6-4-2019

Factors Influencing Safety Performance Among Industrial Manufacturing Facilities in Louisiana

Sarah Emily Ragona
s_ragona@hotmail.com

FACTORS INFLUENCING SAFETY PERFORMANCE AMONG INDUSTRIAL MANUFACTURING FACILITIES IN LOUISIANA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Agricultural and Extension Education and Evaluation

by
Sarah Emily Ragona
B.A. Louisiana Tech University
M.A. Louisiana Tech University
August 2019

To my parents, Irene and Lawrence Ragona

ACKNOWLEDGEMENTS

The completion of this dissertation has been one of the most significant undertakings I have accomplished. This achievement would not have been possible without the support and guidance of my advisors, co-chairs, and mentors, Dr. Sharon Naquin and Dr. Michael Burnett. Working with these scholars has been an honor and a privilege. Meeting Dr. Naquin at a training workshop on leadership that she was presenting opened a new world of academic and professional opportunities for me. Without her encouragement and support I would not be at LSU finishing my doctoral degree and, for that, I thank her. Her support and expertise helped provide the additional motivation needed to cross the finish line of my doctoral research, and the inspiration to pursue future research projects. I must also thank Dr. Burnett, who spent a significant amount of time providing feedback, guidance, and sharing his wealth of knowledge with me. I would also like to thank the other members of my committee, Dr. Satish Verma and Dr. Jennifer Baumgardner. Thank you both for sharing your time and participating in this endeavor. Your participation and interest in this study enhanced my research and played a valuable part in providing me with the additional confidence to complete the undertaking. I would also like to thank Ann Harrington for her assistance with the last few steps. Finally, I must thank my family, my mother, father, sister and especially my brother. Their belief in me, passion for learning, and sense of humor have been a source of motivation, inspiration, and encouragement.

TABLE OF CONTENTS

ABSTRACT

The primary purpose of this study was to determine the influence of selected organizational, demographic, and safety practice factors on the number and types of injuries within the industrial manufacturing plants in eight parishes in southern Louisiana. The target population was industrial organizational facilities. The accessible population was industrial manufacturing plants in the eight parishes surrounding Baton Rouge, Louisiana, who are members of a trade association comprised of industrial manufacturers. The sample was 100% of the defined as the accessible population. The researcher contacted a trade organization to identify the data source, requested and was granted permission to both access and use the data, which was transferred from the databases of the trade organization onto a researcher-designed, computerized recording form.

The number of safety events reported was skewed toward the smaller numbers for the most part, with most responses indicating none or very few incidents. When a comparison of the means was analyzed, companies that were categorized as an “Other” type were significantly different than those that were categorized as Chemical or “Energy”. In a regression model for direct hire employees the variable “Other – Company” explained 46.0% of the variance in the safety events of direct hire employees.

Based on the results of the study, the researcher concluded that the industrial organizational facilities in eight parishes in southern Louisiana had attained a good safety record. This is based on 112 recordables reported from 769 responses from safety offices based on records that encompassed larger numbers of workers. The potential implication of this conclusion is there is still room for improvement in the area of preventing safety events. The researcher recommends that organizations still make efforts toward ensuring the workplace is

safe for all employees. The mean number of safety events for companies in the category Chemical and "Energy" were lower than those of the companies categorized as Other; therefore, it appears the industries do well at managing and mitigating many of the potential risks. "Other" company types may find mirroring some of the practices utilized within the chemical and energy sectors to be beneficial.

CHAPTER 1: INTRODUCTION

Rationale

Importance of Business

Business is the foundation of the American economy. Businesses exist at a fundamental level to generate additional resources and money for the stakeholders. The construction industry, including subcontractors, working in industrial plant facilities comprise a crucial segment of the economy. Plants include petrochemical sites, paper manufacturers, plastic manufacturers, soap manufacturers, energy facilities, and various other industrial manufacturing companies.

To be sustainable business must be profitable. Profit is the degree to which a company, venture, or activity yields exceeding its liabilities. Profit is key to basic financial survival as a corporate entity. Although financing can be used to sustain a company financially for a time, financing is a liability, not an asset. In order to finance an endeavor, investors also need to be able to see the potential for a return on their investment. Yielding a profit is important and necessary for any company to survive because acquired money can be reinvested in the company to aid in growth. It can help a company remain attractive to investors and analysts to raise more capital if needed; or be disbursed to the owners/shareholders as a payout. Hence profitability is critical to a company's long-term survivability.

The value of businesses that are successful goes beyond making a financial return for the owners. Companies produce items or provide service to aid in individuals living comfortably or to allow other businesses to thrive. The industrial sector employs a significant number of individuals. According to the Greater Baton Rouge Industry Alliance (GBRIA) website, within eight parishes/counties in Louisiana, it is estimated that approximately 8% of the workforce is employed in the plant-facilities (GBRIA, 2016). There are about 12,000 plant and regular contract employees hired to work in plant facilities at an average salary of $56,000/year (GBRIA, 2016). The corresponding payroll for these employees is in excess of $900 million (GBRIA, 2016). Additionally, for each job housed in a plant another five to six downstream jobs are created. These jobs, in turn, employ another 40% of the local workforce according to the GBRIA website. The website also states that over $235 million in taxes are paid annually from this industry which in turn funds infrastructure, education, and social service programs.

Factors that Influence Profitability

Factors that influence a company's net profitability are the revenue after the costs related to the manufacturing, producing and selling of products are removed. Revenue is the income produced from the sale of products or services before the costs or expenses are removed. These costs are wide-ranging and typically often necessary for continued participation in the sector. Some of the more typical costs include operational expenses and administrative expenses: building ownership or lease; materials; office equipment; internet and phone lines; vehicle costs; fuel costs; company insurance; fees associated with pre-employment testing; fees assessed by third party vendors – ISNetworld, Avetta, Pecs, etc., and other costs. Employee wages are the payments of money for labor or services usually according to contract or an agreed upon rate. Employers often choose to absorb the cost of employee skill training, both to ensure the employees meet the minimum acceptable standards as well as to ensure employees can thrive in their careers and perform at the most productive level. This cost often allows an employer to be considered an employer of choice (an employer for whom an individual would want to work) rather than other similar organizations that do not offer the same training or advancement options; this is also known as employee branding. Licenses and permits can be legally required to the initial and continued business operations depending on the location of the work and nature of the activities performed.

While taxes are often considered as a compulsory tariff to the government on workers' paychecks or added to the cost of certain goods, services, and transactions, business revenue is also taxable. In addition to taxes, businesses often incur legal and lobbying fees to ensure that they can continue to operate and mitigate the risk of allowing inappropriate, shortsighted, and overly bureaucratic laws which serve to make operations too difficult for the business to continue to thrive. Businesses must procure the raw materials to produce their products or provide their services. They also need to buy office supplies required to conduct business (i.e., paper, pens, phone lines, internet, etc.). There are also expenses related to safety. These costs are unique because while procuring appropriate personal protective equipment (PPE), well-maintained machinery and tools, and safety initiatives and programs have a price tag like all other costs. The cost of not having a robust safety program or being remiss about safety can be a dramatic financial burden.

If a company has too many structural weaknesses, whether in performance, sales, marketability, premature growth; or weak valuations, or lax safety standards, these can ultimately destroy the business. One way to increase the likelihood of profitability is to reduce unnecessary costs. An expensive cost that is undesirable for all employers is the cost of an accident or incident in which an employee is injured or killed. The price tag of accidents can elevate higher worker compensation losses and increase insurance premiums (e.g. workers compensation, general liability, commercial liability, health supplemental including short term disability, and long term disability); medical related expenses (e.g. surveillance, claims, diagnosis, treatment, and rehabilitation); funeral expenses; governmental fines for an actual cited infraction; as well as penalty and interest fees; time and productivity loss of the employee injured, first responders, and management; negative press; retention of supplementary personnel; replacement of equipment; and other administrative costs related to the accident. These later administrative costs can also include additional indirect costs more nebulous in nature, but which must be taken into consideration such as partial compensation rates, the burden of recruiting, interviewing, hiring, training, onboarding, retraining, or providing modified tasks and job responsbilities to injured workers, etc. This does not even include the ramifications on the company that employed the injured worker as a defendant in costly litigation. Worse, for smaller companies, a recordable injury could put the company out of business if their EMR (employer modification rate) equals or exceeds 1.0. There is undoubtedly a ripple effect of a single construction site or industrial plant site incident, accident, injury, near fatality or fatality.

The costs can be such a heavy burden that some organizations go out of business. Within the United States alone, the costs of job-related incidents and injuries are staggering. Findley, Smith, Kress, Gregory, Enoch, (2004) and Ho, Ahmed, Kwan, Min, (2000) report that construction and industrial plants comprise a comparatively large number of both nonfatal and fatal injuries as compared to other occupations.

The Impact of Safety on Business Profits

Lack of safety precautions has a risk of creating an enormous expense for the organization. However, if safety is correctly managed, safety precautions and initiatives can still influence the bottom line. While safety initiatives and programs initially have operating costs, the money spent to ensure safe working conditions can reduce the expense of excessive worker compensation claims and supplemental insurance rates. These benefits contribute directly to improving the business' profits since the added expense is reduced. Safety initiatives not only ensure regulatory compliance, but also serve to improve risk management, enrich the organization's safety culture, and reduce potential unnecessary claims. Such efforts take time and resources to mitigate hazards before they cause damage to the company or injury to employees.

While the monetary costs associated with construction and industrial safety may be relatively quantifiable and reportable, one must also consider the ancillary and potentially long-lasting individual factors related to such safety incidents. Consider the worker who is killed or disabled (whether temporarily or permanently; partially or totally) because of a preventable accident or the psychological effects on the worker(s) who caused or could have prevented the accident.

Numerous factors have a potential to influence the incidence of accidents in the workplace. Some of the factors are:

- Management's visible demonstration to a commitment of total safety;
- safety programs;
- workplace operating procedures and practices;
- health and safety training;
- employees comfort level with incident reporting and cooperation with post-accident investigations;
- inspections of facilities;
- hazard identification;
- workers wearing appropriate personal protective equipment (PPE);
- using the correct tool for the task;
- safety climate;

- communication;
- safety assessments;
- worker recognition and mitigation of hazards; and
- medical monitoring practices (avoiding secondary injuries or exasperating congenital issues).

When organizations strengthen their safety programs by conducting regular inspections, they provide an opportunity to correct problems before injuries and incidents occur, and to protect their employees, property, and profits.

Measures of Safety

There are several different indicators or measures of safety. A non-exhaustive list includes the following: recordable; accident outcome; category of injury; inspection or audit results; and injury indexes or rates.

Occupational Safety and Health Administration (OSHA) defines a recordable injury as an injury or illness that requires medical treatment beyond first aid, or that causes death, days away from work, restricted work, transfer to another job, or loss of consciousness (OSHA General Recording Criteria 1904, 2017). In contrast, injuries that are not considered serious and do not fall into any of the previous categories are instances of first aid. In the case of first aid accidents, the worker receives first aid treatment (typically something that can be self-administered without any professional intervention) either at the worksite facility or an occupational health facility under the direction or supervision of safety personnel and then returns to the job.

Accidents classified by the nature of the injury include fatal accidents and temporary and permanent disablement. Fatal accidents cause the death of the injured worker. The death could occur at the time of the injury or later because of the incident. Temporary disablement involves the reduction of the earning capacity of the worker while he or she is engaged in recovery and recuperation from the injury. An accident that results in an injury which completely reduces the earning capacity of the employee is classified as permanent disablement.

The Bureau of Labor Statistics (BLS) established the Occupational Injury and Illness Classification System (OIICS) to describe occupational injuries and illness incidents (Occupational Injury and Illness Classification System, 2018). They use four characteristics: nature; body part affected; source and secondary source; and event/exposure. Nature is the primary physical characteristic of the injury or illness. Part of the body affected, as the name indicates, identifies the portion of the body directly affected by the detected injury. Source and secondary source refer to the cause of the incident. It can be objects, substances, equipment, or other contributory factors that cause the injury to the worker or impelled the incident.

The Occupational Safety and Health Act (OSH Act), the Occupational Safety and Health Administration (OSHA) is authorized to conduct workplace inspections and investigations to determine whether employers are complying with the safety standards the agency issues. OSHA also enforces § 5(a) (1) of the OSH Act (commonly referred to as the “General Duty Clause”) which requires employers to provide their employees with employment that “is free from recognizable hazards that are causing or likely to cause death or serious harm to employees” (OSHA ACT 1970. 2016). OSHA also conducts audits and issues citations if violations are discovered.

Another method to measure resulting safety is injury rates or indexes. Injury rates and indexes use the number of injuries reported divided by the number of employees and the number of injuries divided by the total number of manhours (number of hours worked by each worker). OSHA defines incidence rates as the number of injuries and illnesses, or lost workdays, per 100 full-time workers (OSHA Standard Interpretation 1904, 2017). Incidence rates are calculated as the number of injuries and illnesses or number of lost workdays times 200 divided by total hours worked by all employees during a specified period (OSHA Laws and Regulations, 2017).

$$\text{Incident Rate} = N \times 200{,}000 \div EH$$

N = number of injuries and illnesses, or number of workdays missed.

EH = total hours worked by all employees during a month a quarter or fiscal year.

200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

Another type of measure used to consider organizational safety is an experience modification rating (EMR). This rate is often abbreviated as EMOD and XMOD. In the United States, ERM is primarily calculated and used by worker's compensation insurance carriers. EMR is used to capture the ratio between claims actually filed and anticipated claims, and reflects the price firms have to pay for workers' compensation insurance (Ng, Cheng, Skitmore, 2005). The EMR formula can be complex, and multiple versions of calculation exist (Ng et al., 2005).

This study is designed to determine the influence of selected organizational demographic and safety practice factors on the number and types of injuries within industrial manufacturing facilites in southern Louisiana. Specifically, the study accomplishes this task by comparing injuries that occur in the industry to the organizational demographics of the organizations at which injuries occurred including:

- facility;
- quarter (timeframe);
- whether the site developed best practices (or plans to) based on the most common recordable events seen at the site;

- type of injury (body part (head, hand, leg, etc.);
- if the injured worker was a direct employee of the facility or a contractor; and
- event category (water cut, access/egress, heat stress, fatigue etc.).

Purpose of the Study

The primary purpose of this study is to determine the influence of selected organizational demographic and safety practice factors on the number and types of injuries within the industrial facilities in eight parishes in southern Louisiana.

Specific Objectives

The following specific objectives were formulated to guide this research study:

1. To describe the responses of the participating safety officers on the type of industrial organizational facilities in the eight parishes on the following selected measures regarding workplace injuries:

(a) Describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred;

(b) Describe the number of safety events (injuries illnesses and first aids) reported by the safety officers at the industrial organizational facilities;

(c) Describe the number of safety events (injuries illnesses and first aids) reported by the safety officers at the industrial organizational facilities overall and during each quarter of the year;

(d) Describe the responding safety offices at the industrial organizational facilities regarding whether or not the site developed best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities;

(f) Describe the number of each type of OSHA recordable event (deaths, time away from work, job transfer, and other) and the number of safety events (injuries, illnesses, and first aids) (overall and for direct employees and contractor employees) as reported by the safety officer at each industrial organizational facility.

2. Describe the injuries at the industrial organizational facilities as reported by safety officers on the following selected characteristics:

(a) Basis (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction) of the injury;

(b) Body part injured (hand, head, leg, foot, arm, chest, back, and/or shoulder).

3. Compare the number of safety events illnesses, first aids, and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities that affected direct employees with the number of safety events and OSHA recordable events that affected contractor employees.

4. Determine if a relationship exists between number of safety events (injuries, illnesses, first aid cases) and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities and the following characteristics of safety event and OSHA recordable event:

(a) Type of facility;

(b) Quarter in which the event occurred;

(c) Basis of the event; and

(d) Body part affected by the event.

5. To determine if a model exists to explain a significant portion of the variance in the number of safety events (injuries, illnesses, and first aids) from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

6. To determine if a model exists to explain a significant portion of the variance in the total recordable incidents from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

Significance of the Study

Ensuring the safety and well-being of people is of the utmost importance. No one should ever be injured while on the job by an accident. Additionally, all employers need to be cognizant of which factors can help ensure that they are preventing potential accidents while still accomplishing their objectives.

CHAPTER 2: REVIEW OF LITERATURE

Introduction

Over the last hundred years, safety has become increasingly important in the workplace. According to an urban legend within the construction industry, when large construction jobs were bid in the early 1900's, the bids included an estimated casualty rate of human lives expected to be lost. In today's workforce, such an inclusion is entirely unheard of, but unfortunately, there are still lives lost due to safety incidents in the workplace. Safety is no longer typically perceived as an optional or unnecessary component of the work, but rather as a major component of comprehensive management within strategic and operational plans. Safety incident or accident prevention is an essential component of good management practices and good workmanship. Both management and employees must fully cooperate in all safety endeavors, but top management must take the lead in safety initiatives. It is also important that there are defined and well-communicated safety policies and procedures in place as well as the resources necessary to implement the policies. It is crucial that the most current and best available knowledge and safety methods are consistently applied. Unfortunately, the number of serious construction-related accidents and deaths and the number of incidents and fatalities occurring in industrial plants is still too high. These incidents result from a myriad of manageable factors that continue to plague the construction and industry

Understanding the nature of the construct of workplace safety requires a discussion of the definition of incidents as they relate to the construction and industrial sectors. Note that the literature often uses the terms incidents and accidents interchangeably. Currently, most researchers who study unintentional injury emphasize influences that raise the risk of severe injury and that reduce injury occurrence and severity while avoiding using the word "accident" and (Robertson, 2015 and Robertson, 1992). Nonetheless, incidents are generally defined as an unexpected, unplanned event in a sequence of events with several causes. An accident is something unexpected, unintended and undesired. Incidents result in physical harm (injury, ill health or disease) of an individual, a near miss, equipment damage, or any combination of these effects. There are two types of incidents. The first are those that cause immediate injury to the employee or damage to equipment or property (i.e., an employee slipping or tripping in a warehouse, an employee receiving an electrical current, a forklift dropping a load, or an explosion or unplanned discharge in a chemical facility, etc.). The second are those that occur over an extended period of time such as the development of an asbestos-related disease caused by years of exposure to asbestos, inhalation of in silica dust which can lead to silicosis, lung disease or lung cancer, or hearing loss from exposure to loud noises.

