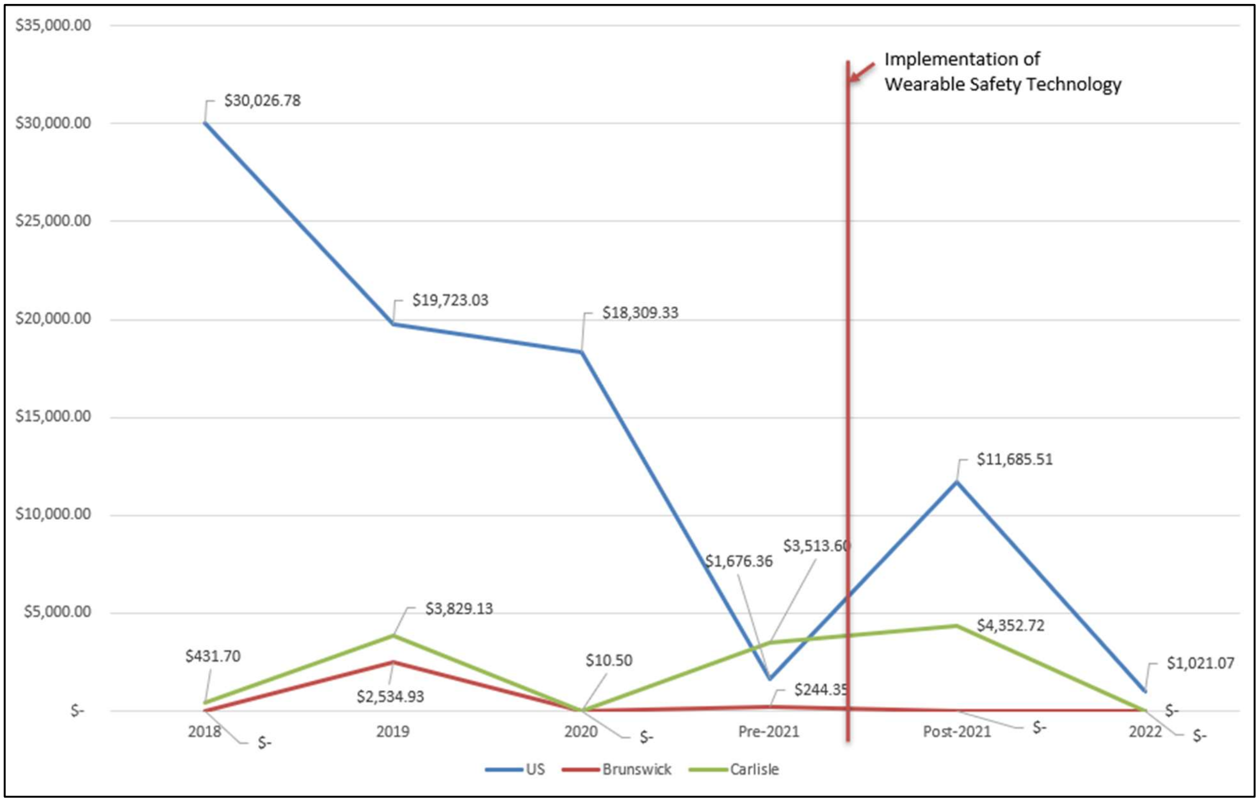
January to March 2022, Ergonomic Injuries in the United States that Resulted in a Worker's Compensation Claim.

Descriptive Statistics					
	N	Minimum	Maximum	Sum	Mean
Amount	5	$181.11	$2,535.21	$5,105.33	$1,021.0660
Valid N (listwise)	5				

This table demonstrates all worker's compensation claims for the United States in 2021 from June to December, as demonstrated by Wallenius Wilhelmsen (2022).

Table 33

2018-2022 Visual Representation of the Cost of Ergonomic Injuries.



This graph demonstrates a visual representation of the average cost of ergonomic injuries at the two implementation sites, compared with the overall United States, as demonstrated by Wallenius Wilhelmsen (2022).

Table 34

Chi-Square Test of Incident Frequency Compared to BLS.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.000[a]	10	.285
Likelihood Ratio	10.411	10	.405
Linear-by-Linear Association	4.114	1	.043
N of Valid Cases	6		

a. 18 cells (100.0%) have expected count less than 5. The minimum expected count is .17.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.414	.285
	Cramer's V	1.000	.285
N of Valid Cases		6	

This table demonstrates the chi-square hypothesis test of comparing the incident frequency of the organization against the BLS. This information is demonstrated by the U.S. Bureau of Labor Statistics. (2018-a; 2018-b; 2019-a; 2019-b; 2020-a; 2020-b) and Wallenius Wilhelmsen (2022).

Table 35

One-Sample t-test of Incident Frequency Compared to BLS.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Wallenius Incident Rate	6	3.6864	.93052	.37988

One-Sample Test

	Test Value = 4.07						
			Significance			95% Confidence Interval of the Difference	
	t	df	One-Sided p	Two-Sided p	Mean Difference	Lower	Upper
Wallenius Incident Rate	-1.010	5	.179	.359	-.38359	-1.3601	.5929

One-Sample Effect Sizes

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Wallenius Incident Rate	Cohen's d	.93052	-.412	-1.232	.444
	Hedges' correction	1.10678	-.347	-1.036	.373

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation.
Hedges' correction uses the sample standard deviation, plus a correction factor.

This table demonstrates the one-sample t-test for alternative hypothesis testing of comparing the incident frequency of the organization against the BLS. This information is demonstrated by the U.S. Bureau of Labor Statistics. (2018-a; 2018-b; 2019-a ;2019-b; 2020-a; 2020-b) and Wallenius Wilhelmsen (2022).