Accidents or incidents are categorized in multiple ways – by type of accident, nature of injury, and category of accident. The types of accidents are classified according to the length of recovery: first aid, lost-time, and home case. In the case of first aid accidents, the worker receives first aid treatment, either at the worksite or an occupational health facility under the direction or supervision of safety personnel if the resulting treatment is beyond diagnostic testing or would be identical to what could be self-care or also administered by a nonmedical person and then returns to the job. In lost time accidents, the worker loses a day or shift in which the accident occurs. Compensation is given to the employee by the employer depending on the severity of the accident. In home-case accidents, the worker loses the remainder of the shifts or days as medically advised. Typically, he is compensated by the employer for lost time, but this is dependent upon a number of factors and is not always cut and dry. Accidents classified by the nature of the injury include fatal accidents, temporary disablement, and permanent disablement.

With fatal accidents the death of the worker could occur at the time of the injury or later. Temporary disablement is another category of injury and involves the reduction of the earning capacity of the worker while he is engaged in recovery and recuperation from the injury. An accident that completely reduces the earning capacity of the employee is classified as permanent disablement injury.

There are four categories of accidents: minor; reportable; fatal; and accidents due to dangerous occurrences. Minor accidents include those accidents that are:

- not as harmful in nature to the worker;
- prevent the worker from performing regular duties for less than 48 hours from the time the accident occurred;
- are not (but possibly should be by organizational policy rather than law) reported to upper level supervision; and
- are relatively easily to handle.

Minor injuries typically result in no treatment or just a first aid treatment. Reportable accidents are slightly more complex than minor accidents. In the case of reportable accidents, the injuries caused to the worker prevent him from working for a timeframe of 48 hours or more. In such cases, the supervisor is typically mandated to report the accident to higher level management and plan for a replacement worker so that production is not hindered. Accidents due to dangerous occurrences generally occur from extreme conditions. Examples include the rupture of a vessel that contains steam under pressure greater than atmospheric pressure; weld failure on a tank in an industrial setting; explosion or fire triggering damage or harm to an individual.

Improving workplace safety has become a worldwide concern and is increasingly regulated and controlled within the United States both to promote worker safety and control accident-related costs. The number of occupational incidents, fatal and nonfatal, in industrial settings and on construction sites is exceedingly high in the United States despite the increasing number of regulations and standards that have been written and enforced within the past several decades (Findley, Smith, Kress, et al., 2004). The Bureau of Labor Statistics (BLS) reports (2012) that there have been more than 1,000 fatal injuries each year in the construction industry in the years between 1995 and 2005. In 2011, construction workers accounted for a fatality rate of 9.1 per 100,000 full-time equivalent (FTE) workers in contrast to a rate of 3.5 per 100,000 full-time workers for the overall worker population (Bureau of Labor Statistics, 2011). Non-fatal injury rates were 3.9 per 100 full-time workers for construction and industry workers as compared to overall worker population of 3.8 for every 100 full-time workers (Bureau of Labor Statistics, 2011). It is clear from these figures that the likelihood of workers on a construction site or in an industrial setting to be injured or killed is greater than it is for workers in other occupational settings.

Within the United States alone, the costs of job-related incidents and injuries are staggering. Findley, Smith, Kress, et al., (2004) and Ho, Ahmed, Kwan, et al., (2000) report that construction and industrial plants account for a relatively high number of fatal and nonfatal injuries as compared to other occupations. The reported financial costs associated with workers' compensation claims in the United States for the most disabling non-fatal construction and industrial injuries from 1998 to 2010 exceeded $600 billion in direct workers' compensation payments. Workers' compensation is mandatory in most states, and it requires employers to obtain insurance for their employees from an insurance carrier. If an employee is injured, the carrier would pay medical and disability benefits according to a state-approved formula. This formula can include hospitalization and medical expenses to diagnose and treat an injury. It also offers disability payments while an employee is unable to work (normally about two-thirds of the employee's regular salary) and may pay for rehabilitation, retraining, and other benefits. These are the direct costs incurred directly from the incident. Despite the enormity of this figure, it is only a tiny percentage of the total cost of all workplace injuries and illnesses in the American workplace.

Indirect costs are the more amorphous costs of the incident, and although they are unseen, they must be taken into consideration. Examples of indirect costs include "Time Away" not covered by workers' compensation insurance; payment of other staff who are not injured but may have stopped to help the injured worker; those who require output from the injured worker in order to complete their responsibilities; and the costs of damage to materials or equipment involved in the accident. Other indirect costs include, but are not limited to, the affected employee's health care costs, wages lost during investigation, waiting or recovery periods, or "partial compensation rates (state rates are approximately 66% or less of worker's wages, although benefits are generally not taxed); the burden on employer" (Leigh, 2011; Leigh & Du, 2012; Marucci-Wellman, Courtney, Corns, Sorock, Webster, Wasiak, Noy, Matz, Leamon, 2015;) to recruit, interview, hire, train, onboard, retrain, or provide modified duty opportunities to workers; the burden on injured workers; and the extraneous problems of reduced income on families and requirements to care for and compensate for the injured worker sometimes for a prolonged period of time, perhaps for many years (Leigh, 2011; Leigh & Du, 2012; Marucci-Wellman, Courtney, Corns, Sorock, Webster, Wasiak, Noy, Matz, Leamon, 2015; Seabury, Scherer, O'Leary, Ozonoff, & Boden, 2014).

Pellicer, Carvajal, Rubio, and Catala (2014) recognized the need for a tool to calculate the actual costs of an incident or accident. They felt that if "employers had a tool that allowed them to calculate aprioristically the occupation health and safety costs during the design phase of a construction project, they could try to reduce these costs later at the construction site by improving procedures and increasing the quantity and quality of accident prevention measures" (Pellicer, et al., 2014, p. 1955). Using accident and incident data obtained from 1990 to 2007, they categorized costs into the following classifications: prevention (obtained from the design phase); insurance (using base salaries and professional contingencies), accident (accidents per cause in a year per million hours worked); and recovery of costs (estimated as the gross daily salary of an average worker affected by the total number of days of medical leave minus one day). Through their data analysis, they determined that the "health and safety costs for the construction project come to approximately 5% of the total cost of the budget. This value is about three times the average investment in prevention" (Pellicer, et al., 2014, p. 1961).

While the monetary costs associated with construction and industrial safety may be relatively easy to ascertain and report, one must also consider the ancillary potentially long-lasting individual factors related to such safety incidents. Consider the worker (and his family) who is killed or disabled (whether temporary or permanent; partial or total) as a result of a preventable accident or the psychological effects of the worker(s) who caused or could have prevented the accident. Consider too, the ramifications on the company that may have employed him which may now be either the defendant in costly litigation or out of business because of unsafe practices of an individual employee, crew, or the entire company. There is undoubtedly a ripple effect of a single construction site or industrial plant site incident, accident, fatality or near fatality.

Federal Initiatives

The responsibility for employee safety in the U.S. shifted to employers with the passage of the Occupational Safety and Health Act of 1970. Shortly after the Occupational Safety and Health Administration (OSHA) was created as an agency within the U.S. Department of Labor, it began establishing and enforcing safety standards, regulations, and protocols. According to OSHA standards, employers are required to provide workers with a workplace free from any recognized safety hazards (29 USC 654 §5). OSHA has oversight regarding employers and workers in construction, maritime, agriculture and general industry. The general industry category covers other trades not included in the other three self-explanatory named categories.

The OSH Act of 1970 also established the National Institute for Occupational Safety and Health (NIOSH) "as a research agency focused on the study of worker safety and health, and empowering employers and workers to create safe and healthy workplaces" ((The National Institute for Occupational Safety and Health (NIOSH), 2018)). NIOSH is not part of the United States Department of Labor (USDOL), but rather part of the U.S. Centers for Disease Control (CDC) and Prevention, in the U.S. Department of Health and Human Services. NIOSH "has the mandate to assure every man and woman in the Nation safe and healthful working conditions and to preserve our human resources" according to the CDC's website (The National Institute for Occupational Safety and Health (NIOSH), 2018)

Like OSHA, the U.S. Department of Labor's also houses the Mine Safety and Health Administration (MSHA). MSHA aim is to prevent death, illness, and injury from mining and to promote safe and healthful workplaces for U.S. miners. MSHA carries out the provisions of the Federal Mine Safety and Health Act of 1977 (Mine Act) as amended by the Mine Improvement and New Emergency Response (MINER) Act of 2006. MSHA develops and enforces safety and health rules for all U.S. mines regardless of size, number of employees, commodity mined, or method of extraction (including fracking and offshore drilling).

The Bureau of Labor Statistics (BLS) is another component of the U.S. Department of Labor, and since 1984, it is the main federal agency responsible for calculating labor market activity, working conditions, and price changes in the economy. According to its website, its mission is to collect, analyze, and disseminate essential economic information to support public and private decision-making (DOL Agencies, 2018). BLS strive to serve as an independent statistical agency helping a variety of users by providing products and services that are objective, timely, accurate, and relevant (DOL Agencies, 2018).

OSHA is typically the most relevant government agency with regard to workplace safety in the industrial and construction setting. Company management is required to operationalize a systematic training program to recognize workplace hazards and to create an environment that promotes safety awareness throughout the organization. The ultimate goal of safety training, as well as company safety standards and goals, should be to foster behavior among employees that enable them to be always aware of the importance of safety for themselves and others and to make safety-conscious decisions continuously. OSHA inspections are an integral part of the agency's mission in an oversight role over many occupational industries.

OSHA focuses its inspection resources on the most hazardous workplaces in the following order of priority: of imminent danger, catastrophes and fatal accidents, complaints and referrals, programmed inspections, and lastly follow-up inspections (Federal OSHA Complaint Handling Process, 2017). The utmost priority, imminent danger, is any condition where there is reasonable certainty that a danger exists that can be expected to cause death or serious physical harm immediately or before the danger can be eliminated through normal enforcement procedures. If a compliance officer finds an imminent danger situation, the officer will ask the employer to correct or eliminate the hazard and remove endangered employees from exposure (Federal OSHA Complaint Handling Process, 2017). If the employer does not rectify the hazard, OSHA may seek an injunction from a federal district court prohibiting further work if unsafe conditions exist (Federal OSHA Complaint Handling Process, 2017). The rationale for imminent danger to superseding the other inspection priorities to prevent an impending disaster and/or fatality. While a catastrophe or fatality is significant, the damage has already occurred, so the goal would be corrective action to avoid a similar event from happening again. All work-related fatalities are required to be reported to OSHA within eight hours, and all work-related in-patient hospitalizations, amputations, or losses of an eye within 24 hours. Complaints and referrals are initiated by employees or someone who is aware of a possible safety issue. Typically, complaints and referrals originate with someone other than an employee, when an individual from another federal, state or local agency, organizations, or the media know about a possible safety issue. Although these are the third priority, OSHA still views them as a high priority. Employees who complain may request anonymity. OSHA typically handles investigations generated by complaints and referrals initially by phoning the employer, describing the alleged hazards, and then following up with written correspondence. The employer must respond within five days, identifying in writing any problems found and noting corrective actions taken or planned. If the response is satisfactory, OSHA may conclude that conducting an on-site inspection is not necessary. Program inspections are targeted at specific high-hazard industries or workplaces that have experienced high rates of injuries and illnesses. For example, currently, an OSHA officer can open an investigation anytime a crane is spotted, even if a safety threat is not visible (Federal OSHA Complaint Handling Process, 2017). Finally, follow-up inspections verify abatement of violations cited during prior inspections.

As a result of the OSHA inspections, OSHA publishes each year the top ten violation citations. For fiscal years 2018 and 2017, the violations in descending order were:

1. Fall protection in construction with 7,216 violations in 2018 and 6,072 in 2017. This type of a breach often includes unprotected edges and open sides, primarily in residential construction, and failure to provide fall protection on low-slope roofs.

2. Hazard communication with 4,537 in 2018 and 4,176 in 2017. This comprises not having a hazard communication program or not providing access to safety data sheets.

3. Scaffolding with 3,319 in 2018 and 3,288 in 2017: examples would be improper access to surfaces and lack of guardrails.

4. Respiratory protection with 3112 in 2018 and 3,097 in 2017; primarily meaning failure to provide a respiratory protection program and secondly a failure to provide medical evaluations.

5. Lockout/tag-out violations with 2,923 in 2018 and 2,877 in 2017: common violations are insufficient worker training and inspections not completed.

6. Ladders in construction violations with 2,780 in 2018 and 2,241 in 2017. This citation encompasses the improper use of ladders, damaged ladders, and using the top step of a ladder.

7. Powered industrial trucks violations with 2281 in 2018 and 2,162 in 2017 included inadequate worker training and refresher training.

8. Fall protection training requirement violations with 1978 in 2018 and 1,523 in

2017 (this violation was ninth in 2017). These violations can cover failure to train workers in identifying fall hazards to the proper use of fall protection equipment by workers.

9. Machine guarding violations with 1969 in 2018 and 1,933 in 2017 (in 2017 this item was eighth); meaning exposure to an area of a machine that is in motion or performing a function.

10. Personal protective/lifesaving equipment specifically eye and face protection was the tenth most frequently cited violation with 1,528 citations in 2018 (PR Newswire, 2018 and Breaking: OSHA announces top 10 violations for FY 2017, 2017).

In 2017, electrical wiring methods violations was the tenth most frequent violation to be cited. Violations of this standard were found in most general industry sectors and have to do with how electrical wiring is mapped and housed. Often violations may include using temporary wiring instead of permanent wiring. The 2017 violation citations are different than the previous year's (2016) because item six (ladders in construction) and item seven (powered industrial trucks) swapped places (Musick, 2016). Fall protection training did not make the top-ten list: instead, 2016 top ten was rounded out with violations having to do with electrical systems design (Musick, 2016).

Workplace inspections and investigations are conducted by OSHA compliance safety and health officers (compliance officers) professionals trained in the disciplines of safety and industrial hygiene. Industrial hygiene is defined by OSHA on their website, OSHA 3143 Informational Booklet on Industrial Hygiene,1998, as "the science of anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers' injury or illness. Industrial hygienists use environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering, work practice controls, and other methods to control potential health hazards." States that administer their own occupational safety and health programs may have different inspection procedures. Employers typically contact the state agency directly to determine if there are any unusual or additional state occupational safety and health requirements. Louisiana falls under Region VI – Dallas. Louisiana is not a "state plan" state; meaning, Louisiana does not have a unique federally approved occupational safety and health regulatory program to cover the workers who earn a living within the state. Private sector employers are governed by federal OSHA regulations and must follow federal job safety and health requirements. Since there is no supplemental plan, there are no state safety and health regulations for public sector employees (Lafourche Parish Government Employment and Workforce Housing Assessment, 2015). State Plan states performed many more inspections than in federally planned states, but the percentage of inspections that cited penalties was lower in State Plan states than in federally planned states (Gray and Mendeloff, 2005). Huber 2007 and (Ko, Kilkon, Mendeloff, John, and Gray, Wayne, 2010), noted when an employee accompanies the inspector, the number of violations cited in programmed inspections is approximately 30% higher than if an employee does not accompany the inspector. While employees escorting inspectors is common in workplaces where unions represent the workers; an employee escort is uncommon in workplaces where there is not a significant union presence (Ko, et al., 2010).

Quantify Workplace Injuries

There are multiple ways to quantify workplace injuries. Some frequently used methods and commonly used terminology are briefly outlined in the following text. First, within the United States of America, there is an (OSHA) recordable injury, which is not the same thing as an inspection citation. OSHA regulation 1904.7(a) sets forth a basic requirement that any injury or illness meeting the general recording criteria must be documented. The requirement for recording an injury is that it results in any of the following: death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness (OSHA General Recording Criteria 1904, 2017). Additionally, if the incident involves a significant injury or illness diagnosed by a physician or other licensed health care professional, even if it does not result in death, days away from work, restricted work or job transfer, medical treatment more than first aid, or loss of consciousness it must also be recorded by the employer. The records are maintained on the OSHA 300 log of injuries and illnesses: see attachment A. These requirements for documentation do not differ across industries (Probst & Estrada, 2010). A recordable differs from an instance of first aid, which is essentially providing a treatment that is not medically invasive and could often be performed by the employee. OSHA defines first aid (OSHA Standard 1910, 2017) as medical attention that entails a one-time, short-term treatment which requires little technology or training to administer. First aid can include the following treatments:

- using a nonprescription medication at nonprescription strength;
- cleaning, flushing or soaking wounds on the surface of the skin;
- wound coverings such as bandages, gauze pads, butterfly bandages, eye patches, finger guards, or Steri-Strips;
- hot or cold therapy;
- any non-rigid means of support, such as elastic bandages, wraps, non-rigid back belts, etc.;
- temporary immobilization devices while transporting someone (e.g., splints, slings, neck collars, back boards, etc.);
- drilling of a fingernail or toenail to relieve pressure, or to drain fluid from a

blister;

- removing foreign bodies from the eye using only irrigation or a cotton swab;
- removing splinters or foreign material from areas other than the eye by irrigation;
- tweezers, cotton swabs or other simple means;
- massages; or
- drinking fluids for relief of heat stress.

The term "near miss" is used when there is no injury, but one likely could have occurred. Examples of near misses would include a possible situation in which a tool falls to the ground from an elevated platform but does not injure anyone or cause damage or if the wrong wire is pulled, but the pulled wire also does not have an electrical charge.

Lost time injuries (LTI) are when an employee misses a work day after an accident. Often missing three days or more is considered a significant injury. They are usually fairly easy to measure because the "Time Away" is easily recorded. Much of the focus and attention of certain personnel roles is devoted to safety. In fact, an employment sector has been established to oversee safety management system and to measure the level of safety. This measurement is mostly based on lost time injuries LTIs. However, the number of LTIs is a weak measure of safety because the days away can be manipulated and because the level of safety and the number of LTIs at a given time are not necessarily interrelated (Jørgensen, 2016).

Some studies use a variation of this by calculating the total cases of incidents recorded per 100 employees per year, which is a simple frequency rate (Johnson, 2007). Lost work day case record is the number of lost workdays per 100 employees per year, or the number of lost workdays per 100 employees per year is a statistic that can point to the severity of accidents

(Johnson, 2007). Accident rate measures safety performance merely by the number of accidents, and it is often considered a weak measure because an honest contractor who accurately reports and investigates accidents are at a disadvantage than those who do not report all accidents (Ng, et al., 2005). OSHA defines incidence rates as the number of injuries and illnesses, or lost workdays, per 100 full-time workers. Rates are calculated as the number of injuries and illnesses or the number of lost workdays times 200 divided by total hours worked by all employees during a specified period.

Incident Rate = N × 200,000 ÷ EH

N = number of injuries and illnesses, or number of lost workdays.

EH = total hours worked by all employees during a month a quarter or fiscal year.

200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

As previosly mentioned, another type of measure used to consider organizational safety is an experience modification rating (EMR). This rate is often abbreviated to EMOD or XMOD too. In the United States, ERM is primarily calculated and used by worker's compensation insurance carriers. EMR is used to capture the ratio between claims actually filed and anticipated claims for a specific type of work, and reflects the cost organizations must pay for workers' compensation insurance (Ng, Cheng, Skitmore, 2005). The EMR formula can be complex, and multiple versions of calculation exist (Ng et al., 2005). One example of a simplified version of the formula used by National Council on Compensation Insurance (NCCI) is:

$$\frac{\text{Actual Primary Losses + Stablizing Value + Ratable Excess = Total Actual Primary Losses}}{\text{Expected Primary Losses + Stablizing Value + Ratable Excess = Total Expected Primary Losses}}$$

(Experience Modification Rating - The EMR, EMOD and XMOD, 2017). EMR does not represent the actual current safety performance of organizations because the inputs are used in the formula are generated on running average from the past (Ng et al., 2005).

Philosophical Initiatives Effecting Safety Outcomes

With the above measures, the intent is to provide an indication of safety. Several years ago, the vision of zero accidents came into vogue. The initial use of a zero vision was the 'zero defects' method, created in the mid-1960s used as part of the Titan Missile program by Martin Marietta Corporation which is not a part of Lockheed Martin (Halpin, 1966). Zero visions have been used for a variety of different causes including zero defects, zero emissions, zero traffic accidents, zero wastes or zero economic waste (Zwetsloot, Aaltonen, Wybo, Saari, Kines, and Beeck, 2013). Zero accident visions first gained popularity as a Scandinavian road safety program (Zwetsloot et al., 2013), but expanded to occupational safety and health arenas. There is a consensus that zero-accident vision was initiated as an actual vision, meaning a goal to strive to achieve, rather than a tangible objective. Zero accident vision is a safety commitment strategy rather than a risk control strategy (Zwetsloot et al., 2013).

Zwetsloot, Kines, Wybo, Ruotsala, Drupsteen, Bezemer, (2017) looked at how zero accident visions were successfully implemented throughout organizations in seven different European countries. They found that the companies that implemented zero-related initiatives successfully had several traits in common. These include a high commitment to a zero-accident vision by their managers and workers. The managers demonstrate via their strategies and practices an obligation to advance safety and realize that effort is continual. Safety commitment, communication, culture, and learning, (although all interrelated) provide an important focus when an organization is attempting the vision of zero accidents.

The other elements they noted, include zero accident vision as the basis for inspiring innovative approaches to improve safety. Zero accident vision is propelled by both organizational and individual commitment. For example, in a setting where workers can be open about mistakes to promote learning, the culture is encouraging a healthy value system that can propel success with the traits noted earlier. Zero accident vision commitment is a core value in a company's business strategy.

Work environments, especially industrial construction environments, are incredibly complex. Significant safety improvements have come from technology and a methodical management approach of continual process improvement thus turning safety management systems into an administrative process in constant pursuit of the best paths to achieve a safe workplace and the need to frequently evaluate current safety practices (Zwetsloot et al., 2013). There is a tendency to treat workplace safety as an administrative function. However, since human reactions and behavior play an intricate role in safety, safety issues can never be entirely foreseen. Human reliability analysis models are characteristic of known and knowable contexts, and so often common managerial practices are not appropriate when managers face complex or chaotic contexts (Snowden 2000, Snowden and Boone 2007, and French et al., 2011). This does not mean that the systems in place are unreliable or unsafe; but rather that the reliability or safety cannot be assured to lower than negligibly small probability. (French et al., 2011, and Zwetsloot et al., 2013).

Zero accidents or any measure of accident rate or resulting outcome is a lagging indicator of safety since the outcomes can only be tabulated after they occur. While accident rate can be a result of a robust safety strategy in place, it can also be influenced by chance in accident occurrence, or even by concealing reporting with punitive measures or inducements such as bonuses and or other reward programs (Mathis, 2013). Lagging indicators are accountability metrics as they can indicate if the rate is improving, worsening, or remaining about the same. They do not tell us how to improve. Therefore, process indicators should be sought out and used if applicable. In an endeavor to get away from being reactive and relying only on lagging measures, some organizations attempt to develop leading indicators for safety to be proactive. This initiative leads them to develop metrics. While metrics can be beneficial, they still need to be measuring something that influences the safety of the workers. Otherwise, the metric is just more administrative work without adding value. If the strategy involves processes with the intent of desirable outcomes, a measure can be put in place to indicate how well the processes are working. Essentially it boils down to the ability to measure if the strategy or plan works.

Paired with the rationale that zero-accident vision is a figurative vision, there is a concern that as the vision is communicated throughout an organization, the actual intent can get muddled as employees, and first-line supervisors may view the vision as an objective or minimum acceptable performance standard. Dekker, S. and Long, R., Wybo J. (2016) point out that if zero accident initiatives are interpreted literally, it could paradoxically create new kinds of misery for employees. For example, the sanctioning or punishment of employees who are involved in incidents could lead employees to refrain from reporting incidents. The accident-free vision may also generate an illusion by making injuries, accidents, and unpleasantness disappear via underreporting.

Injury underreporting is the occurrence of inconsistencies between the number of incidents that meet an employer's definition of reportable incidents and the number of incidents that are reported by the worker to the employer (Probst, Petitti, and Barbaranelli, 2017).

However, the definition can also be expanded to include both underreporting of the number of injuries or incidents reported by the employee to the organization in addition to the number of injuries or incidents experienced by employees but not reported by the organization (Probst and Armando 2010). OSHA administered a Recordkeeping National Emphasis Program (NEP) from 2009 to 2012 to assertain the scope and reasons occupational injuries and illnesses were unrecorded and incorrectly recorded. OSHA discoverd recordkeeping violations in nearly half of all facilities inspected (Fagan and Hodgson, 2017). Beyond the injuries that are recordable items on the OSHA 300 log, there is not a universal requirement for reporting other injuries or illness. Therefore the responsibility for outlining the incidents or resulting injuries to be documented or recorded lies with each organization or entity.

There can be many logical reasons that an employee may not want to report an injury. Probst, Petitta, and Barbaranelli, 2017, note several factors that can lead to not reporting an injury to an employer including job insecurity, production pressure, safety reporting attitudes and safety compliance. Fagan and Hodgson, 2017, and noted that employee interviews recognized a concern of punishment and employer disciplinary programs as the most significant causes of underreporting. When Probst and Armando, 2013, looked at employee's rationale in their 2010 article, via survey data, that allowed respondents to apply multiple reasons if appropriate there were a multitude of reasons. These reasons, in descending order from most frequently cited to least noted included: taking care of the issue or safety concern themselves (73.8%); not wanting to experience follow-up talks and questions (69.0%); an assumption that nothing would be done to fix the problem (51.2%); felt like it was not important (47.5%); believed reporting the injury would create hostile work experience (41.5%); not wanting to be the individual who breaks the company’s accident-free record (37.5%); understood the injury would negatively affect the crew's safety scorecard (37.2%); having the consequence of reporting results in the workgroup losing scorecard points (37.3%); getting blamed for the incident (23.9%); getting blamed for ending the company's accident-free record (21.7%); opening up for others to gossip in an undesirable way (19.7%); unethically disciplined (18.6%); mistreated in some other way (11.6%); being provided with an unfair performance evaluation (11.4%); and/or subsequently receiving less favorable duties (10%).

Probst and Armando, 2010, also found that when the organizational safety climate was viewed to be healthy there were fewer injuries, and beyond the lower injury rate, there were only slight differences between the extent of reported and unreported incidents. However they also note, on the other side, when the employees viewed the work safety climate to be poor, the proportion of accident underreporting meaningfully increased to more than three unreported accidents for every one accident that was reported correctly.

Measuring underreporting of accidents and injuries can be quite difficult. Perhaps it can be a bit easier to possibly quantify the discrepancy between the OSHA 300 log and the injuries that should have been reported by the organization but were not. In some settings, this could possibly be accomplished by reviewing leave and attendance records in tandem with health insurance and supplemental insurance claims. However, this could not only be difficult to obtain, but may not necessarily contain the desired data, and legal issues. The Health Insurance Portability and Accountability Act (HIPAA) make a medical information very restrictive. HIPPA encompasses a law intended to provide privacy standards to protect patients' medical records and other health information provided to health plans, doctors, hospitals and other healthcare providers. Reviewing an employee's medical record is not something an employer can legally access in the United States. Rosenman et al., (2006) as noted in Probst et al., (2017) matched and compared companies and employees who reported job-related injuries and illness on the OSHA 300 log to information contained within four workers' compensation databases in the state of Michigan which resulted in findings that 60-67% of all workplace injuries were not included on the OSHA logs. Fagan and Hodgson (2017) found that onsite medical clinics were a potential new cause of both underreporting and recording of work-related injuries and illnesses. Where employees are not sharing injury information, individual-level underreporting, with their organizations, the degree to which it may occur would be even harder to capture. In part, because research is likely to attempt to obtain this information through a memory recall or a recognition-based approach as Probst and Estrada, 2010, did. Anytime an individual must rely on memory there can be a chance that the memory may be faulty and lack accuracy.

The literature on regulatory enforcement pulls from the economic model of deterrence; meaning decisions are made based on probable costs and benefits of compliance or non-compliance (Ko et. al 2010 and Weil 1996). Government enforcement programs, such as OSHA, utilize penalties that increase the economic costs of non-compliance. While the numbers are not exact, OSHA inspectors only visit about 2% of the workplaces every year (Davidson, Worrell, and Cheng, 2001) and the local OSHA Legal Presentation 2017). Weil (1996) while studying machine guard standards, found that 42% of all plants have no cited violation of the machine-guarding standards during their first OSHA inspection. The rate improved to 65.7% at the time of the second inspection and continues to slightly improve for subsequent inspections. However, more recent research discovered the extent of decline in compliance rate may be estimated to be very small. Ko, et al., 2010 found that in the years since 1996, there was only approximately a 3% increase in the number of serious violations for each added year between OSHA inspections. Specifically, they say that increasing to "seven years versus two years would increase the number of serious violations found by an average of approximately 15%; for example, from 2.5 per inspection to 2.88." Ko, et al., 2010. OSHA limits repeat violations to cases where the violation occurs within three years of the previous citation. (Ko, Mendeloff, and Gray 2010). Additionally, it is important to remain cognizant that the percentages are citation violations and not workplace injuries.

Numerous empirical studies examining OSHA have reviewed data at the industry-level (Viscusi (1979), Bartel and Thomas (1985), Viscusi 1986) and plant-level (Smith (1979), McCaffrey (1983), and Ruser and Smith (1991), and Gray and Scholz 1993). Except for Viscusi's (1986) and Gray and Scholz which had a statistically significant impact on injuries (penalties linked with a 15–22% reduction in injuries over a three-year period), the other studies did not find a significant impact on injuries from OSHA inspections and subsequent penalties. Gray and Mendeloff, 2005 found that personal protective equipment (PPE) standards had a statistically significant effect on the number of injuries when the standard for general requirements for personal protective equipment is cited in the previous three years. The PPE coefficients for caught-in and eye abrasion injuries were significant and led to reductions of about 25 percent in the number of injuries The PPE standard likewise had statistically significant effects (at the 0.10 level) on exertion injuries (the substantive effect of these citations was close to 30 percent). (Mendoeloff and Gray, 2005). Haviland, Burns, Gray, Ruder, and Mendeloff, (2012) found violations of the standard requiring PPE had the greatest effect on preventing injuries. This could be due in part to the PPE serving as a constant reminder to be safety-conscious as well as a physical protector from the environments.

Initially, over the years there has been a decline in serious injuries. In the mid-1980s "restricted work activity" injuries, became more prevalent while "days-away from-work" injuries decreased (Gray and Mendeloff, 2005). However, the rate of accidental deaths at work, when adjusted by population, decreased at almost the same rate before and after the passage of the 1970 OSH Act and therefore cannot be primarily attributed to regulatory controls on the part of government (Hood 1995). In addition to penalties and fines, there can be other factors that serve as motivations for compliance. These could include negative press. Davidson, Worrell, and Cheng (2001) attempted to link OSHA sanctions and fines to how well publicly traded on the stock exchange. They found that while a sanction negatively can affect the stock's price, the actual amount of the fine or number of citations was irrelevant. They speculate negative press, likelihood of civil lawsuits, and the expectation of capital expenditures to correct the problems are what triggers the change in stock value, and not the fine itself. The subpar public relations image can also negatively impact how the available labor force views the employer.

Hazard identification, through skill, awareness, and recognition is a critical element of an effective safety program because of the myriad of safety hazards that exist in the industrial setting and on construction sites. According to National Safety Council (NSC; as cited in Mitropoulos, Abdelhamid, and Howell, 2005, p. 817), a hazard is "an unsafe condition or activity that, if left uncontrolled, can contribute to an accident." To prevent safety hazards, management is required to provide employees with adequate training to become more aware of the existence of potential risks in the workplace, thus allowing them to become more safety-conscious. Subsequently, all decisions and behaviors in an industrial setting should be focused on safety.

Potential hazards are identified based on factors such as knowledge of the operations; experience with similar work assignments; knowledge of the environmental factors associated with a particular job or assignment; awareness of the capabilities and limitations of other crew members; condition of tools and equipment available for use; job design; etc. Several formal analytical hazard identification and evaluation methodologies are used in the manufacturing and other industrial settings. One such tool is a hazard and operability (HAZOP) analysis which systematically uses keywords to identify potential hazards that may arise from deviations from planned operations (Mushtaq and Chung, 2000). The construction industry typically utilizes an intensive review of schedules, project scope documents; safety data sheets (SDSs), environmental conditions; required tools and equipment; and other relevant documentation to define the construction task. The potential hazards are linked to the individual tasks and behaviors, and a risk assessment is conducted (MacCollum, 2006). Risk controls are then put into place based on the results of the analysis. These controls may either be procedural (e.g., policies and procedures) or physical (e.g., safety harnesses, barricades, respirators, etc.) and are designed to minimize or eliminate the risks or potential hazards.

Regrettably, the risk assessment process for both the industrial sector and the construction industry is completely dependent on data from the evaluation process (Mitropoulos & Namboodri, 2011). This dependence has hindered researchers and practitioners' ability to identify and control factors prior to construction (Mitropoulos & Namboodri, 2011) and other factors not mentioned in either the HAZOP or the evaluation process. Other factors complicating worker safety that must be recognized include overly complex construction processes; nonstatic organizational structure; fluctuating work sites (Li et al.; Building, 1987; Fang and Wu, 2013); and the characteristics of worker behaviors which are not as standardized as those in manufacturing settings (Li et al., and Geller, 2001a,b). Also, due to decentralization, construction workers usually work on different work locations and must make their decisions when fronting unique and unplanned for problems (Olson and Austin, 2001). Unidentified hazards are particularly dangerous as they can lead to a lack of perceived risks associated with a project and a worker's false sense of security.

Causation Theories

Poor safety performance has prompted researchers to model accident causation specifically to identify proactive hazard management measures. In fact, there are multiple accident causation theories and models published and studied by researchers. Accident causation models can be traced to the 1920s and range from simplistic linear models to complex non-linear models.

These simple sequential linear models theorized that incidents or accidents are the culmination of human error. Early researcher efforts were rudimentary and focused on the worker as the cause of workplace incidents. These early studies reported that workers were unable to adjust to dynamic work environments (Shaw and Sichel, 1971, p. 14), Kerr (1950, 1957). These early studies postulated an employee's characteristics and dangerous behavior as responsible for incidents (Greenwood and Woods et al., 1919).

The more significant focus on improving safety began in earnest around the 1930's with H.W. Heinrich's publication of *Industrial Accident Prevention*. According to Heinrich, five consecutive influences contribute to a construction accident injury: ancestry and social environment; the fault of an individual; unsafe acts and mechanical or physical hazards; accidents; and finally, the injury (Chi and Han, 2013). These generate a string of events resulting in an incident producing worker injuries (Chi and Han, 2013). Heinrich indicated that accidents are caused when a worker performs unsafe acts, or there are direct mechanical or physical hazards related to the work: the incidents or accidents can then result in injuries to the employee. Heinrich advocated "that the unsafe acts and conditions can be managed by social and organizational supports such as safety training, and the number of accidents can be reduced by understanding and eliminating unsafe acts (i.e., human-related factors) and unsafe conditions (i.e., environment-related factors)" (Chi and Han, 2013). He is well known for proposing 88% of industrial incidents are unsafe acts taken by an individual or people; 10% are dangerous mechanical or physical conditions; and 2% are unpreventable, and subsequently his theory estimating "that in a unit group of 330 accidents, 300 result in no injuries, 29 in minor injuries, and one in a major or lost-time case" inclusive of death (Choudhry, 2014, Manuele, 2011).

Theories such as Heinrich's domino theory hypothesize a chain of successive events culminating in an accident but do not redirect the fault away from the employee (Heinrich, 1932; Manuele, 2003). Specifically, the domino theory suggests that occupational injuries are caused when unsafe conditions are combined within unsafe actions that originate from the faults of individuals. The domino theory was often used for accident alleviation (Heinrich et al., 1980) and eventually evolved into Deviation Theory (Kjellen et al., 1984 a,b) where potential changes in each domino are articulated and assessed. The crux of the Heinrich Domino Theory (1930) is summarized below.