Table 36

Linear Multiple Regression Model for Brunswick, Georgia.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.528[a]	.278	.260	5.60458	2.051

a. Predictors: (Constant), Brussels

b. Dependent Variable: Brunswick

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	484.461	1	484.461	15.423	<.001[b]
	Residual	1256.451	40	31.411		
	Total	1740.913	41			

a. Dependent Variable: Brunswick

b. Predictors: (Constant), Brussels

This table demonstrates a linear multiple regression model to compare the incident frequency of Brunswick, Georgia against all other similar sites. This information is demonstrated by Wallenius Wilhelmsen (2022).

Table 37

Model of Potential Injuries in Brunswick, Georgia.

	Potential Injuries			
	Location	Hours	Injuries	Incident Rate
Actual	Brussels, Belgium	20871	2	19.17
Actual	Brunswick, Georgia	106980	0	0
Modeled	Brunswick, Georgia	106980	10.255	19.17

This table demonstrates the number of injuries that would have occurred in Brunswick, Georgia, during the implementation of the wearable safety technology according to the statistical correlation to Brussels, Belgium. This information is demonstrated by Wallenius Wilhelmsen (2022).

Table 38

Chi-Square test of Carlisle, Pennsylvania Injuries Compared Before and After Implementation.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.000[a]	4	.199
Likelihood Ratio	6.592	4	.159
Linear-by-Linear Association	.710	1	.399
N of Valid Cases	3		

a. 9 cells (100.0%) have expected count less than 5. The minimum expected count is .33.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	1.414	.199
	Cramer's V	1.000	.199
N of Valid Cases		3	

This table demonstrates the chi-square hypothesis test of comparing the injury cost of the Carlisle, Pennsylvania facility compared to itself before and after the implementation of the wearable safety technology. Demonstrated by Wallenius Wilhelmsen (2022).

Table 39

One-Sample t-test of Carlisle, Pennsylvania Injuries Compared Before and After Implementation.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Cost After Implementation	3	$4,352.7200	$3,559.49232	$2,055.07385

One-Sample Test

	Test Value = 1725						
			Significance			95% Confidence Interval of the Difference	
	t	df	One-Sided p	Two-Sided p	Mean Difference	Lower	Upper
Cost After Implementation	1.279	2	.165	.329	$2,627.72000	-$6,214.5491	$11,469.9891

One-Sample Effect Sizes

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Cost After Implementation	Cohen's d	$3,559.49232	.738	-.634	1.997
	Hedges' correction	$6,309.03587	.417	-.358	1.126

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation.
Hedges' correction uses the sample standard deviation, plus a correction factor.

This table demonstrates the chi-square hypothesis test of comparing the injury cost of the Carlisle, Pennsylvania facility compared to itself before and after the implementation of the wearable safety technology. Demonstrated by Wallenius Wilhelmsen (2022).

Table 40

One-Sample t-test of Carlisle, Pennsylvania Injury Costs Compared Before and After Implementation.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Cost After Implementation	3	$4,352.7200	$3,559.49232	$2,055.07385

One-Sample Test

	Test Value = 18994						
			Significance			95% Confidence Interval of the Difference	
	t	df	One-Sided p	Two-Sided p	Mean Difference	Lower	Upper
Cost After Implementation	-7.124	2	.010	.019	-14641.2800	-23483.5491	-$5,799.0109

One-Sample Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval Lower	95% Confidence Interval Upper
Cost After Implementation	Cohen's d	$3,559.49232	-4.113	-8.033	-.396
	Hedges' correction	$6,309.03587	-2.321	-4.532	-.223

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation.
Hedges' correction uses the sample standard deviation, plus a correction factor.

This table demonstrates the chi-square hypothesis test of comparing the injury cost of the Carlisle, Pennsylvania facility to the entire organization before and after implementing the wearable safety technology. Demonstrated by Wallenius Wilhelmsen (2022).

Table 41

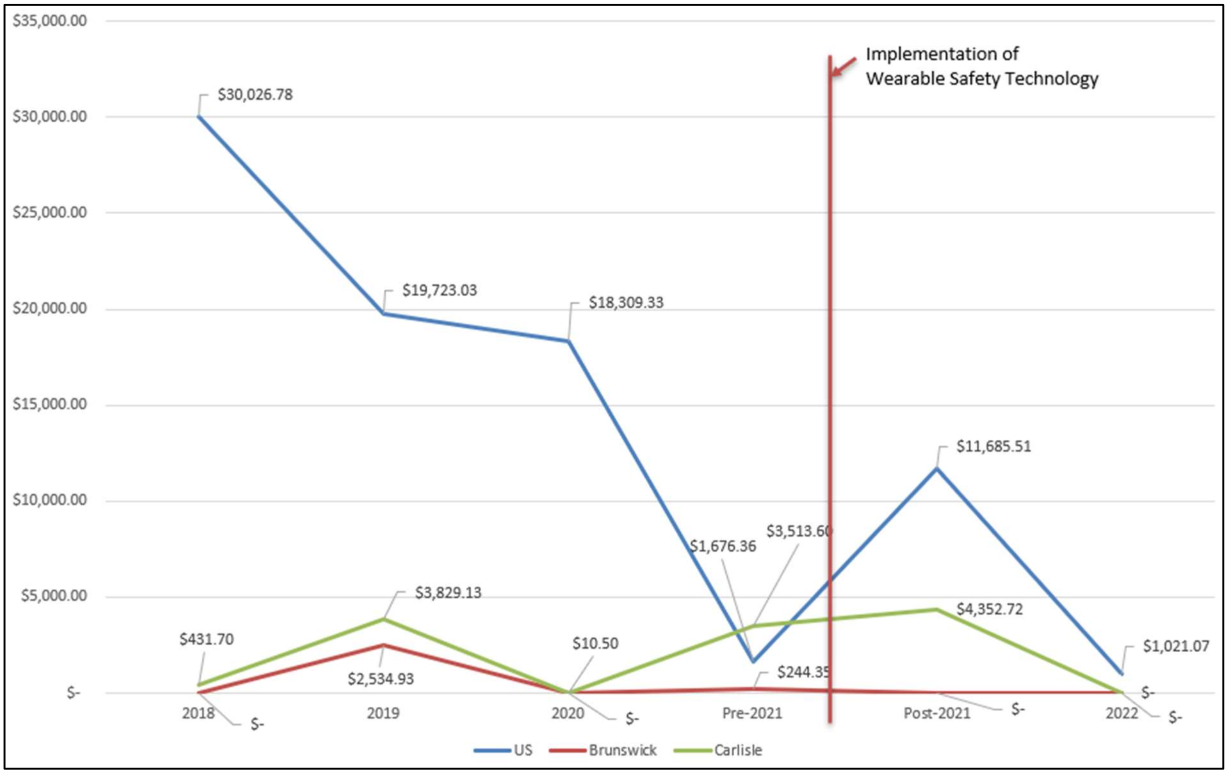
2018-2022 the Cost of Ergonomic Injuries.