- Injuries are caused by accidents.
- Accidents are caused by unsafe acts and unsafe conditions.
- Unsafe acts and unsafe conditions are caused by the faults of persons.
- Faults of personnel are caused by personal flaws such as violent temper, nervousness, or ignorance.
- The injured worker's ancestry and social ancestry can be contributory factors.

There is continual debate around H.W Heinrich's work. The main issues that are cited often include further research on causation, as previously noted, but also a deficiency about statistical rigor. The question of the number of near misses/close calls to actual injuries (Heinrich: 300 to 29 (1930) has been revisited several times, for example, by Frank Bird finding 600 to 10 to 1 in 1969, and the U.K. safety society finding 189 no injury events for every three (3) days of lost time in the 1990s, (Tomlinson, 2015). Chi and Han, 2013, analyzed 9,358 accidents that occirred in the U.S. construction industry and merged systems theory into Heinrich's theory to understand association between risks and accident causation. They tested central correlations between accidents and injuries and those between risks and accidents with the Chi-square analysis and Fisher's exact test, which confirmed the suitability of Heinrich's theory to the data set and reliability of the accident data. Correlations among different risk factors including environmental condition, worker behavior, and injury source were also statistically identified.

Heinrich's work has fallen out of favor over the last few decades, primarily because understanding has advanced about how accidents happen and their contributing factors. A focus is now placed on improving the work system rather than primarily on employee's behavior (Manuele, 2011). Therefore, there have been some continued studies to explore the "inter-relationships among risk elements including unsafe acts, mechanical hazards, and environmental conditions that were identified" (Chi and Han, 2013) as accident origins by Heinrich (1936). Robert J. Firenze (1978) believed accident causality is a collection of interacting and interrelated risk parts and stressed synchronization between human, machine, and environment for accident prevention rather than the environment as being filled with danger and the workers as being disposed to making mistakes; hence he assumed with normal and stable conditions the chance of an accident is small (Chi and Han, 2013).

Later accident research (Haddon et al., 1964), known as injury epidemiology, postulates that accident prevention efforts do not inevitably lead to injury prevention. These theories moved beyond focusing solely on the individual as the root-cause of the incident or accident and began examining the injuries themselves. As a result, the understanding of the complexity of the accident causation improved. This group of theories emphasizes energy transfer as a critical part of an injury or incident and attempts to lessen the extent of the severity of the incidents as a means to decrease the losses. Researchers began to focus on explaining the multifaceted aspect of the worker's interaction with the work environment.

Hinze (1996) created and formed the distraction theory which proposes that productivity demands, and difficulties reduce a worker's ability to pay attention to hazards thereby increasing the likelihood of an accident. Productivity demands on accident rates and underreporting were also reviewed by Probst and Graso (2013). Abdelhamid and Everett (2000) found that occupation injury typically occurs due to one or more of the following factors:

1) Misinterpret or overlook a dangerous condition that existed prior to starting an activity or that developed after work started;

2) opting to go forward with a work activity after the worker recognizes an unsafe condition; or

3) determining to act precariously irrespective of the circumstances of the environment.

The system approach to accident causation appeared in the 1970s to address the task of sustaining safety in progressively complex work systems. Khanzode et al., (2012) state, “Injury epidemiology models perceive three aspects to explain the injury phenomenon as (Haddon et al., 1964): the host (the person injured), the agent (the energy leading to injury), and the environment (physical, biological and organizational)” (Khanzode et al., 2012, p. 1360). They go on to say, the features evolving with time are the most direct influences causing injury.

The Haddox matrix was developed in 1970 and is a model designed to focus on human, environmental, and organizational factors that could cause or promote an injury before an event, during an event, and following an incident (Robertson, 1992) (McDonald, Lipscomb, Bondy, and Glazner, 2009). McDonald et al.; 2009, found the Haddon Matrix to be valuable in classifying influences that contribute to construction injuries (Bondy et al., 2005; Glazner, et al., 2005; Glazner et al., 1998; Lipscomb et al., 2003). During this period, safety was no longer typically perceived as optional or optional component of the work, but rather as a piece of the comprehensive management plan.

The development of the Behavior Based Safety (BBS) approach was an effort to create a safety system dynamic enough to oversee and handle unique, variable, actual risks and safety threats. According to Ismail et al., 2012 and Li, Lu, Hsu, Gray, Huang, 2015, “The four basic steps of the Behavior-Based Safety approach are (1) identification, (2) observation, (3) intervention, and (4) review (or follow-up observation) and monitoring”. They also note seven basic principles BBS is grounded in are:

1) intervention;

2) identification of internal factors;

3) motivation to behave in the desired manner;

4) focus on the positive consequences of appropriate behavior;

5) application of the scientific method;

6) integration of information;

7) planned interventions.

Due to the likelihood and ability of construction workers to spread out and move continually around construction sites, monitoring observing, and controlling individual and group behavior is difficult (Zhang and Fang, 2013 and Li et al., 2015).

Safety factors

Many factors that can ultimately affect safety outcomes are quite numerous. Hallowell, Hinze, Baud, and Wehle (2013) identified over fifty proactive measures for measuring safety performance and labeled thirteen of them as top priorities. The top thirteen included reporting on near misses, project management team safety process, worker examination process, stop work authority, auditing programs, pre-task planning, housekeeping program, owner's participation in worker orientation, foreman discussions and meetings with the owner's project manager, owner safety walkthroughs, pre-task planning for vendor activities, vendor safety audits, and vendor exit debriefs. Other extensive lists include a chart that Ismail, Doostdar, and Harun, 2012 provided which reflects safety factors adopted by various countries (see Figure 1).

Country	Safety Factors Adopted
Australia	Project management committee (management support)
	Hazard management (accident analysis, safety controlling)
	Training, information and promotion
	Implementation (equipment, safety environment, safety supervisor)
	Recording, reporting and investigation (safety process factor)
	Emergency procedures (safety organization)
	Safety review (develop committee and responsibility)
China	Safety meeting (management support)
	Safety inspection (safety motivation)
	Safety regulation enforcement (safety responsibility)
	Safety training (safety training)
	Safety communication (personal factors)
	Safety cooperation (safety culture)
	Management worker relationship (safety organization)
	Safety resources (safety clear instruction)
Finland	Training and practice
	Work involvement (process factor & environment, etc.)
	Personal factors
	Responsibility (safety responsibility)
	Clear and realistic goals (safety clear instruction)
	Management support
Jordan	Safety policy (safety culture)
	Training (safety training)
	Safety meeting (management support)
	Safety equipment (safety organization)
	Safety inspection (safety motivation)
	Workers attitude (personal factors)
	Labor turnover rate (process factors)
	Safety Motivation (safety motivation)
Malaysia	Organization in construction management (safety organization)
	Good communication (personal factors)
	Clear goals (safety clear instruction)
	Availability (safety culture)
	Control of sub-contractors (safety controlling)
	Contractors satisfaction (safety motivation)
	Codes and standards (safety code & standards)
	Training (safety training)
	Staff responsibility (safety responsibility)
	Construction cost optimization (safety process factors)
	Safety controlling
	Management commitment (management support)
Netherland	Safety standards (safety code & standards)
	Safety responsibility (safety responsibility)
	Training expert extra safety staffs (safety training)
	Safety organization (safety organization)
	Thematic approach (safety clear instruction)
	Safety analysis (management support)

Figure 2.1. Safety Factors Adopted by Various Countries
(figure cont’d.)

Singapore	Incentive and punishment and recognition (safety motivation)
	SMS and Insurance policy and statutory requirement (safety policy or safety culture)
	Safety framework and management difficulty and sub contractors (process factors)
	Safety attitude and management commitment and contextual characteristics of worker (personal factors)
Spain	Safety policy (safety culture)
	Incentive for participation (safety motivation)
	Training (safety training)
	Communication (personal factors)
	Prevention planning (management support)
	Emergency planning (safety organization)
	Internal controlling (safety controlling)
	Benchmarking (safety code and standards)
Thailand	Personal attitude, positive group, communication, personal competency (personal factors)
	Personal motivation, (safety motivation)
	Teamwork, (safety training)
	Equipment management, employee participation, enforcement scheme (process factors)
	Program evaluation (safety organization)
	Sufficient resources, clear goals, (safety clear instruction)
	Management commitment, supervision (management support)
	Authority and responsibility, (safety responsibility)
USA	Safety meeting (management support)
	Safety inspection (safety motivation)
	Safety regulation enforcement (safety responsibility)
	Safety training (safety training)
	Safety communication (personal factors)
	Safety cooperation (safety culture)
	Management worker relationship (safety organization)
	Safety resources (safety clear instruction)

Their [Ismail, et al 2012] study utilized a self-administered three-part questionnaire to employees as well as interviews with industry experts. It looked at leading safety factors that determined the effective of safety management systems used for construction sites and the frequency/awareness of construction workers of matters concerning safety. They determined "that among the influencing cluster of factors determining the success of a safety management system the most influential was the Personal Factor (awareness, strong communication, attitude, positive groups, personal competency); and among the subfactors making up this cluster the prominent factor was safety awareness." (Ismail, Doostdar, and Harun, 2012 page 9). Their survey results also revealed that the respondents were thoughtful regarding the requisite of management to ensure their workers are better informed about safety issues, improved design and use of equipment and PPE, and employers ponder reducing manual labor.

Falls often can lead to serious injury or death, yet seem to happen at an alarming frequency. The US Department of Labor via their education material, Fall Prevention Training Guide A Lesson Plan for Employers OSHA 3666-04 2014 A Guide for Employers to Give Fall Prevention Training to Workers Occupational Safety and Health Administration U.S. Department of Labor, 2018, lists multiple ways injuries from falling can occur: falls from stairs or steps; falls through existing floor openings; falls from ladders; falls through roof surfaces (inclusive of roof openings and skylights); falls from roof edges; falls from scaffolds or staging; falls from building girders or other structural steel; falls while jumping to a lower-level; falls through existing roof openings; falls from floors, docks, or ground level, and other non-classified falls to lower levels.

Temporary work, specifically at heights, is a primary cause of construction accidents that result in serious injuries and fatalities. Many of these accidents occur when a worker falls from scaffolding and work platforms (Rubio-Romero, Rubio, and García-Hernández, 2003). Though various practical solutions exist to prevent falls from different heights, falls are still a significant issue in the industry due to a deficiency of education and awareness of how to correctly utilize preventions (Bunting, Branche, Trahan, Chris, Goldenhar, 2017). In 2014 and 2015 training, equipment inspection, and safety audits were popular endeavors by companies to help reduce falls. Scaffolding standardization led to improved safety on construction sites (Rubio-Romero, Rubio, and García-Hernández, 2003).

Previously Janicak, 1998, found that employee training, requiring the use of fall protection systems as well as testing and maintenance of the fall protection systems should be used to prevent fatal work-related falls in the construction industry. OSHA standards for fall protection can include guardrails or a personal fall arrest system. Regarding falls resulting in death, some frequently cited reasons for the fall include no fall protection, structural collapse, falling off of a ladder, fall protection not attached to a structure or the employee, improper work surface, damaged fall protection, or the task of erecting or dismantling scaffolding (Janicak, 1998). Mason, et al., 2017 attributed deaths from falling in the oil and gas industries to workers who fell when their harnesses were not attached to an anchor point, incorrect wearing/ill-fitting fall protection harness, and equipment failure. Fall protection equipment should to be checked daily. Damaged, broken or inappropriately altered equipment should be taken out of the worksite or destroyed to prevent someone using it in the future. The two main categories of fall protection are primary or active and secondary or passive fall protection (Chi, et al., 2005 & Bobick et al., 1994). Active or primary fall protection measures physically prevent falls to a lower level from happening. These include surface protections (nonslip flooring), fixed barriers (handrails and guardrails), and surface opening protections (removable covers and guardrails). Passive or secondary protections impede the severity or minimize injury after the event has already been set in to motion or occurred. Secondary measures can include travel restraint systems (safety line and belt), fall arrest systems, and fall containment systems (safety nets, safety line and harness, tie-off with both self-retracting lifeline (SRL) (Chi, et al., 2005).

Multiple studies have found that postural stability, or conversely instability, is a frequent factor relating injuries from falling (Hsiao and Simeonov (2001), DiDomenico et al., (2010) Houtan Jebelli, Changbum R. Ahn, Terry L. Stentz (2016). Body stability is studied by analyzing dynamic and postural stability, the assessment can improve worker safety on the job sites.

Equipment

Individual protective equipment does not prevent accidents or incidents but only prevents the injury or reduces the severity by protecting the worker from the effects, whether the effect is from the impact of force or chemical substances, toxin, allergic, etc., (Oliveira & Pilon 2003). Workers that utilize personal protective equipment have a significant effect on the statistics that related to the equipment and accidents because they are the ones who ultimately wear and utilize it correctly or misuse it or in some instances, remove it. (de Souza and Souza, 2017).

In addition to preventing falls from heights, equipment can protect workers from other impacts including falling items; sharp edges; and debris around the site. Some examples of safety equipment include guardrails, safety nets, screens against risk of projection materials and tools; resistant temporary locks on floor openings; protection flooring; specifically on ramps; walkways and stairs; fire extinguishers; signs of possible dangers (sirens, warning signs, striped ribbons); protection trays; and electrical groundings. Safety equipment specific to the individual includes safety helmet; gogles (for debris or high-intensity light such as welding); respiratory masks; and gloves; ear plugs; steel or compost toe boot; rubber boots to prevent contact with harsh chemicals; dust mask; chemical mask; seat belt; work glove; visibility vest; and protective visor.

Construction equipment related accidents are a substantial source of workplace fatalities and injuries in the construction industry. Specifically, visibility issues (or blind spots) are another primary reason for construction equipment related accidents and injuries. Efforts have been made to lessen the problem of collisions by providing assistance to workers, however being struck by objects and equipment remains the third leading cause of construction fatalities (behind falls and transportation incidents) (Sua, Panb, Grintera, 2015). A possible remedy could include using external views that offer supplementary spatial information to correct for the visibility problem. However, this may create additional problems because the additional spatial information may increase mental workload and present difficulties in processing the information by workers (Sua et al., 2015). Resources for worker focused data and communications technology could reduce such disadvantages. Lin, Tsai, Gatti, Lin, Lee, Kang (2014) reviewed the use of an original two-step user-centered design approach to develop and evaluate an iPad application with the goal of improving the routine practices and management of safety inspections. They ultimately found indications that the tool is useful and practical because it gathers consistent data that can be used in the future to assist with the development of progressive safety and health data analysis techniques. (Lin, Tsai, Gatti, Lin, Lee, Kang 2014). Previous research studies have attempted to overcome this issue by using remote tracking methods to provide equipment-worker proximity notifications like, Radio Frequency Identification (RFID), Ultra-wideband (UWB), and Global Positioning Systems (GPS).

However, a negative feature in the attempts to use remote locating/tracking devices is the necessity to install sensors on the equipment and ensure workers wear the sensors, for the data sent from the devices could be read to know the location movement tracking of the equipment and workers (Zhu, Park, Koch, Soltani, Hammad, Davari, 2016). Zhu, Park, Koch, Soltani, Hammad, Davari, 2016 suggested and investigated the use of Kalman filters for predicting the movements of workers and moving equipment on construction sites. Kalman filters use the positions of the equipment and workers to estimated future locations from multiple video cameras resulting in the corresponding estimates of the equipment and workers' future positions and could adjust their predictions based on the worker or equipment's preceding location changes. The researchers noted their efficacy tests with real site videos reflect results with a high prediction accuracy of the Kalman filters (Zhu, et al., 2016).

Temporary Workforce

In the late 1950s it is estimated that there were about 20,000 temporary employment and help services workers (Luo, 2010). In the early 1970s that number grew to around 200,000, ballooned to approximately 1.1 million in the 1990s, and by the late 2000's reached roughly 2.3 million (Luo, 2010). Most recently, in 2017 the U.S. DOL's Bureau of Labor Statistics (BLS) estimation of contingency employment agreements encompass about 5.9 million workers (Contingent and Alternative Employment Arrangements — May 2017, December 2018). There are multiple names and forms of non-traditional employment, including contingent workers, contract workers, long-term temps, on-demand freelance, seasonal workers, and workers in dual employer situations. Some of the labels are self-explanatory and merely serve to describe the employment arrangement. General definitions of the other terms, which the DOL consider major categories of temporary workers are:

Contingent workers grouping is perhaps the broadest category because the term is inclusive of those workers who do not have an implicit or explicit contract for continuing employment. Workers who do not expect to continue in their jobs for personal reasons such as retirement or returning to school are excluded from this category since as long as they would have the possibility of continuing in the job were it not for these personal reasons (Contingent and Alternative Employment Arrangements, February 1999, 2018).

Independent contractors including independent consultants and freelancers remained the largest of the four alternative work arrangements. The Internal Revenue Service the client has the authority to govern only the result of the work and not what will be done or how the work will be performed (Contingent and Alternative Employment Arrangements, February 1999, 2018).

On-call workers are workers who are called to work only when necessary. Temporary help agency workers are paid by a temporary help agency, regardless of the length of the job they are assigned to perform.

Workers furnished by contract companies are employed by an organization that offers the worker or their services to other entities under formal agreements. Typically, the worker is assigned to one customer at a time and performs the duties at the client's worksite. They may move from client to client while remaining employed by their employment agency (Contingent and Alternative Employment Arrangements, February 1999, 2018).

Subcontracting is “the process of subletting the performance of tasks which often affects the employment status of the workers doing the tasks as well as the manner in which those tasks are performed, the structure of control at the workplace and the patterns of regulation” Mayhew et al., (1997). Chiang, 2009 and (Tam, Shen and Kong, 2011), describe the subcontracting system “as the contractual process in which a primary contractor subcontracts parts of the job to other contractors, who might also subcontract to yet another organization. This latter description is multi-layered subcontracting.

The following chart issued by the BLS (2018) shows the breakdown of different percentages of different employment situations over the years. As a note, this chart is not specific to industrial construction or manufacturing, but rather all sectors of employment. In the industry relating to the manufacturing of energy and chemicals, many of the workers are provided by contracted firms.

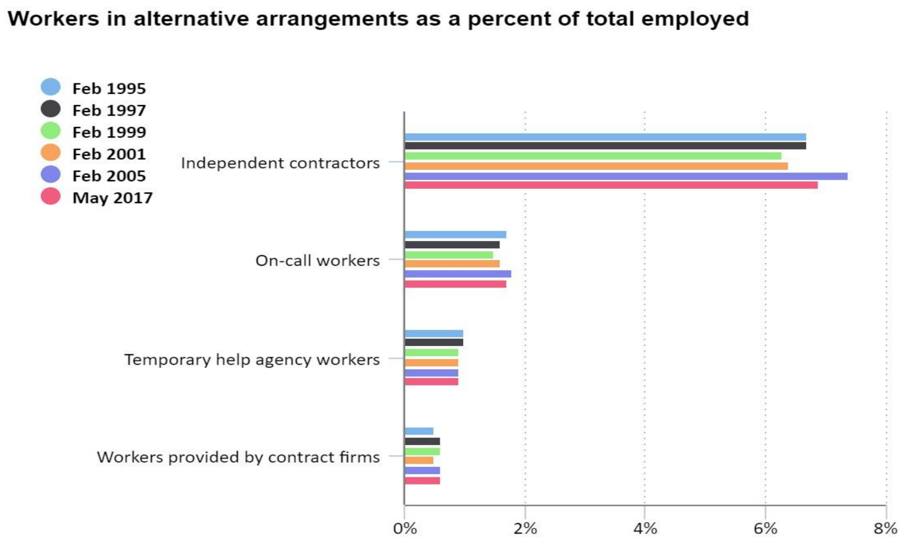

Figure 2.2. Percentages of Different Employment Situations

There are numerous reasons for the significant numbers of contingent workers in the United States including: specialization of work; flexibility with labor costs and quickly meet changing demands; externalize unrewarding activities or those viewed as more dangerous; capability to bargain down labor prices; encourage faster task completion; the shift of financial risk; and avoidance of direct costs relating to workers' compensation. (Manu, 2013; Chiang, 2009; ILO, 2001; Mayhew and Quinlan, 1997; Wong and So, 2002).

While there are numerous benefits to these types of arrangements, there are also some potential drawbacks or concerns. These can include, as noted in Manu, 2013 who referenced several sources, the following five rationales. These types of employment relationships can be disintegration or self-centered decision-making units because of conflicting interests. Uncertainty about authority and obligations, as well as blurred work associations subsequent to the subcontracting relationships. Poor or weak communication and cooperation among contractors stemming from divisions of a centralized employer. Some arrangements may decrease awareness of subcontracted workers with safety issues of site activities; which is a problem that is further increased by the temporary duration of construction projects and the short timeframe spent by subcontractor workers on site within project span. Lastly, there may be "differences in safety cultures between main contractors and subcontractors" (Manu, 2013; Ankrah, 2007; Hide et al., 2003).

The CDC points out that there is mounting research that temporary workers have a higher rate of workplace injuries. They have noted that "temporary workers were more likely to rate their job as less hazardous than permanent employees in similar industries, possibly indicating a lower ability to accurately assess hazards" (Estill, 2015). It is likely that pre-assignment screening, safety training, or safety equipment did not occur prior to starting their assignment (Estill, 2015). According to Luria and Yagil (2010) temporary workers tended to focus more on safety as it relates to the individual, while more permanent employees also looked to organizational and group level referents. Previous research has also found that temporary workers had more confidence in their own safety along with a higher need to prioritize safety than permanent workers (Alexander et al., (1994).

Organizational Programs and Characteristics including Safety Climate and Safety Culture

For the last few decades, starting in the early 1980s, the trend has been to attempt to quantify safety climate safety and culture because they may link to better indicators to prevent possible safety issues. Schein (1992) explained organizational culture as "a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems". Guldenmund (2000), used a more succinct definition of safety culture as those characteristics of the organizational culture, which will influence attitudes and behavior related to increasing or decreasing risk. Safety culture is a subsection of the general overarching culture of an organization and seems to influence the opinions of members in relationship to safety performance (Cooper, 2000 and Zhou et al., 2008). Typically, safety culture is framed as a set of prevailing indicators, beliefs, and values concerning safety within an organization (Fang et al., 2006; Zhou et al., 2008). The safety culture can influence the current and future members' decisions, behaviors, and practices as it impacts both current worker's individual habits and the decisions, behaviors, and practices of future workers. Organizational climate denotes common perceptions among organizational members regarding the collective's policies, procedures, and practices (Reichers and Schneider, 1990; Rentsch, 1990; Z. Dov, 2008). Safety climate accordingly relates to shared perceptions about safety policies, procedures, and practices (Dov, 2008).

Safety in the construction industry, as in most industries, could improve from a constructive safety climate, helpful and frequent safety communication, and a practical and positive error management climate (K.P. Cigularov et al., 2010). Much of the research suggests management should encourage a proactive and useful approach to handling errors, reassure employees and encourage them to discuss errors and near misses, and urge employees to inquire and discuss safety concerns (e.g., Cheyne et al., 1998; Griffin and Neal, 2000; Hofmann and Mark, 2006; Hofmann and Morgeson, 1999; Mearns et al., 2003; Probst, 2004; K.P. Cigularov et al., 2010).

CHAPTER 3: METHODOLOGY

Purpose of Study

The primary purpose of this study is to determine the influence of selected organizational, demographic and safety practice factors on the number and types of injuries within the industrial manufacturing plants in eight parishes in southern Louisiana.

Specific Objectives

The following specific objectives were formulated to guide this research study:

1. To describe the responses of the participating safety officers on the type of industrial organizational facilities in the eight parishes on the following selected measures regarding workplace injuries:

(a) Describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred;

(b) Describe the number of safety events (injuries illnesses and first aids) reported by the safety officers at the industrial organizational facilities;

(c) Describe the number of safety events (injuries illnesses and first aids) reported by the safety officers at the industrial organizational facilities overall and during each quarter of the year;

(d) Describe the responding safety offices at the industrial organizational facilities regarding whether or not the site developed best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities;

(f) Describe the number of each type of OSHA recordable event (deaths, time away from work, job transfer, and other) and the number of safety events (injuries, illnesses, and first aids) (overall and for direct employees and contractor employees) as reported by the safety officer at each industrial organizational facility.

2. Describe the injuries at the industrial organizational facilities as reported by safety officers on the following selected characteristics:

(a) Basis (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction) of the injury;

(b) Body part injured (hand, head, leg, foot, arm chest back and/or shoulder).

3. Compare the number of safety events illnesses, first aids, and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities that affected direct employees with the number of safety events and OSHA recordable events that affected contractor employees.

4. Determine if a relationship exists between number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities and the following characteristics of safety event and OSHA recordable event:

(a) Type of facility;

(b) Quarter in which the event occurred;

(c) Basis of the event; and

(d) Body part affected by the event.

5. To determine if a model exists to explain a significant portion of the variance in the number of safety events (injuries, illnesses, and first aids) from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

6. To determine if a model exists to explain a significant portion of the variance in the total recordable incidents from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

Dependent Variable

The dependent variables of this study are the number and types of injuries that occurred to workers in industrial manufacturing plants in south Louisiana. The study specifically focuses on injuries that were reported between the first quarter of 2014 and the last quarter of 2016 in eight parishes in southern Louisiana.

Population and Sample

The target population for this study was industrial manufacturing plants. The accessible population was industrial manufacturing plants in the eight parishes surrounding Baton Rouge, Louisiana. The sample was 100% of the defined accessible population.

Instrumentation

The instrument used to collect data for this study consisted of a researcher-designed, computerized, recording form. The specific variables to be measured were selected based on the review of literature, logical argument, and the information that was obtainable from a database. The information from the databases was downloaded into a file, which served as the research instrument. The variables to be recorded include:

1. Time Frame Year – Four Digit Date;
2. Time Frame Quarter – Label;
3. Type of injury/event for a direct hire employee (Death, Cases Involving Days Away from Work, Job Transfers, Other Recordable, Illness, First Aids Cases);
4. Type of injury/event for a contract employee (Death, Cases Involving Days Away from Work, Job Transfers, Other Recordable, Illness, First Aid Cases);
5. Source of injury (water cut - plant injury, line of fire, access/egress, heat stress, fatigue, equipment failure or improper use of equipment, improper procedure use or violation, other.);
6. What body part(s) were affected (hand, head, leg, foot, arm, chest, back, or shoulder);
7. Has your site developed (or plan to develop) any best practices based on the most common recordable seen at your site? Yes, no or blank.

Data Collection

Data collection came from contact with industry trade association to determine if they were willing to share their data. Prior to the transfer of data, all individual identifiers were removed. The data received by the researcher has been maintained strictly confidential.

Transferring information from the databases onto a computerized recording form designed by the researcher was the method that was used to collect the data. Permission for this study was requested and granted from the trade association; permission to access the necessary data and approval for conducting the study was obtained from the Institutional Review Board (IRB).

Specific demographic and descriptive variables were selected according to the research questions presented in this study. Variables were systematically retrieved from the initial database, and a new file was established.

Data Analysis

The first objective of this study to describe the responses of the participating safety officers on the type of industrial organizational facilities in the eight parishes on the following selected measures regarding workplace injuries:

(a) Describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred;

(b) Describe the number of safety events (injuries illnesses and first aids) reported by the safety officers at the industrial organizational facilities;

(c) Describe the number of safety events (injuries illnesses and first aids) reported by the safety officers at the industrial organizational facilities overall and during each quarter of the year;

(d) Describe the responding safety offices at the industrial organizational facilities regarding whether or not the site developed best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities;

(f) Describe the number of each type of OSHA recordable event (deaths, time away from work, job transfer, and other) and the number of safety events (injuries, illnesses, and first aids) (overall and for direct employees and contractor employees) as reported by the safety officer at each industrial organizational facility.

To describe the data for this objective, frequencies and percentages were utilized for the categorical variables: quarter, if a site-specific plan has been developed (coded as 0 or 1). Type of events, type of injury, whether the worker was a direct employee of the facility or a contractor. These were coded as direct hire = 1 and contractor = 2.

The second objective of this study was to describe the injuries at the industrial organizational facilities as reported by safety officers on the following selected characteristics:

(a) Basis (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction) of the injury;

(b) Body part injured (hand, head, leg, foot, arm chest back and/or shoulder).

The analysis that was used to accomplish this objective was to report the frequencies and percentages of injuries in each of the categories identified.

The third objective was to compare the number of safety events illnesses, first aids, and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities that affected direct employees with the number of safety events and OSHA recordable events that affected contractor employees.

The fourth objective was to determine if a relationship exists between number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities and the following characteristics of safety event and OSHA recordable event:

(a) Type of facility;

(b) Quarter in which the event occurred;

(c) Basis of the event; and

(d) Body part affected by the event.

This analysis used the chi-square test of independence to determine if the type of employee, direct hire or contract employee, is independent of each of the injury's characteristics.

The fifth objective is to determine if a model exists to explain a significant portion of the variance in the number of safety events (injuries, illnesses, and first aids) from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction); and

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Number of injuries by body part affected.

The final objective is to determine if a model exists to explain a significant portion of the variance in the total recordable incidents from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

The researcher used stepwise entry of the independent variables due to the exploratory nature of the study.

In these regression equations-variables were added that increased the explained variance by one percent or more while the overall regression model remained significant. In conducting the multiple regression analyses, four of five variables which were treated as independent variables are categorical in nature and were prepared as dichotomous variables in preparation for entry into the analysis. These variables include the type of facility at which the injury occurred, quarter (timeframe) in which the injury occurred, source (water cut, access/egress, heat stress, fatigue etc.) of the injury, and body part affected. Whether organizations have or plan to have established best practices or not is already dichotomous.

Each of the dichotomous variables was examined for correlation with the scale/subscale scores. If there is a large number of variables with very small correlations with the dependent variable, they were eliminated from the regression analysis. However, initially each original variable had at least one of the dichotomous categories included in the analysis.

The first step in conducting the regression analysis is to examine the bivariate correlations. Two-way correlations between factors used as independent variables and "VARIABLE NAME".

To ensure that variables entered into the regression analysis do not have excessive collinearity or that any combination of the independent variables formed a singularity, the variance inflation factor (VIF) were examined. According to Hair et al., (2006), "A common cutoff threshold is a tolerance value of 0.10 which corresponds to a VIF value of 10," (p. 230).

CHAPTER 4: RESULTS

The primary purpose of this study was to determine the influence of selected organizational, demographic and safety practice factors on the number and types of injuries within the industrial manufacturing plants in eight parishes in southern Louisiana.

Specific Objectives

The following specific objectives were formulated to guide this research study:

1. To describe the responses of the participating safety officers on the type of industrial organizational facilities in the eight parishes on the following selected measures regarding workplace injuries:

(a) Describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred;

(b) Describe the number of safety events (injuries, illnesses, and first aids) reported by the safety officers at the industrial organizational facilities;

(c) Describe the number of safety events (injuries, illnesses, and first aids) reported by the safety officers at the industrial organizational facilities overall and during each quarter of the year;

(d) Describe the responding safety offices at the industrial organizational facilities regarding whether or not the site developed best practices (or have specific plans to do so) based on the most common recordable events seen at the site.;

(e) Describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities;

(f) Describe the number of each type of OSHA recordable event (deaths, time away from work, job transfer, and other) and the number of safety events (injuries, illnesses, and first aids) (overall and for direct employees and contractor employees) as reported by the safety officer at each industrial organizational facility.

2. Describe the injuries at the industrial organizational facilities as reported by safety officers on the following selected characteristics:

(a) Basis (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction) of the injury;

(b) Body part injured (hand, head, leg, foot, arm, chest, back and/or shoulder).

3. Compare the number of safety events illnesses, first aids, and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities that affected direct employees with the number of safety events and OSHA recordable events that affected contractor employees.

4. Determine if a relationship exists between number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities and the following characteristics of safety event and OSHA recordable event:

(a) Type of facility;

(b) Quarter in which the event occurred;

(c) Basis of the event; and

(d) Body part affected by the event.

5. To determine if a model exists to explain a significant portion of the variance in the number of safety events (injuries, illnesses, and first aids) from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Number of injuries by body part affected.

6. To determine if a model exists to explain a significant portion of the variance in the type of OSHA recordables from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction).

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

Objective 1

The first objective of this study was to describe the responses of the participating safety officers on the type of industrial organizational facilities in the eight parishes on the following selected measures regarding workplace injuries:

(a) Describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred;

(b) Describe the number of safety events (injuries, illnesses, and first aids) reported by the safety officers at the industrial organizational facilities.

(c) Describe the number of safety events (injuries, illnesses, and first aids) reported by the safety officers at the industrial organizational facilities overall and during each quarter of the year;

(d) Describe the responding safety offices at the industrial organizational facilities regarding whether or not the site developed best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities;

(f) Describe the number of each type of OSHA recordable event (deaths, time away from work, job transfer, and other) and the number of safety events (injuries, illnesses, and first aids) (overall and for direct employees and contractor employees) as reported by the safety officer at each industrial organizational facility.

Company Type

The first part of the objective was to describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred. The data used for this objective consisted of frequencies and percentages because the variables are categorical in nature. A total of 742 respondents participated in providing information and of that number 739 identified their organization. The first variable analyzed was the type of facility (primary function). The majority of respondents had a primary function related to Chemicals (n = 475, 64.3%). The next largest category was those facilities that had as their primary function the generation of Energy (n = 235, 31.8%). The smallest was the category of Other (n = 29, 3.9%).

Table 4.1. Company Type as Defined by Primary Function of Industrial Organizational Facilities in Eight Parishes in Southern Louisiana in which Responding Safety Officers were Employed

Company Type (Primary Function)	n	%
Chemical	475	64.3
Energy	235	31.8
Other[a]	29	3.9
Total	739[b]	100

[a]Other company types are paper (n = 23) and grain (n = 6)
[b]Three participants did not provide information regarding company type.

Number of Safety Events Reported

The next variable examined was the number of each type of safety event reported by the responding safety officers in the facilities. These safety events included injuries, illnesses, and first aids. The first type of safety event examined was injuries. For direct hire workers, the majority 73.5% (n= 538) of responding safety officers indicated there were no (0) injuries at their facilities during the timeframe reported. The mean number of injuries was 0.42, (SD = 1.008), with range from a low of 0 to a high of 15 (see Table 2). For contract workers, the majority 77.0% (n = 551) of responding safety officers indicated there were no (0) injuries at their facilities during the timeframe reported.

Table 4.2. Number of Safety Events (Injuries, Illnesses and First Aids) which Occurred to Direct Hire Employees Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana

	Injury[a] n/%	Illness[b] n/%	First Aid[c] n/%
0	538 / 73.5	695 / 95.2	263 / 36.6
1	129 / 17.6	23 / 3.2	116 /16.2
2-4	59 / 8.1	12 / 1.6	192 / 26.7
5-7	5 / 0.7	0	70 / 9.7
8-10	0	0	28 / 3.9
11-20	1 / 0.1	0	30 / 4.2
21-30	0	0	8 / 1.1
31-40	0	0	7 / 1.0
41-50	0	0	4 / 0.6
51+	0	0	0
	732[d]/100	730[e]/100	718[f]/100

(table cont'd.)

[a]Mean = 0.42, SD = 1.008, Range = 0 – 15
[b]Mean = 0.07. SD = 0.369, Range = 0 – 4
[c]Mean = 3.31, SD = 6.162, Range 0 – 50
[d]10 of the participants did not provide a response to this item
[e]12 of the participants did not provide a response to this item
[f]24 of the participants did not provide a response to this item

The mean number of injuries for contract employees was 0.50, (SD = 2.300), and with range from a low of 0 to a high of 51 (see Table 4.3). For direct hire and contract workers combined, the majority 58.9% (n = 432) of responding safety officers indicated there were no (0) injuries at their facilities during the timeframe reported. There were 23.9% (n = 175) with one reported injury, 110 (n = 15.0%) with two to four injuries. The mean number of injuries was 0.91, (SD = 2.789), and with range from a low of 0 to a high of 55 (see Table 4).