		Average Incident Cost		
		US	Brunswick	Carlisle
Year	2018	$ 30,026.78	$ -	$ 431.70
	2019	$ 19,723.03	$ 2,534.93	$ 3,829.13
	2020	$ 18,309.33	$ -	$ 10.50
	Pre-2021	$ 1,676.36	$ 244.35	$ 3,513.60
	Post-2021	$ 11,685.51	$ -	$ 4,352.72
	2022	$ 1,021.07	$ -	$ -

This graph demonstrates the average cost of ergonomic injuries at the two implementation sites, compared with the overall United States, as demonstrated by Wallenius Wilhelmsen (2022).

Table 42

2018-2022 Visualization of the Cost of Ergonomic Injuries.



This graph demonstrates a visual representation of the average cost of ergonomic injuries at the two implementation sites, compared with the overall United States, as demonstrated by Wallenius Wilhelmsen (2022).

Table 43

Leadership Codebook Legend.

Codes

Search Project

Name	Files	References
Financial Impact	0	0
Balance Sheet	1	14
Customer Reduction	1	7
Healthcare Costs	1	27
Headcount Impact	0	0
Added Headcount	1	23
Added Training	1	25
Added Working Hours	1	4
Morale Impact	0	0
Site Morale	1	23
Productivity Impact	0	0
Accident Investigations	1	10
Injury Prevention	1	2
Insurance Claims	1	19
Root Cause	1	2
Travel	1	1
Workload	1	14
Safety Impact	0	0
Safety Score	1	16
Sustainability	1	8

This figure shows the legend codebook used to highlight the emergent themes for the leadership interviews.

Table 44

Hourly Codebook Legend.

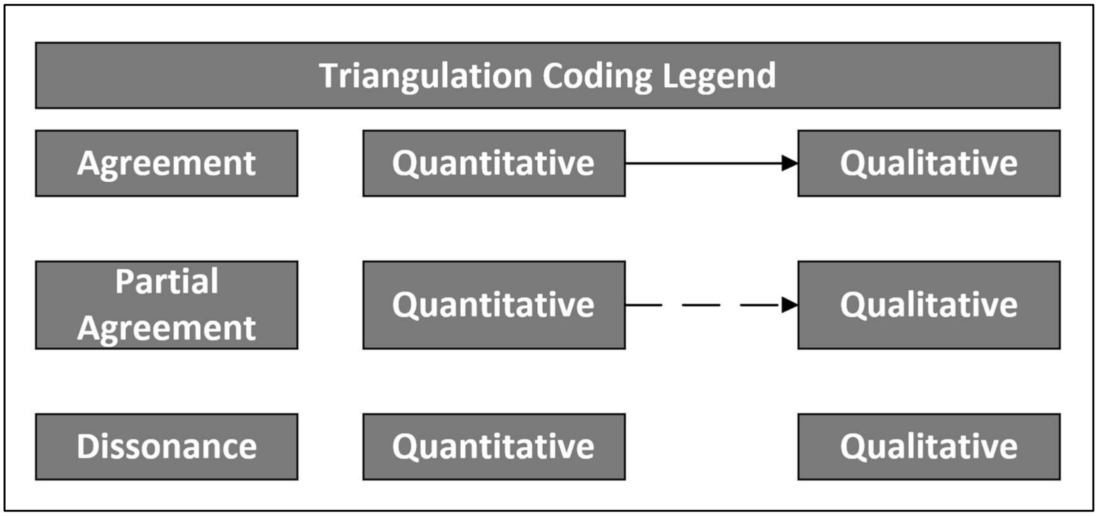
Codes | Search Project

Name	Files	Referen
Holistic-Impact	0	0
Hoistic Safety	1	29
Holistic Cognizance	1	9
Holistic Communication	1	20
Holistic Injuries	1	7
Holistic Work Modifications	1	8
Personal-Impact	0	0
Personal Cognizance	1	3
Personal Safety	1	11
Personal Work Modifications	1	3

This figure shows the legend codebook that highlights the emergent themes for the hourly employee interviews.