Regarding the number of work-related illnesses reported among direct hire employees of industrial organizational facilities in eight parishes of southern Louisiana, for direct hire workers, the majority (n = 695, 95.2%) of safety officers reported that there were no work-related illnesses during the reported timeframe.

The mean number of work-related illnesses of direct hire employees reported was 0.07 (SD = 0.369) and ranged from 0 to 4 (see Table 4.2). Regarding the number of work-related illnesses reported among contract employees of industrial organizational facilities in eight parishes of southern Louisiana, the majority (n = 701, 97.9%) of safety officers reported that there were no work-related illnesses during the reported timeframe. The mean number of work-related illnesses reported was 0.03 (SD = 0.228) and ranged from 0 to 3 (see Table 4.3).

Regarding the number of work-related illnesses reported among both direct workers and contract employees of industrial organizational facilities in eight parishes of southern Louisiana, the majority (n = 687, 93.9%) of safety officers reported that there were no work-related illnesses during the reported timeframe.

Table 4.3. Number of Safety Events (Injuries, Illnesses and First Aids) which Occurred to Contractors Employees Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana

	Injury [a] n/n%	Illness [b] n/n%	First Aid [c] n/n%
0	551 / 77.0	701 / 97.9	228 / 32.3
1	105 / 14.7	9 / 1.3	103 / 14.6
2-4	53 / 7.4	6 / 0.8	131 / 18.6
5-7	3 / 0.4	0	75 /10.6
8-10	1 / 0.1	0	48 / 6.8
11-20	1 / 0.1	0	69 / 9.8
21-30	1 / 0.1	0	24 /3.4
31-40	0	0	12 / 1.7
41-50	0	0	4 / 0.6
51+	1 / 0.1	0	12 / 1.7
Total	716[d]	716[f]	706[g]
	99.9[e]	100	100.1

[a] Mean = 0.50, SD = 2.3, Range = 0 – 51
[b] Mean = 0.03. SD = 0.228, Range = 0 – 3
[c] Mean = 6.48, SD = 13.903, Range 0 – 190
[d] 26 of the participants did not provide a response to this item
[e] 26 of the participants did not provide a response to this item
[f] 36 of the participants did not provide a response to this item

The mean number of work-related illnesses reported for both direct hire and contract employees combined was 0.10 (SD = 0.476) and ranged from 0 to 6 (see Table 4.4).

The third area of safety events examined was First Aids. The mean number of First Aid safety events for direct hire workers was 3.31 (SD = 6.162) and ranged from a low of 0 to a high of 50. When first aid safety events were examined, the category with the highest number of responses for direct hire employees was “0” (n = 263, 36.6%). The category with the second highest number of responses (n = 192, 26.7%) was the “2 - 4” category (see Table 2). The mean number of First Aid safety events for contract employees was 6.48 (SD = 13.903) and ranged from a low of 0 to a high of 190. When first aid safety events reported for contract employees were examined, the category with the highest number of responses was still “0” (n = 228, 32.3%). The category with the second highest number of responses (n = 131, 18.6%) was the “2

- 4” category, and the third highest category was one response (n = 103, 14.6%), (see Table 4.3). The mean number of ‘First Aid’ safety events for direct hire and contractor workers combined was 9.6 (SD = 16.129) and ranged from a low of 0 to a high of 190. When first aid safety events were examined, the category with the highest number of responses was “0” (n = 153, 21.1%). The category with the second highest number of responses (n = 147, 20.30%) was the “2 - 4” category, and the third highest category was 11 -20 responses (n = 104, 14.4%), (see Table 4.4).

Table 4.4. Number of Safety Events (Injuries, Illnesses and First Aids) which Occurred to Direct Hire and Contractors Combined Employees Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana

	Injury [a] n/n%	Illness [b] n/n%	First Aid [c] n/n%
0	432 / 58.9	687 / 93.9	153 / 21.1
1	175 / 23.9	27 / 3.7	82 / 11.3
2-4	110 / 15.0	17 / 2.3	147 / 20.3
5-7	9 / 1.2	1 / 0.1	77 / 10.63
8-10	0	0	59 / 8.14
11-20	5 / 0.7	0	104 / 14.36
21-30	0	0	54 / 7.46
31-40	1 / 0.1	0	17 / 2.34
41-50	0	0	16 / 2.21
51+	1 / 0.1	0	15 / 2.07
Total	733[d]	732[f]	724[g]
	99.9[e]	100	99.9[h]

[a]Mean = 0.91, SD = 2.789, Range = 0 – 55
[b]Mean = 0.10. SD = 0.476, Range = 0 – 6
[c]Mean = 9.60, SD = 16.129, Range 0 – 190
[d]9 of the participants did not provide a response to this item
[e]Totals do not equal 100 due to rounding error
[f]10 of the participants did not provide a response to this item
[g]18 of the participants did not provide a response to this item
[h]Totals do not equal 100 due to rounding error

Number of Safety Events Reported by Quarter

The third part of the first objective examined the number of injuries during each quarter of the year. The largest portion of the incidents occurred in the first quarter (n = 190, 25.9%).

However, all the quarters had roughly similar frequencies of incidents, the second quarter (n = 180, 24.5%), third quarter (n = 180, 24.5%), and fourth quarter (n = 185, 25.2%), (see Table 4.5).

Table 4.5. Number of Safety Events ("Injuries", "Illnesses" and "First Aids") which Occurred to Direct Hire and Contractor Employees Combined Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana per Quarter

	n	%
First Quarter	190	25.9
Second Quarter	180	24.5
Third Quarter	180	24.5
Fourth Quarter	185	25.2
Total	735	100.1[a]

Note. Seven participants did not provide information regarding quarter.

The following table reflects the means, standard deviations, minimum and maximum for the safety events that were reported for each quarter, see Table 4.6.

Table 4.6. Safety Events ("Injuries", "Illnesses" and "First Aids") which Occurred to Direct Hire and Contractor Employees Combined Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana by Quarter

	Q1	Q2	Q3	Q4	Total
	M / SD min / max	M / SD min / max	M / SD min / max	M / SD min / max	M / SD min / max
Injuries	0.75 / 1.139 0 / 5	1.03/4.257 0 /55	0.95 / 2.990 0 / 33	0.91/ 1.786 0 / 15	0.91/2.789 0 /55
Illnesses	0.10 / 0.427 0/3	0.16/0.691 0 / 6	0.12 / 0.455 0 / 3	0.04 / 0.219 0 / 2	0.10/0.476 0 /6
First Aids	8.74/12.847 0 /73	9.59 /17.918 0 / 190	11.01 /15.400 0 / 98	8.04 / 13.627 0 / 122	9.60/16.129 0 /190
Total	9.44 / 13.453 0 / 77	10.62/21.529 0 / 245	4.88/16.597 0 / 99	8.86 / 14.369 0 / 128	10.46/17.778 0 / 245

Best Practices

The fourth part of the objective was to describe facilities on whether or not the site developed best practices based on the most common recordable events seen at the site (or plan to do so). The majority of the responding safety officers,(61.7% n = 282) stated the site developed best practices based on the most common recordable events seen at the site (or plan to do so). Whereas 38.3% (n = 175) responded that their site did not develop best practices based on the most common recordable events seen at the site (or plan to do so). A total of 285 study participants did not provide a response to this item. The frequencies and percentages of whether the site developed best practices based on the most common recordable events seen at the site (or plan to do so) are presented in Table 4.7.

Table 4.7. Frequencies of Whether or Not the site Developed Best Practices Based On The Most Common Recordable Events Seen at the Site (or Plan to) Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana

	Frequency	Percent
Yes	282	61.7
No	175	38.3
Total	457[a]	100.0
System	285	38.4

[a]285 of the participating safety officers did not respond to this item

OSHA Recordables

The fifth part of this objective was to describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities. These OSHA recordable events included death, time away from work, job transfer, and other. Table 4.3 reflects the OSHA recordable events reported by the industrial facilities for both the direct hire workers and contract workers. Examination of the data revealed recordable events are skewed toward the smaller numbers of incidents.The majority 99.6% (n= 729) of responding safety officers indicated there were no (0) fatalities at their facilities during the specified time period. Regarding the number of instances of “Time Away” from work reported, the majority (n = 629, 85.7%) reported that there was no instance of “Time Away” from work. Regarding the number of instances of “Job Transfers” reported, the majority (n = 622, 85%) reported that there were no job transfers. Regarding the number of “Other Recordables” reported, the majority once again (n = 527, 72.0%) reported that there was no of “Time Away” from work. There were two incidents

(0.3%) of single ”Deaths” reported, 82 instances (11.2%) of a single injury involving “Time Away” from work; 87 (11.9%) injuries involving “Transfers”; and 130 (17.8%) injuries listed as “Other”.

Table 4.8. OSHA Recordable Events Reported by Industrial Facilities in Eight Parishes Surrounding East Baton Rouge Parish - Direct Hire and Contractor Employee Combined Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana

	Death[a] n/n%	Time Away[b] n/n%	Job Transfer[c] n/n%	Other[d] n/n%
0	729 / 99.6	629 / 85.7	622 / 85.	527 / 72.0
1	2 / 0.3	82 / 11.2	87 / 11.9	130 / 17.8
2-4	1 / 0.1	22 / 3	21 / 2.8	70 / 9.6
5-7	0	0	2 / 0.3	1 / 0.1
8-10	0	0	0	3 / 0.4
11-20	0	1 / 0.1	0	0
21-30	0	0	0	0
31-40	0	0	0	1 / 0.1
41-50	0	0	0	0
51+	0	0	0	0
Total	732[e]/100	734[f]/100	732[g]/99.9[h]	732[i]/100

[a] Mean = 0.011, SD = 0.09, Range = 0 – 2
[b] Mean = 0.20, SD = 0.722, Range = 0 – 15
[c] Mean = 0.20, SD =0.581, Range 0 – 5
[d] Mean = 0.50, SD =1.683, Range 0 – 38
[e]10 of the participants did not provide a response to this item
[f]8 of the participants did not provide a response to this item
[g]10 of the participants did not provide a response to this item
[h]Totals do not equal 100 due to rounding error
[i]10 of the participants did not provide a response to this item

Safety Events by Direct Employee or Contract Employee

The last part of the first objective was to describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) and the number of safety events (injuries illnesses, and first aids) for direct employees and contractor employees as reported by the responding safety officers at the industrial organizational facilities. This objective analyzed the frequencies of the safety events; see Table 4.9 for direct employee results and Table 4.10 for contractor employee results.

Table 4.9. Number of Each Type of OSHA Recordable Event for Direct Hires Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana

	Death[a] n/n%	Time Awa [b] n/n%	Job Transfer[c] n/n%	Other[d] n/n%
0	728 / 99.7	675 / 92.2	662 / 90.7	611 / 84
1	1 / 0.1	40 / 5.5	57 / 7.8	89 / 12.2
2-4	1 / 0.1	17 / 2.3	10 / 1.4	27 / 3.7
5-7	0	0	1 / 0.1	0
8-10	0	0	0	1 / 0.1
11-20	0	0	0	0
21-30	0	0	0	0
31-40	0	0	0	0
41-50	0	0	0	0
51+	0	0	0	0
Total	730[e]/99.9[f]	732[g]/100	730[h]/100	728[i]/99.9[j]

[a]Mean = 0.004, SD =0.083, Range = 0 – 2
[b]Mean = 0.10. SD = 0.388, Range = 0 – 3
[c]Mean = 0, SD = .410, Range 0 – 5
[d]Mean = 0, SD = .602, Range 0 – 8
[e]12 of the participants did not provide a response to this item
[f] Totals do not equal 100 due to rounding error
[g] 10 of the participants did not provide a response to this item
[h] 12 of the participants did not provide a response to this item
[i]14 of the participants did not provide a response to this item
[j] Totals do not equal 100 due to rounding error

Table 4.10. Number of Each Type of OSHA Recordable Event for Contract Employees Reported by Safety Officers at Industrial Manufacturing Plants in Eight Parishes in Southern Louisiana

	Death [a] n/n%	Time Away [b] n/n%	Job Transfer [c] n/n%	Other [d] n/n%
0	717 / 99.9	663 / 92.7	666 / 93.0	596/83.1
1	1 / 0.1	48 / 6.7	41 / 5.7	87/12.1
2-4	0	3 / 0.4	9 / 1.3	31 / 4.3
5-7	0	0	0	2 / 0.3
8-10	0	0	0	0
11-20	0	1 / 0.1	0	0
21-30	0	0	0	0
31-40	0	0	0	1/ 0.1
41-50	0	0	0	0
51+	0	0	0	0
Total	718[e]/100	715[f]/99.9[g]	716[h]/100	717[i]/99.9[j]

[a] Mean = 0.01, SD =0.037, Range = 0 – 1
[b] Mean = 0.10. SD = 0.565, Range = 0 – 13
(table cont'd.)

[c] Mean = 0.09, SD = 0.383, Range 0 – 4
[d] Mean = 0.29, SD = 1.556, Range 0 – 38
[e] 24 of the participants did not provide a response to this item
[f] 27 of the participants did not provide a response to this item
[g] Totals do not equal 100 due to rounding error
[h] 26 of the participants did not provide a response to this item
[i] 25 of the participants did not provide a response to this item
[j] Totals do not equal 100 due to rounding error

Objective 2

The second objective of the study was to describe the OSHA recordable injuries at the industrial organizational facilities as reported by safety officers on the following selected characteristics:

(a) Basis (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction of the injury.

(b) Body part injured (hand, head, leg, foot, arm chest, back and/or shoulder).

Frequencies and percentages of safety events in each of the categories identified comprised the analysis used to accomplish this objective. A total of 112 OSHA recordable events were reported by the responding safety officers. When these injuries were described on the “Basis” of the injury, the most frequently reported “Basis” was “Line of Fire” with more than one third of the injuries reported by the safety officers (n = 41, 36.6%). The second most frequently reported “Basis” for the injury was “Improper Procedure” (n = 34, 30.3%). The third most often reported “Basis” for the injury was “Equipment Malfunction” (n = 24, 21.4%). The data is reported in Table 4.11.

Table 4.11. “Basis” for OSHA Recordable Injuries Reported by Safety Officers at Industrial Organizational Facilities in the Eight Parish region in south Louisiana

Basis Variable	Frequency	Percent
Line of fire	41	36.6%
Improper procedure	34	30.3%

(table cont’d.)

Basis Variable	Frequency	Percent
Equipment malfunction	24	21.4%
Water cut	7	6.3%
Heat stress	3	2.7%
Access/egress	2	1.8%
Fatigue	1	0.9%
Total	112	100

In addition to describing the safety events on their “Basis,” the events were also described on the body part that was affected by the injury. The “Body Part” that was reported as affected by the injury most frequently was the worker’s “Hand” (n = 37, 24.8%). The “Body Part” that was reported as affected second most frequently was the worker’s “Arm” (n = 25, 16.8%) and the third most frequently cited “Body Part” was the worker’s “Back” (n = 20, 13.4%) (see Table 4.12).

Table 4.12. “Body Part” Affected by the OSHA Recordable Injuries Reported by Safety Officers at Industrial Organizational Facilities in the Eight Parish Region in South Louisiana

Body Part Variable	Frequency	Percent
Hand	37	24.8%
Arm	25	16.8%
Back	20	13.4%
Leg	18	12.1%
Shoulder	16	10.7%
Foot	15	10.1%
Head	15	10.1%
Chest	3	2.0%
Total	149	100

Objective 3

The third objective of the study was to compare the number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers that affected direct employees with the number of safety events and OSHA recordable events that affected contractor employees at industrial organizational facilities in the eight parish region in south Louisiana. To accomplish this objective, the independent t-test statistical procedure was used to compare the mean number of each category of safety event and OSHA recordable injury reported by safety officers at industrial organizational facilities for direct employees and contractor employees. An a priori significance level of .05 was established by the researcher. Of the nine variables that were compared by type of employee (direct and contractor), three were found to be significantly different. The safety event that was found to have the highest degree of difference by type of employee was "First Aid" ($t_{df = 699} = 6.683$, $p < .001$). The mean number of "First Aid" events reported for contractor employees (Mean = 6.53, SD = 13.953) was found to be significantly higher than the number of First Aid safety events reported for direct employees of the facilities (Mean = 3.05, SD = 5.633). "Overall Safety Event" which was a combined measurement of "First Aid," "Illness," and "Injury" had the second highest degree of difference by type of employee (t df = 718 = 6.015, p < .001). The mean number of "Overall Safety Events" reported for contractor employees (Mean = 6.90, SD = 15.263) was found to be significantly higher than the number of "Overall Safety Events" reported for direct employees of the facilities (Mean = 3.54, SD = 6.212). The large number of first aids compared to the number of injuries and illnesses influenced this result since this variable is a combination of three variables. The third significant difference was found for "Illnesses" and the number of "Illnesses" reported for direct employees (Mean = 0.07, SD = 0.366) was found to be significantly higher than for contractor employees (Mean = 0.03, SD = 0.229) ($t_{df = 713} = 2.844$, $p = .005$). No significant differences were found for total injuries or any of the categories of the OSHA recordable events by type of employee (see Table 4.13).

Table 4.13. Comparison of the Safety Events and OSHA Recordable Events Reported by Type of Employee (Direct Hire Employee or Contractor Employee) Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

		Mean	n	SD	t	df	Significance
First Aid	Direct Employee	3.05	700	5.633	6.683	699	< 0.001
	Contractor Employee	6.53		13.953			
Total Injury, Illness and First aid	Direct Employee	3.54	718	6.212	6.015	717	< 0.001
	Contractor Employee	6.9		15.263			
Total Illness	Direct Employee	0.07	714	0.366	2.844	713	0.005
	Contractor Employee	0.03		0.229			
Other Recordable	Direct Employee	0.2	713	0.504	1.635	712	0.103
	Contractor Employee	0.29		1.56			
Total Injuries	Direct Employee	0.38	715	0.819	1.429	714	0.153
	Contractor Employee	0.5		2.347			
Total Recordable	Direct Employee	0.4	717	0.82	1.044	716	0.297
	Contractor Employee	0.48		2.103			
Death	Direct Employee	0	716	0.084	0.816	715	0.415
	Contractor Employee	0		0.037			
Job Transfer	Direct Employee	0.1	714	0.36	0.676	713	0.499
	Contractor Employee	0.09		0.384			
Away from Work	Direct Employee	0.09	713	0.358	0.181	712	0.856
	Contractor Employee	0.1		0.565			

Objective 4

The fourth objective was to determine if a relationship exists between the number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) as reported by the safety officers at the industrial organizational facilities and the following characteristics of safety events and OSHA recordable events:

(a) Type of facility;

(b) Quarter in which the injury occurred;

(c) Basis of the event;

(d) Body part affected by the event.