Table 45

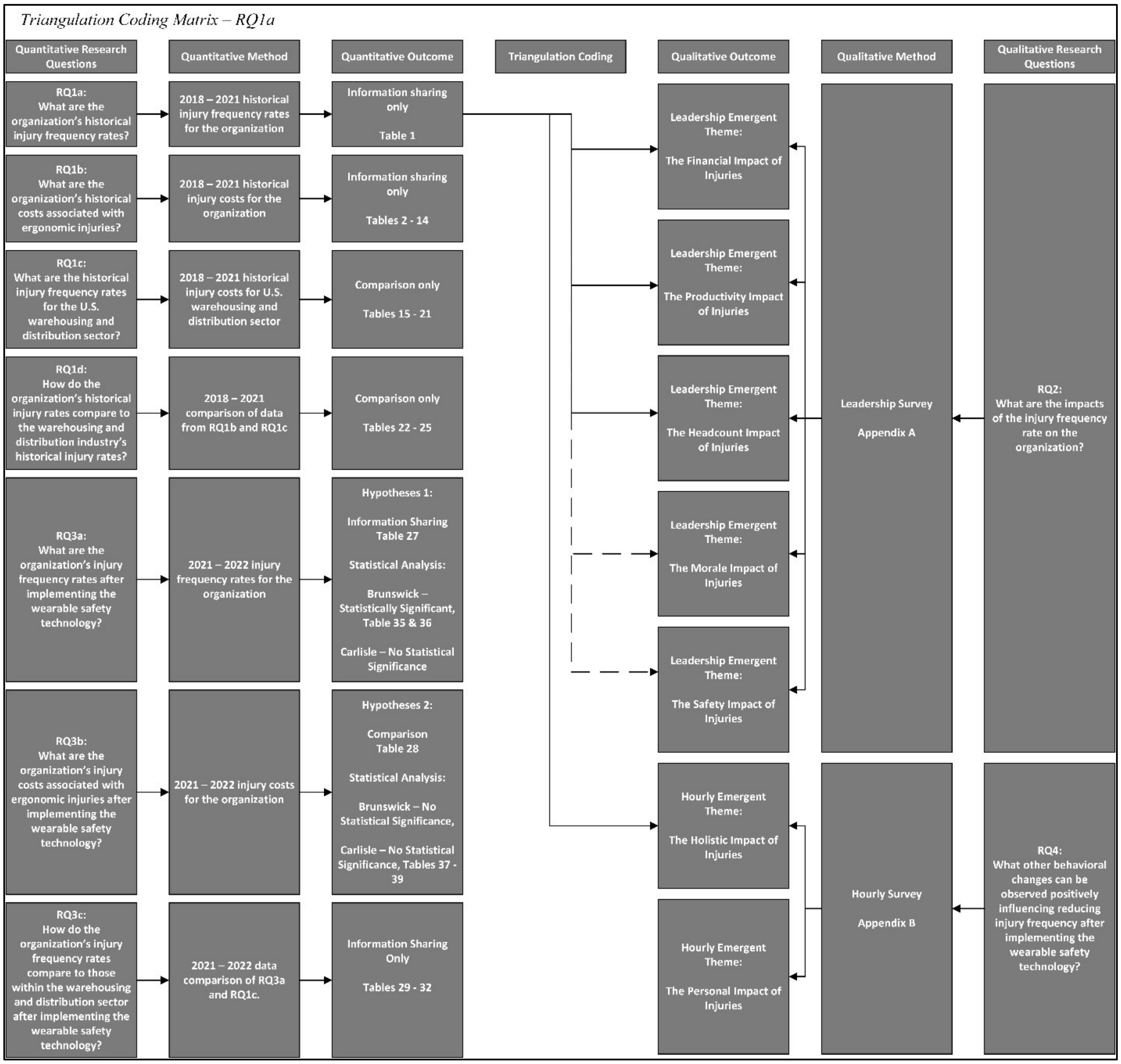
Triangulation Coding Legend.



This figure shows the legend for the triangulation coding.

Table 46

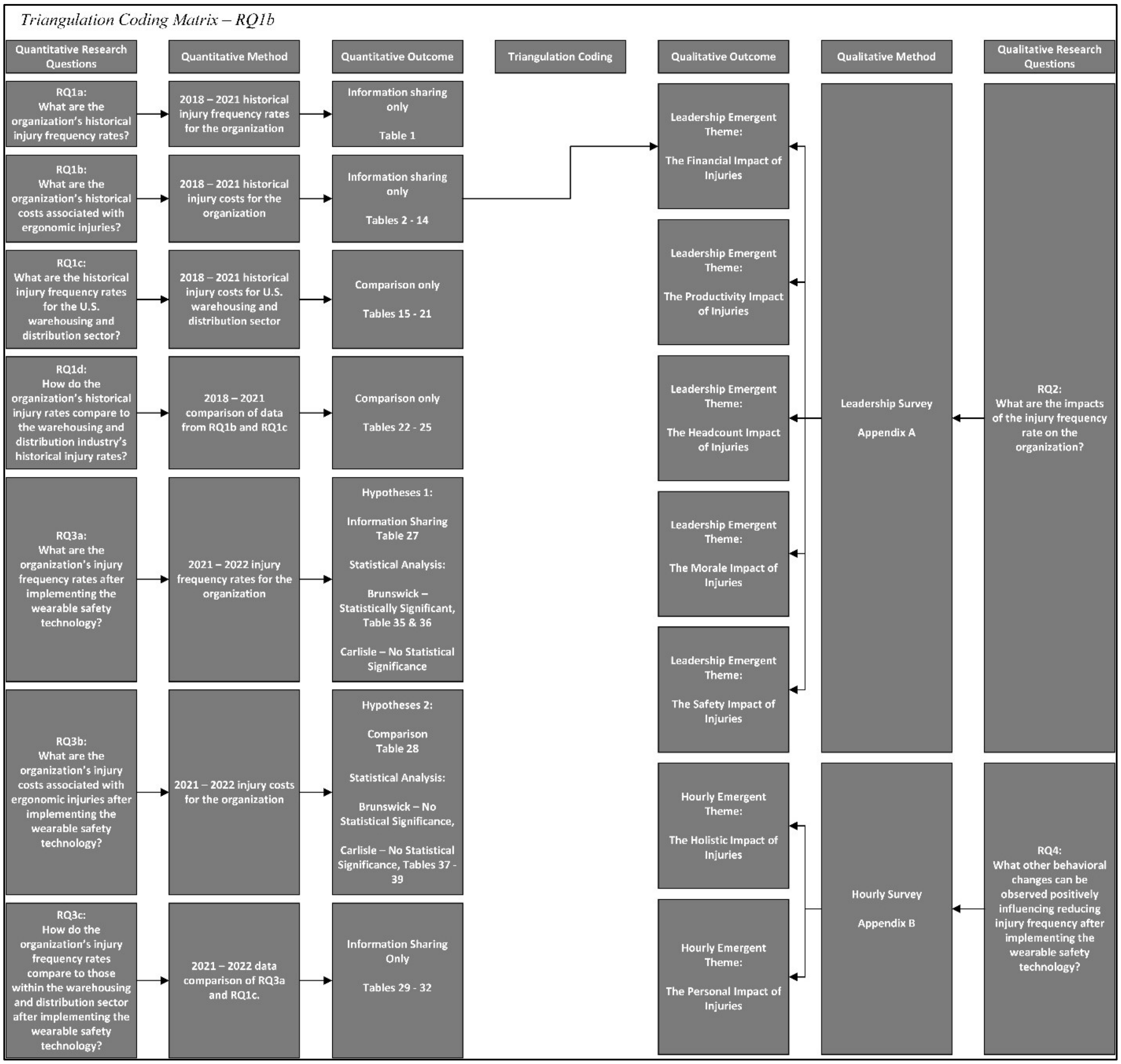
Triangulation Coding Legend – RQ1a.