Facility

The first variable examined for relationships with the number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) as reported by the safety officers at the industrial organizational facilities was the type of facility as defined by their primary function. Three types of facilities were identified in the responses of the safety officers, specifically “Chemical”, “Energy”, and “Other”. Because of the nature of the variable, type of facility (nominal data) the most interpretable statistical method to accomplish this objective was determined to be a comparison of each safety event and OSHA recordable measure by categories of the variable type of facility. These comparisons were made using the one-way analysis of variance procedure with the Tukey’s post hoc multiple comparison procedure for identifying specific differences in means when a significant ANOVA was found (see Table 4.14). A total of nine comparisons were made of which at least one statistically significant difference was found by type of facility for eight of the safety events and OSHA recordables.

Table 4.14. Comparison of "Type of Facility" by Safety Incident and Type of OSHA Recordable Events Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	n	df	F	p
Total All Injury, Illnesses, & First Aids	733	2, 730	14.338	<.001
Total All First Aids	721	2, 718	13.737	<.001
Total All Injury	730	2, 272	10.135	<.001
Total All Recordable Transfers	729	2, 726	9.879	<.001
Total ALL Recordable	731	2, 728	9.615	<.001
Total All Illness	729	2, 726	7.947	<.001
Total All Recordable "Days Away"	731	2, 728	6.173	0.002
Total All Recordable Other	729	2, 726	5.532	0.004
Total All Recordable Deaths	729	2, 726	1.548	0.213

The comparison that was found to have the highest degree of significant difference was "Total of All Injuries", "Illnesses", and "First Aids" ($F_{df=2,730}$) = 14.338, p < .001). The Tukey's Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.15. The "Other" type of facility was found to have a significantly higher (mean = 27.41) number of total "Injuries", "Illnesses", and "First Aids" than both the "Chemical" and "Energy" facilities which were not found to be significantly different from one another, see Table 15.

Table 4.15. Comparison of " Injury, Illness and First Aid" and Type of Facility Reported by Safety Officers in Eight Parishes in Southern Louisiana

Source	df	MS	F	p
Between Groups	2	4387.201	14.338	<.001
Within Groups	730	305.981		
Total	732			
Group		n	M	Tukey [a]
Energy		235	9.21	A
Chemical		469	10.06	A
Other		29	27.41	B

[a] Groups that do not have a common letter are significantly different.

The comparison of total of "All First Aids" also had a statistically significant difference of ($F_{df\ 2,718}$ = 13.737, p < .001). The Tukey's Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.16. The "Other" type of facility was found to have a significantly higher (Mean = 24.96) number of "First Aids" than both the "Chemical" and "Energy" facilities, which were not found to be significantly different from one another.

Table 4.16. Comparison of "First Aid" and "Type of Facility" Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Source	df	MS	F	p
Between Groups	2	3462.551	13.737	<.001
Within Groups	718	252.059		
Total	720			
Group		n	M	Tukey [a]
Energy		235	8.57	A
Chemical		458	9.22	A
Other		28	24.96	B

[a] Groups that do not have a common letter are significantly different.

The comparison of ""'Injuries" had a statistically significant difference of (F df-2,727 = 10.135, p < .001). The Tukey's Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.17. The "Other" type of facility was found to have a significantly higher (Mean = 2.90) number of total "Injuries", than both the "Chemical" and "Energy" facilities were not found to be significantly different from one another.

Table 4.17. Comparison of "Injury" and "Type of Facility" Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Source	df	MS	F	p
Between Groups Within Groups	2 727	77.183 7.615	10.135	<.001
Total	729			
Group		n	M	Tukey[a]
Energy		235	0.51	A
Chemical		466	0.99	A
Other		29	2.90	B

[a] Groups that do not have a common letter are significantly different.

The comparison of “Total All Recordable Transfers” had a statistically significant difference of (F df-2,726 = 9.879, p < .001). The Tukey’s Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.18. The “Other” type of facility was found to have a significantly higher (mean = .066) number of “Transfers” than both the “Chemical” and “Energy” facilities, which were not found to be significantly different from one another.

Table 4.18. Comparison of “Recordable Transfers” and “Type of Facility" Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Source	df	MS	F	p
Between Groups	2	3.258	9.879	<.001
Within Groups	726	0.330		
Total	728			
Group		n	M	Tukey [a]
Energy		235	0.15	A
Chemical		465	0.20	A
Other		29	0.66	B

[a] Groups that do not have a common letter are significantly different.

The comparison of “Total All Recordables” had a statistically significant difference of (F df-2,728 = 9.615, p < .001). The Tukey’s Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.19. The “Other” type of facility was found to have a significantly higher (mean = 2.69) number of “Total All Recordables” than both the “Chemical” and “Energy” facilities, which were not found to be significantly different from one another.

Table 4.19. Comparison of “Recordables” and “Type of Facility" Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Source	df	MS	F	p
Between Groups	2	57.295	9.615	<.001
Within Groups	728	5.959		
Total	730			
Group		n	M	Tukey [a]
Energy		235	0.60	A
Chemical		467	0.95	A
Other		29	2.69	B

[a] Groups that do not have a common letter are significantly different.

The comparison of “Illness” had a statistically significant difference of (F df-2,726 = 7.947, p < .001). The Tukey’s Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.20. The “Other” type of facility was found to have a significantly higher (Mean = 0.41) number of “Illnesses” than both the “Chemical” and “Energy” facilities, which were not found to be significantly different from one another (see Table 4.20).

Table 4.20. Comparison of “Illness” and “Type of Facility" Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Source	df	MS	F	p
Between Groups	2	1.770	7.947	<.001
Within Groups	726	.223		
Total	728			
Group		n	M	Tukey [a]
Energy		465	.07	A
Chemical		235	.13	A
Other		29	.41	B

[a] Groups that do not have a common letter are significantly different.

The comparison of “Recordables Away” had a statistically significant difference of (F df-2,728 = 6.173, p < .001). The Tukey’s Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.21. The “Other” type of facility was found to have a significantly higher (Mean = 0.62) number of “Recordable Away” than both the “Chemical” and “Energy” facilities were not found to be significantly different from one another, see Table 4.21.

Table 4.21. Comparison of “Recordable Away” and “Type of Facility" Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Source	df	MS	F	p
Between Groups	2	3.177	6.173	<.001
Within Groups	728	0. 515		
Total	730			
Group		n	M	Tukey [a]
Energy		235	0.13	A
Chemical		467	0.20	A
Other		29	0.62	B

[a] Groups that do not have a common letter are significantly different.

The comparison of “Other Recordables” had a statistically significant difference of (F df-2,728 = 5.532, p = .004). The Tukey’s Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. These results are presented in Table 4.22. The “Other” type of facility was found to have a significantly higher (Mean = 1.38) number of “Recordable Other” than both the “Chemical” and “Energy” facilities, which were not found to be significantly different from one another.

Table 4.22. Comparison of “Other Recordable” and “Type of Facility" Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Source	df	MS	F	p
Between Groups	2	15.537	5.532	.004
Within Groups	726	. 2.809		
Total	728			
Group		n	M	Tukey [a]
Energy		235	.32	A
Chemical		465	.55	A
Other		29	1.38	B

[a] Groups that do not have a common letter are significantly different.

Quarter

The second variable examined for relationships with the number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) as reported by the safety officers at the industrial organizational facilities was the quarter in which the event occurred. The nature of the variable is also nominal data. Therefore, the most interpretable statistical method to accomplish this objective was determined to be a comparison of each safety and OSHA recordable measure by quarter (see Table 4.23). These comparisons were made using the one-way analysis of variance procedure with the Tukey's post hoc multiple comparison procedure for identifying specific differences in means when a significant ANOVA was found. However, there were no significant differences by quarter among any of the comparisons.

Table 4.23. Comparison of Quarter by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	n	df	F	P
Total All Illness	725	3, 721	2.026	0.109
Total All Recordable "Days Away"	727	3, 723	1.725	0.161
Total All First Aids	717	3, 713	1.281	0.280
Tot All Injury Illness First Aids	729	3, 725	1.162	0.323
Total All Recordable Transfers	729	3, 721	1.095	0.350
Total All Recordable	727	3, 724	0.824	0.481
Total All Recordable Deaths	725	3, 721	0.467	0.705
Total All Recordable Other	725	3, 721	0.43	0.732
Total All Injury	726	3, 722	0.348	0.791

Basis

The next part of this objective focused on the basis for the safety event. In order to determine if a relationship existed between the number of safety events (injuries, illnesses, and first aids) and OSHA Recordables (deaths, transfers, time away from work and other) and the "basis" of the safety event/OSHA Recordable, the researcher determined the most effective statistical methods to examine these possible relationships was to compare the number of each types of safety events/OSHA recordables by categories of the identified “Basis” of the event using an independent t-test analysis for the procedure. Each of the variables was established as a dichotomous variable such that if the safety officer reported that “Basis”, the response was coded one (1), and if the safety officer did not report the variable as the “Basis”, the response was coded as zero (0). However, the number of reported “Bases” in several of the different categories was insufficient to conduct a statistical analysis; these included “Water Cut;” “Access/Egress;” “Heat;” and “Fatigue.” Since the number of reported cases of each of these “Bases” was very low no analysis could be done to statistically examine the relationship between the variables. However, three of the “Bases” did have sufficient data to measure possible relationships. These included, “Line of Fire;” “Equipment Failure;” and “Improper Procedure.” Each of these groups were then compared on the number of each type of safety event/OSHA Recordable.

When these comparisons were made by whether “Line of Fire” was the “Basis” for the safety event, only one of the nine comparisons was found to be statistically significant. The total of “All Recordables” (which included deaths, transfers, days away from work, and other) was found to be significantly higher ($t_{df = 730} = 2.020$, $p = .044$) for those who reported “Line of Fire” as the basis for the events (Mean = 1.06, SD = 1.706) than for those who did not report Line of Fire as the ”Basis” for the event (Mean = 0.48, SD = 1.678). No other safety events/OSHA Recordables were found to be significantly different (see Table 4.24).

Table 4.24. Comparison of Basis of “Line of Fire” by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable - Line of Fire		n	M	SD	t	df	p
Recordable Other	No	696	0.48	1.678	2.020	730	0.044
	Yes	36	1.06	1.706			
Total All Recordable	No	698	0.87	2.471	1.898	732	.0580
	Yes	36	1.67	2.255			
Recordable Transfers	No	696	0.19	0.56	1.522	36.504	.137
	Yes	36	0.42	0.874			
Injury	No	697	0.88	2.813	1.416	731	.157
	Yes	36	1.56	2.210			
Illness	No	696	0.09	0.448	1.099	36.037	.279
	Yes	36	0.25	0.841			
Recordable Deaths	No	696	0.01	0.093	0.372	730	.710
	Yes	36	0.00	0.00			
Injuries, Illnesses and First Aids	No	700	10.41	18.006	0.304	734	.761
	Yes	36	11.31	12.692			
First Aids	No	689	9.59	16.331	0.075	722	.940
	Yes	35	9.80	11.621			
Recordable “Days Away”	No	698	0.20	0.735	0.015	732	.988
	Yes	36	0.19	0.401			

When these comparisons were made by whether “Equipment Failure” was the “Basis” for the safety event, two of the nine comparisons were found to be statistically significant. The total of “All Recordables - Other” was found to be significantly higher ($t_{df = 730}$ = 2.297, p = .022) for those who reported “Equipment Failure” as the basis for the events (Mean = 1.33, SD = 1.528) than for those who did not report “Equipment Failure” as the ”Basis” for the event (Mean = 0.48, SD = 1.682). The total of “All Recordables” (which included deaths, transfers, days away from work, and other) was found to be significantly higher ($t_{df = 732}$ = 2.246, p = .025) for those who reported “Equipment Failure” as the basis for the events (Mean = 2.10, SD = 2.095) than for those who did not report “Equipment Failure” as the ”Basis” for the event (Mean = 0.87, SD = 2.468). No other safety events/OSHA Recordables were found to be significantly different, (see Table 4.25).

Table 4.25. Comparison of Basis of“Equipment Failure” by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable - Equipment Failure		n	M	SD	t	df	p
Recordable Other	No	711	0.48	1.682	-2.297	730	.022
	Yes	21	1.33	1.528			
Recordable	No	713	0.87	2.468	-2.246	732	.025
	Yes	21	02.10	2.095			
Injuries Illness First Aid	No	715	10.10	17.271	-1.982	20.435	.061
	Yes	21	22.48	28.458			
First Aids	No	703	09.27	15.544	-1.831	20.366	.082
	Yes	21	20.57	28.149			
Recordable Transfers	No	711	0.20	.566	-1.378	20.442	.183
	Yes	21	0.48	.928			
Illness	No	711	0.10	.456	-1.189	20.296	.248
	Yes	21	0.33	.913			
Injury	No	712	0.89	2.813	-1.096	731	.273
	Yes	21	1.57	1.690			
Recordable “Days Away”	No	713	0.19	.728	-.577	732	.564
	Yes	21	0.29	.463			
Recordable Deaths	No	711	0.01	.092	0.281	730	.779
	Yes	21	00	<.001			

n t-test using separate variance estimate

When these comparisons were made by whether “Improper Procedure” was the “Basis” for the safety event, four of the nine comparisons were found to be statistically significant. The total First Aid was found to be significantly higher ($t_{df = 722}$ = 2.543, p = .011) for those who reported “Improper Procedure” as the “Basis” for the events (Mean = 17.03, SD = 22.715) than for those who did not report “Improper Procedure” as the “Basis” for the event (Mean = 9.29, SD = 15.741). The total of “All Injuries, Illnesses, and First Aids” was found to be significantly higher ($t_{df = 734}$ = 2.630, p = .009) for those who reported "Improper Procedure" as the "Basis" for the events (Mean = 18.93, SD = 23.133) than for those who did not report "Improper Procedure" as the "Basis" for the event (Mean = 10.11, SD = 17.457). The total of "Recordables - Other" was found to be significantly higher ($t_{df = 730}$ = 1.961, p = .050) for those who reported "Improper Procedure" as the basis for the events (Mean = 1.10, SD = 1.235) than for those who did not report "Improper Procedure" as the "Basis" for the event (Mean = 0.48, SD = 1.695). The total of "All Recordables" (which included deaths, transfers, days away from work, and other) was found to be significantly higher ($t_{df = 732}$ = 2.288, p = .022) for those who reported "Improper Procedure" as the "Basis" for the events (Mean = 1.93, SD = 1.624) than for those who did not report "Improper Procedure" as the "Basis" for the event (Mean = 0.87, SD = 2.468). No other safety events/OSHA Recordables were found to be significantly different, (see Table 4.26).

Table 4.26. Comparison of Basis of "Improper Procedure" by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable - Equipment Failure		n	M	SD	t	df	p
Total All Injury, Illness, First Aid	No	707	10.11	17.457	2.630	734	.009
	Yes	29	18.93	23.133			
First Aid	No	695	9.29	15.741	2.543	722	.011
	Yes	29	17.03	23.715			
Recordable	No	705	0.87	2.486	2.288	732	.022
	Yes	29	1.93	1.624			
Recordable Other	No	703	0.48	1.695	1.961	730	.050
	Yes	29	1.10	1.235			
Recordable "Days Away"	No	705	0.19	0 .724	1.923	732	.055
	Yes	29	0.45	0.632			
Illness	No	703	0.09	0.431	1.831	28.387	.078
	Yes	29	0.45	1.055			

(table cont'd.)

Variable - Equipment Failure		n	M	SD	t	df	p
Recordable Transfers	No	703	0.20	0.579	1.337	730	.182
	Yes	29	0.34	0.614			
Injury	No	704	.89	2.832	1.053	731	.293
	Yes	29	1.45	1.270			
Recordable Deaths	No	703	0.00	0.084	0.875	28.478	.390
	Yes	29	0.03	0.186			

n t-test using separate variance estimate

Body Part

Subsequently, this objective lastly analyzed safety events based on the body part affected. In order to determine if a relationship existed between the number of safety events (injuries, illnesses, and first aids) and OSHA Recordables (deaths, transfers, time away from work and other) and the “Body” of the safety event/OSHA Recordable, the researcher determined that to maximize the interpretability of the results, the most effective statistical methods to examine these possible relationships was to compare the number of each of the types of safety events/ OSHA recordables by categories of the identified “Body Part” of the event using an independent t-test analysis for the procedure. Each of the variables was established as a dichotomous variable such that if the safety officer reported that “Body Part”, it was coded one (1), and if they did not report the variable as the body part, the response was coded as zero (0). However, the number of reported “Body Part” in several of the categories, “Chest” and “Shoulder” were insufficient to conduct a statistical analysis. Since the number of reported cases of each of these “Body Part” were very small no analysis could be done to statistically examine the relationship between the variables. However, six of the “Body Part” did have sufficient data to measure possible relationships. These included, “Hand,” “Head,” “Leg,” “Foot,” “Arm,” and “Back.” Each of these groups were then compared on the number of each type of safety event /OSHA Recordable.

When these comparisons were made by whether or not “Hand” was the “Body Part” involved in the safety event, only two of the nine comparisons were found to be statistically significant, “Total All Recordables – Other” and total of “All Recordables” (which included deaths,transfers, days away from work, and other). The total of “All Recordables - Other” was found to be significantly higher ($t_{df = 730} = -2.283$, $p = .023$) for those who reported “Hand” as the “body part” for the events (Mean = 1.21, SD = 1.853) than for those who did not report “Hand as the “body part” for the event (Mean = 0.48, SD = 1.671). The total of “All Recordables” (which included deaths, transfers, days away from work, and other) was found to be significantly higher ($t_{df = 732} = 2.399$, $p = .017$) for those who reported “Hand” as the “Body Part” for the events (Mean = 2.00, SD = 2.419) than for those who did not report Hand as the ““Body Part” for the event (Mean = 0.86, SD = 2.459). No other safety events/OSHA Recordables were found to be significantly different, (See Table 4.27).