This figure shows the triangulation coding in relation to RQ1a.

Table 47

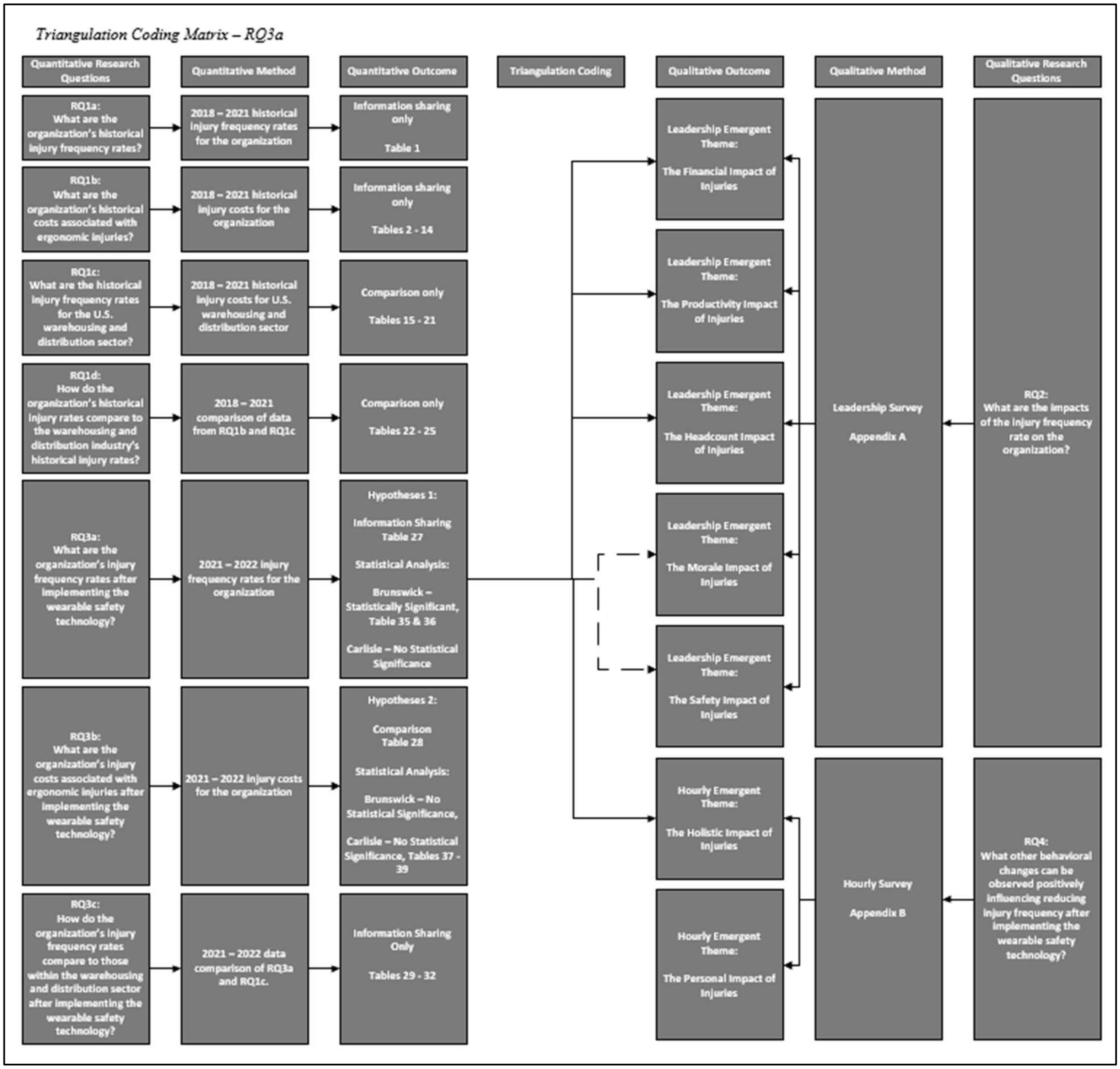
Triangulation Coding Legend – RQ1b.



This figure shows the triangulation coding in relation to RQ1b.

Table 48

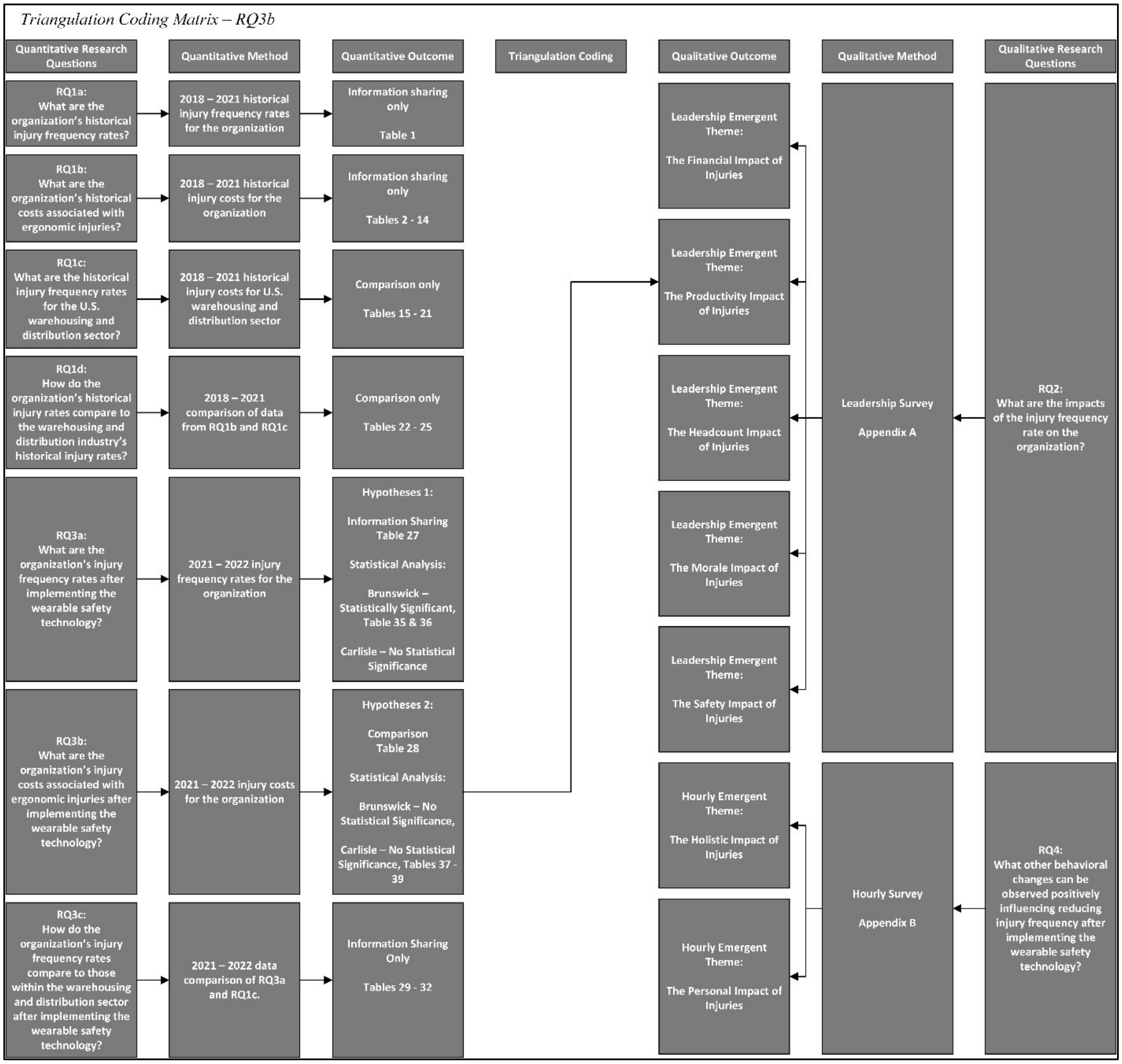
Triangulation Coding Legend – RQ3a.



This figure shows the triangulation coding in relation to RQ3a.

Table 49

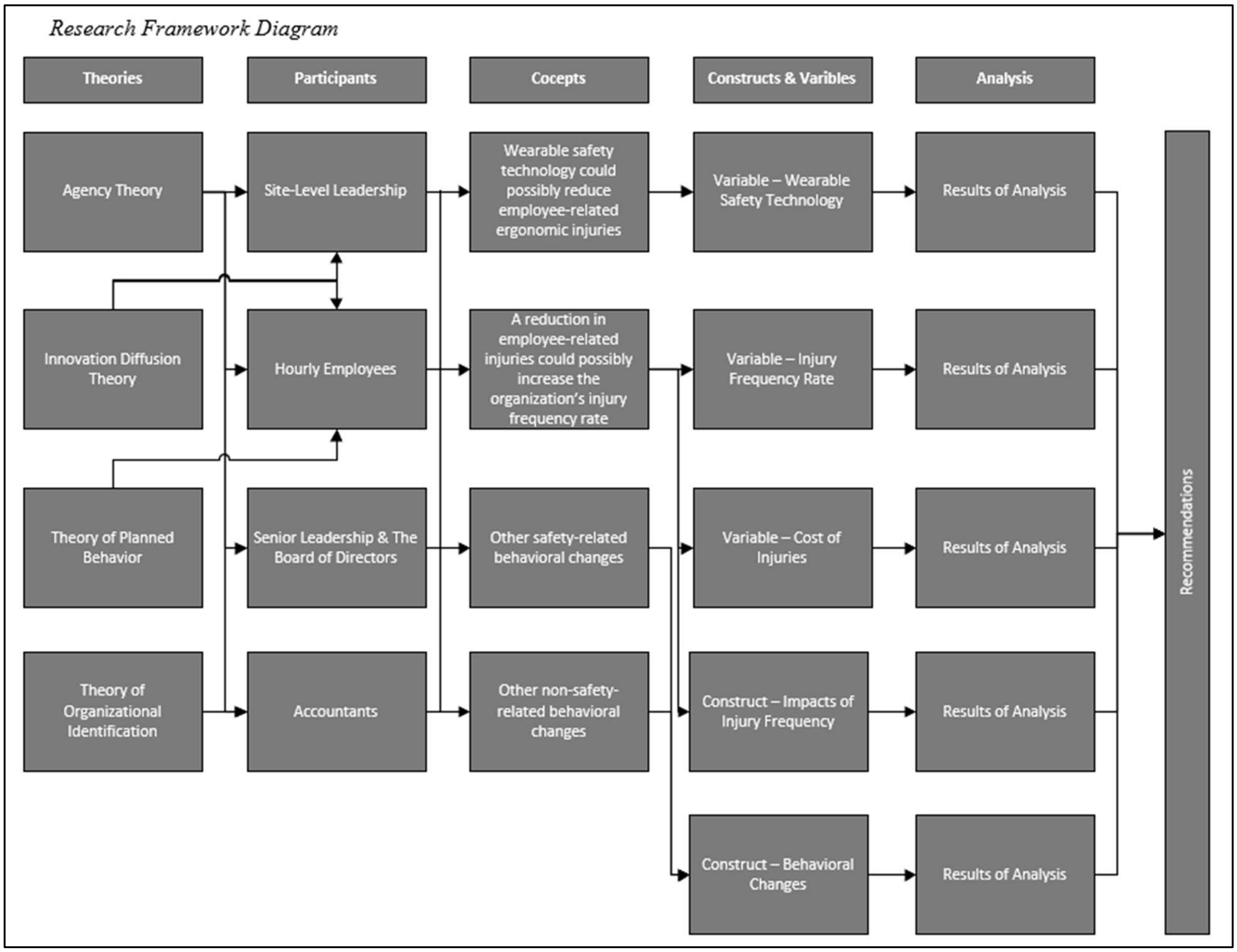
Triangulation Coding Legend – RQ3b.



This figure shows the triangulation coding in relation to RQ3b.

Figure 1

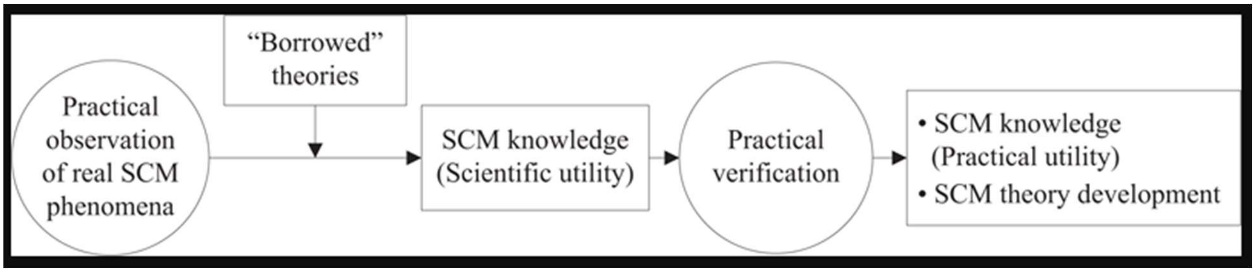
Research framework diagram.



This figure shows the connection between theories, participants, concepts, constructs, variables, and the analysis of this research study.

Figure 2

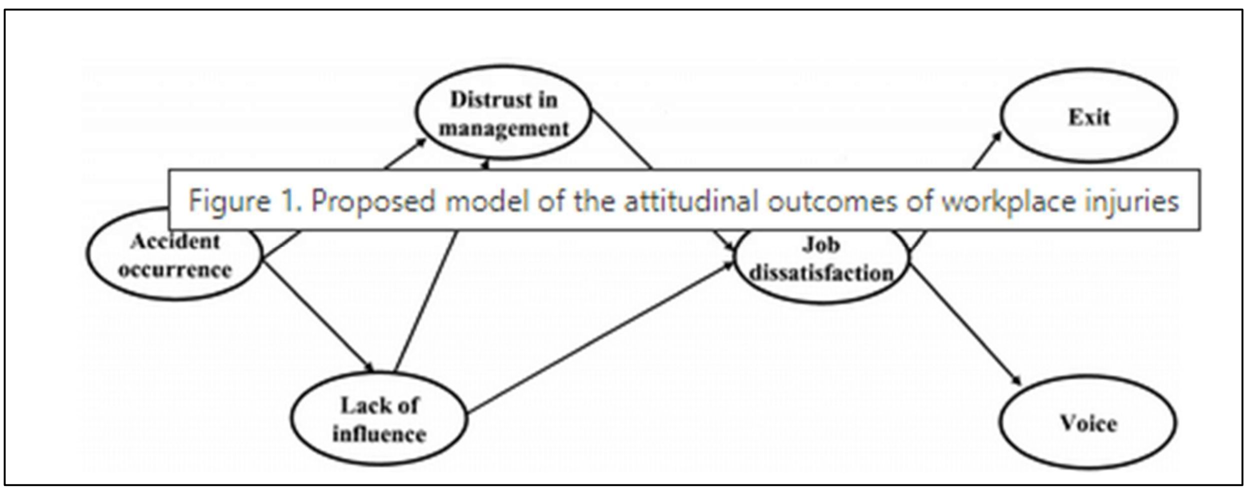
A practical approach to relevance with theory driven SCM research.



This figure shows an approach to bringing practical relevance to theory driven SCM research proposed by Liu and McKinnon (2019).

Figure 3

Attitudinal outcomes of workplace injuries.



This figure shows the attitudinal outcomes of workplace injuries used by Barling et al. (2003).

Figure 4

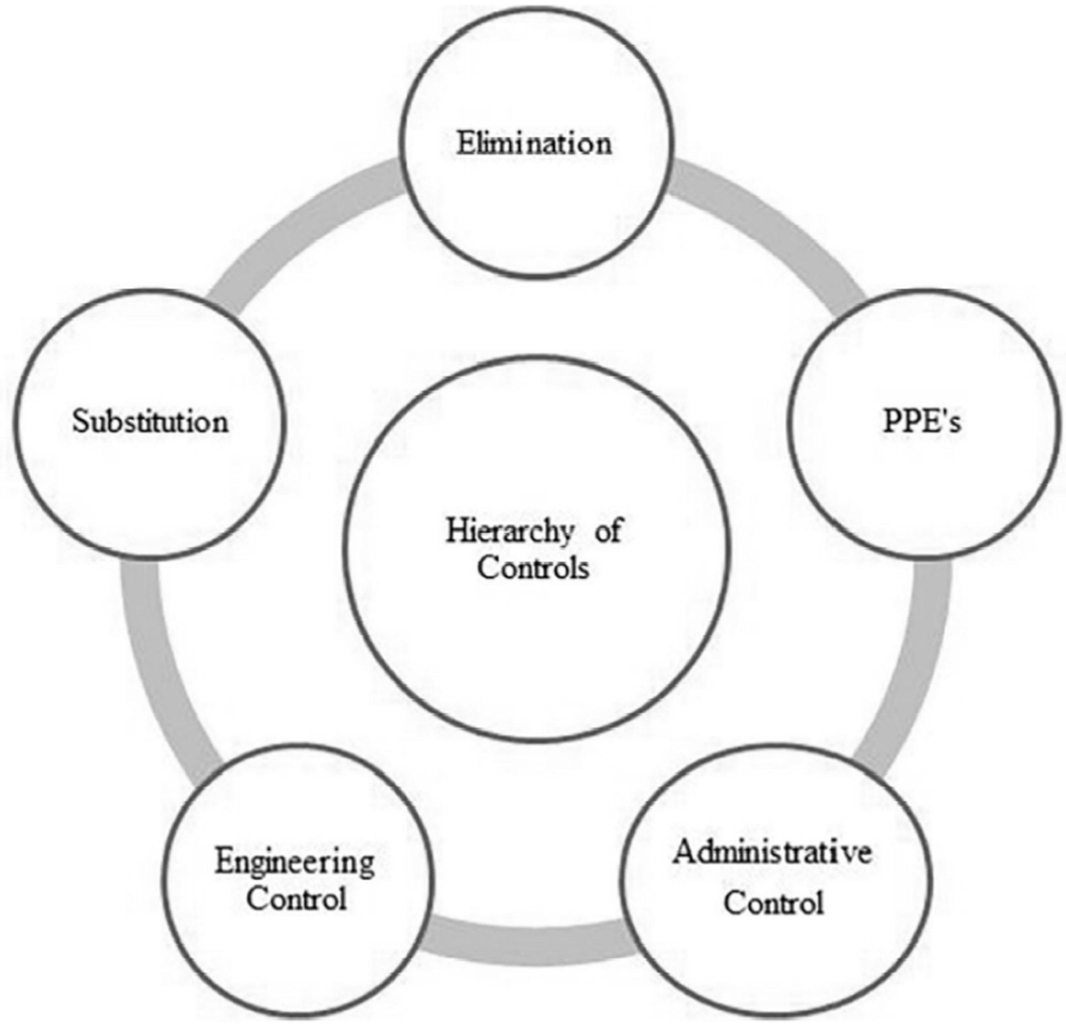
Job safety analysis.

JOB SAFETY ANALYSIS						
Name of the Company						
Unit :	F	Department :	FERROUS	In-Charge :	Mr...............	JSA No: 01
Job Tittle :	Preheat Sand			Machine Name / Number :	Sand Dryer	
Required Personal Protective Equipment's (PPE's) :			Safety Helmet , Apron, Safety Shoes, Mask			
S.No	Step by Step Work Sequence in Job	Hazards / Risks	Who/ Which Involving Man/ Machine	Score	Control Measures/ Recommendation	Reasonability
1	Sand Loading to Dryer	Sharp Edge Tool		9	Should be Wear PPE while Operation Time	Supervisor
2	Diesel Loading to Tank for Dryer	Spillage		12	Properly Unloading to Tank	Supervisor
3	Diesel Supply to Dryer for Ignition	Fire		19	Use Fire Extinguisher to Control the Fire	Supervisor
4	Sand In to Dryer	Dirty		3	Should be Wear PPE while Operation Time	Supervisor
5	During the Operation	Noise		4	Should be Wear Earplug while Operation Time	Supervisor
Prepared By : Dated :			Approval By: Dated :			
Reviewed By: Dated:						
Prepared Date :						
Last Revised Date :						
Next Review Date :						

This figure shows an example of job safety analysis used by Rajkumar et al. (2021)

Figure 5

Corrective action hierarchy of controls.



This figure shows the hierarchy of controls used by Rajkumar et al. (2021) to mitigate the risks found in a job hazard assessment