Table 4.27. Comparison of Body Part of “Hand” by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable – Hand		n	M	SD	t	df	p
Recordable	No	706	0.86	2.459	2.399	732	.017
	Yes	28	2.00	2.419			
Recordable Other	No	704	0.48	1.671	2.283	730	.023
	Yes	28	1.21	1.853			
Injury	No	705	0.88	2.799	1.827	731	.068
	Yes	28	1.86	2.384			
Recordable Transfers	No	704	0.19	0.562	1.336	27.808	.192
	Yes	28	0.43	0.920			
Recordable “Days Away”	No	706	0.19	0.727	1.204	732	.229
	Yes	28	0.36	0.559			
Illness	No	704	0.10	0.468	0.966	28.2	.342
	Yes	28	0.21	0.630			

(table cont’d.)

Variable – Hand		n	M	SD	t	df	p
Injury Illness and First Aid	No	708	10.33	17.989	0.935	734	.350
	Yes	28	13.54	10.943			
First Aid	No	697	9.51	16.318	0.752	722	.453
	Yes	27	11.89	10.017			
Recordable Deaths	No	704	0.01	0.092	0.326	730	.745
	Yes	28	0.00	0.000			

Comparisons of the "Head" (see Table 4.28), "Leg" (see Table 4.29), "Foot" (see Table 4.30), and "Arm" (see Table 4.31) revealed no significant differences in the means of safety events that involved those "Body Parts" or not.

Table 4.28. Comparison of Body Part of "Head" by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable – Head		n	M	SD	t	df	p
Recordable Other	No	721	0.49	1.697	1.709	730	.088
	Yes	11	0.36	1.206			
Recordable	No	723	0.89	2.475	1.482	732	.139
	Yes	11	2.00	1.342			
Injury	No	722	0.90	2.805	0.974	731	.330
	Yes	11	1.73	1.191			
Recordable Transfers	No	721	0.20	0.58	0.921	730	.357
	Yes	11	0.36	0.674			
Injury, Illness, First Aid	No	725	10.40	17.86	0.649	734	.517
	Yes	11	13.91	11.131			
Illness	No	721	0.10	0.467	0.633	10.081	.541
	Yes	11	0.27	0.905			
First Aid	No	713	9.56	16.205	0.478	722	.633
	Yes	11	11.91	10.183			
Recordable "Days Away"	No	723	0.20	0.725	0.354	732	.723
	Yes	11	0.27	0.467			
Recordable Deaths	No	721	0.01	0.091	0.202	730	.840
	Yes	11	0.00	<.001			

Table 4.29. Comparison of Body Part of "Leg" by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable – Leg		n	M	SD	t	df	p
Recordable	No	720	0.89	2.478	-1.676	732	.094
	Yes	14	2.00	1.359			
Illness	No	718	0.09	0.442	-1.612	13.061	.131
	Yes	14	0.94	1.277			
Recordable Other	No	718	0.49	1.691	-1.596	730	.111
	Yes	14	1.21	0.975			
Recordable Transfers	No	718	0.20	0.579	-1.465	730	.143
	Yes	14	0.43	0.646			
Injury, Illness, First Aid	No	722	10.37	17.853	-0.935	734	.350
	Yes	14	14.86	13.049			
Recordable "Days Away"	No	720	0.19	0.725	-0.842	732	.400
	Yes	14	0.36	0.497			
Injury	No	719	0.90	2.809	-0.794	731	.428
	Yes	14	1.50	1.286			
First Aid	No	710	9.54	16.191	-0.729	722	.466
	Yes	14	12.71	12.652			
Recordable Deaths	No	718	0.01	0.091	0.228	730	.820
	Yes	14	0.00	<.001			

Table 4.30. Comparison of Body Part of "Foot" by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable – Foot		n	M	SD	t	df	p
Recordable	No	723	0.89	2.446	1.854	732	.064
	Yes	11	2.27	3.379			
Injury	No	722	0.89	2.777	1.63	731	.104
	Yes	11	2.27	3.379			
Recordable Other	No	721	0.49	1.659	1.392	10.113	.194
	Yes	11	1.64	2.73			
Recordable Transfers	No	721	0.20	0.58	0.921	730	.357
	Yes	11	0.36	0.674			
Illness	No	721	0.10	0.479	0.720	730	.472
	Yes	11	0.00	0.000			

(table cont'd.)

Variable – Foot		n	M	SD	t	df	p
Injury, Illness, First Aid	No	725	10.42	17.87	0.393	734	.695
	Yes	11	12.55	10.25			
Recordable "Days Away"	No	723	0.20	0.725	0.354	732	.723
	Yes	11	0.27	0.467			
First Aid	No	714	9.58	16.202	0.336	722	.737
	Yes	10	11.3	9.889			
Recordable Deaths	No	721	0.01	0.091	0.202	730	.840
	Yes	11	0.00	0.000			

Table 4.31. Comparison of Body Part of "Arm" by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable – Arm		n	M	SD	t	df	p
Recordable Transfers	No	716	0.19	0.56	1.498	15.16	.155
	Yes	16	0.63	1.147			
Injury	No	717	0.89	2.783	1.485	731	.138
	Yes	16	1.94	2.977			
Recordable	No	718	0.89	2.45	1.383	732	.167
	Yes	16	1.75	3.066			
Recordable Other	No	716	0.49	1.669	1.192	730	.234
	Yes	16	1.00	2.251			
Injury, Illness, First Aid	No	720	10.46	17.932	0.089	734	.929
	Yes	16	10.06	8.583			
Illness	No	716	0.10	0.481	0.871	730	.384
	Yes	16	0.00	0.00			
Recordable "Days Away"	No	718	0.2	0.728	0.399	732	.690
	Yes	16	0.13	0.342			
First Aid	No	709	9.26	16.261	0.226	722	.821
	Yes	15	8.67	7.825			
Recordable Deaths	No	716	0.01	0.091	0.244	730	.807
	Yes	16	0.00	0.000			

The total of "All Recordables - Other" was found to be significantly higher ($t_{df = 730} = -2.242$, $p = .025$) for those who reported "Back" as the "Body Part" for the events (Mean = 1.54, SD = 2.504) than for those who did not report back as the ""Body Part"" for the event (Mean =

0.49, SD = 1.661). No other safety events or OSHA Recordables were found to be significantly different regarding the back, (see Table 4.32).

Table 4.32. Comparison of Body Part of "Back" by Safety Incident and Type of OSHA Recordable Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable – Back		n	M	SD	t	df	p
Total All Recordable Other	No	719	0.49	1.661	2.242	730	.025
	Yes	13	1.54	2.504			
Total All Recordable	No	721	0.88	2.446	1.956	732	.051
	Yes	13	2.23	3.244			
Total All Injury	No	720	0.89	2.777	1.619	731	.106
	Yes	13	2.15	3.288			
Total All Recordable Transfers	No	719	0.20	0.577	1.134	730	.257
	Yes	13	0.38	0.768			
Total All Illness	No	719	0.10	0.48	0.784	730	.434
	Yes	13	0.00	.000			
Total All Recordable "Days Away"	No	721	0.19	0.723	0.562	732	.574
	Yes	13	0.31	0.63			
Total All First Aid	No	712	9.64	16.224	0.472	722	.637
	Yes	13	7.42	8.949			
Total All Injury, Illness, First Aid	No	723	10.48	17.892	0.298	734	.766
	Yes	13	9.00	9.798			
Total All Recordable Deaths	No	719	0.01	0.091	0.22	730	.826
	Yes	13	0.00	0.000			

Objective 5

The fifth objective was to determine if a model exists explaining a significant portion of the variance in the number of safety events (injuries, illnesses, and first aids) from the following measures:

(a) Type of facility (chemical, energy, or other);

(b) Quarter of the year (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

To accomplish this objective multiple regression analyses was performed. The total number of safety events involving direct hire employees of the organization was used as the dependent variable, and the other specified variables were treated as independent variables. The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In this regression analysis, variables were added that increased the explained variance by one percent or more as long as the overall regression model remained significant.

In conducting this multiple regression analysis, all of the independent variables were categorical in nature. The variables that had to be restructured as dichotomous variables in preparation for entry into the analysis included the type of facility, quarter of the year, basis of the safety event, and “Body Part” affected. However, whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events, was already dichotomous in nature. Three multiple regression analyses were performed: direct hire workers, contract workers, and a both direct hire and contract workers combined.

For direct hire workers, the variable “Type of facility” has three categories: “Energy”, Chemical, and Other. Each of these levels of the variable were used to create a dichotomous variable as being a member of the category or not. For example, each response was classified as either “Chemical” (coded “1” or “Not Chemical” (coded “0”), etc.

The next variable, quarter of the year (timeframe), had four categories: “Quarter 1” January through March), “Quarter 2” (April through June), “Quarter 3” (July through September), and “Quarter 4” (October through December). Each of these levels of the variable quarter of the year was used to create a dichotomous variable as being a member of the category or not. For example, either the safety event occurred in Quarter 1 (coded 1) or it did not occur in Quarter 1 (coded 0), etc.

Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site was already set up as a dichotomous variable and thus it was entered into the analysis.

Regarding the number of injuries with each of the specified bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction), each safety event was recoded such that the basis for the event was either “Water Cut” (coded 1) or it was not “Water Cut” (coded 0). The same was done for each of the other six bases of the safety event. However, when the data were examined, four of the safety event bases had insufficient data to enable them to be entered as an independent variable in the analysis. These bases included “Water Cut”, “Access/Egress”, “Heat Stress”, and “Fatigue”. Consequently, each of these four variables were excluded from the regression analysis. However, “Line of Fire”, “Equipment Failure”, and “Improper Procedure” did have sufficient data for inclusion in the analysis.

Regarding the number of injuries with “Body Part” affected (arm, back, chest, foot, hand, head, leg, and shoulder), each safety event was recoded such that the affected “Body Part” was coded either “Arm” (coded 1) or it was not “Arm” (coded 0). The same was done for each of the other eight body parts. However, when the data were examined, "Body Part" did not have sufficient data to be included.

The first step in conducting the regression analysis was to examine the bivariate correlations. Two-way correlations between factors used as independent variables and the total number of safety events reported for direct hire employees of the organization are presented in Table 33. Six of the eleven correlations were found to be statistically significant. The highest correlation with the number of safety events was found to be with the variable "Other Company Type" ($r = 68.0$, $p<.001$). The second highest correlation with the total number of safety events for "Direct Hire" employees was "Whether or not the Basis for the Safety Event was "Improper Procedure" ($r = .21$, $p < .001$). The third highest correlation was with whether or not the Company Type was "Chemical" ($r = -.20$, $p < .001$). Three additional variables were found to be significantly related to the total number of safety events reported for the direct hire employees. These variables included whether the basis for the safety event was "Line of Fire," ($r=.10$, $p=.002$) whether the company type was "Energy" ($r=.08$, $p=.016$) and whether the safety event occurred in the "Third Quarter" ($r=.07$, $p=.032$) (see Table 4.33).

The second step in conducting the regression analysis was to examine the data for the presence of excess collinearity among the independent variables or that any combination of the independent variables formed a singularity. To make this assessment, the researcher examined the variance inflation factor (VIF). According to Hair et al., (2006), "A common cutoff threshold is a tolerance value of 0.10 which corresponds to a VIF value of 10," (p. 230). The VIF values for this analysis ranged from 1.000 to 1.054. Therefore, there was no excess multicollinearity present in the data.

Table 4.33. Relationship between Selected Demographic Characteristics and Safety Events for Direct Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	r	p
Other Company Type	.68	<.001
Basis – Improper Procedure	.21	<.001
Chemical Company Type	-.20	<.001
Basis – Line of Fire	.10	.002
Energy Company Type	-.08	.016
Third Quarter	.07	.032
Fourth Quarter	.05	.104
Second Quarter	-.03	.212
Equipment Failure	.03	.216
First Quarter	.01	.412
Best practice	.01	.442

Note. n = 742

For direct hire workers, Table 4.34 presents the results of the multiple regression analysis utilizing total safety events as the dependent variable. The variable that entered the regression first was “Other – Company”. Considered alone this variable explained 46.0% of the variance in the safety events of direct hire employees. Three additional variables explained an additional 1.5% of the variance in the total number of safety events. They were “Third Quarter”, “Improper Procedure”, and whether or not the site had “Best Practices” (or planned to).

The analysis was repeated for contract employees. To accomplish this objective multiple regression analysis was performed. The total number of safety events involving contract employees was used as the dependent variable, and the other specified variables were treated as independent variables.

The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In this regression analysis, variables were added that increased the explained variance by one percent or more as long as the overall regression model remained significant.

Table 4.34. Multiple Regression Analysis between Safety Incidents and Selected Characteristics for Direct Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

ANOVA					
Source of Variation		df	MS	F	p
Regression		4	3,821.43	166.445	<.001
Residual		737	22.959		
Total		741			
Model Summary					
Model	R Square	R Square Change	F Change	Sig. F Change	Standardized Coefficients Beta
Other Company	.460	.460	630.461	<.001	.670
Third Quarter	.466	.006	8.911	.003	.081
Improper Procedure	.471	.005	6.424	.011	.068
Best Practice	.475	.004	4.969	.026	.060

Variables not in the Equation		
Variables	t	p
Fourth Quarter	-1.191	0.234
Line of Fire	0.191	0.849
Equipment failure	-1.177	0.239
Energy Company	0.729	0.466
Chemical Company	-0.729	0.466
1st Quarter	1.166	0.244
2nd Quarter	0.016	0.987

In conducting this multiple regression analysis, all of the independent variables were categorical in nature. The variables that had to be restructured as dichotomous variables in preparation for entry into the analysis included the type of facility, quarter of the year, basis of the safety event, and “Body Part” affected. However, whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events, was already dichotomous in nature.

The variable “Type of Facility” has three categories: “Energy”, “Chemical”, and “Other”. Each of these levels of the variable were used to create a dichotomous variable as being a member of the category or not. For example, each response was classified as either “Chemical” (coded “1” or “Not Chemical” (coded “0”), etc.

The next variable, quarter of the year (timeframe), had four categories: “Quarter 1” (January through March), “Quarter 2” (April through June), “Quarter 3” (July through September), and “Quarter 4” (October through December). Each of these levels of the variable Quarter of the Year was used to create a dichotomous variable as being a member of the category or not. For example, either the safety event occurred in “Quarter 1” (coded 1) or it did not occur in “Quarter 1” (coded 0), etc.

Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site was already set up as a dichotomous variable and thus it was entered into the analysis.

Regarding the number of injuries with each of the specified bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction), each safety event was recoded such that the basis for the event was either “Water Cut” (coded 1) or it was not “Water Cut” (coded 0). The same was done for each of the other six bases of the safety event. However, when the data were examined, four of the safety event bases had insufficient data to enable them to be entered as an independent variable in the analysis. These bases included “Water Cut”, “Access/Egress”, “Heat stress”, and “Fatigue”. Consequently, each of these four variables were excluded from the regression analysis. However, “Line of Fire”, “Equipment Failure”, and “Improper Procedure” did have sufficient data for inclusion in the analysis.

Regarding the number of injuries with “Body Part” affected (arm, back, chest, foot, hand, head, leg, and shoulder), each safety event was recoded such that the affected “Body Part” was coded either “Arm” (coded 1) or it was not “Arm” (coded 0). The same was done for each of the other eight body parts.

The first step in conducting the regression analysis was to examine the bivariate correlations. Two-way correlations between factors used as independent variables and the total number of safety events reported for contract employees are presented in Table 35.

Table 4.35. Relationship between Selected Demographic Characteristics and Safety Incidents for Contract Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	r	p
First Quarter	-.35	0.173
Energy Company	-.30	0.207
Other Company Type	-.05	0.102
Best practice	.01	0.442
Fourth Quarter	.03	0.217
Second Quarter	.03	0.209
Basis – Line of Fire	.10	0.002
Equipment Failure	.15	<.001
Basis – Improper Procedure	21	<.001
Third Quarter	35	0.173
Chemical Company Type	48	0.095

Note. n = 742

Three of the eleven correlations were found to be statistically significant. "Basis", "Improper Procedure" (r = 0.21, p = <.001)," Equipment Failure" (r = 0.21, p = <.001), and "Line of Fire" (r = 0.10, p = .002).

The second step in conducting the regression analysis was to examine the data for the presence of excess collinearity among the independent variables or that any combination of the independent variables formed a singularity. To ensure that variables entered into the regression analysis did not have excessive collinearity or that any combination of the independent variables formed a singularity, the variance inflation factor (VIF) was examined. According to Hair et al., (2006), "A common cutoff threshold is a tolerance value of 0.10 which corresponds to a VIF value of 10," (p. 230). The VIF values for this analysis was only 1.000. Therefore, there was no excess multicollinearity present in the data.

For contract workers, Table 4.36 presents the results of the multiple regression analysis utilizing total safety events as the dependent variable. The only variable that entered the regression was "Equipment Failure". This variable explained 2.4% of the variance in the safety events of contract employees. No other variable entered the model.

Table 4.36. Multiple Regression Analysis between Safety Incident and Selected Demographic Characteristics for Contract Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

ANOVA					
Source of Variation		df	MS	F	p
Regression		1	3939.305	17.871	<.001
Residual		740	220.435		
Total		741			
Model Summary					
Model	R Square	R Square Change	F Change	Sig. F Change	Standardized Coefficients Beta
Equipment Failure	.024	.0.24	17.871	<.001	.154

Variables not in the Equation		
Variables	t	p
Other Company Type	-1.59	0.113
Chemical Company Type	1.47	0.143
Second Quarter	0.95	0.340
Energy Company	-0.85	0.397
Third Quarter	0.80	0.421
Best practice	0.73	0.464
Fourth Quarter	-0.65	0.516
Basis – Line of Fire	-0.65	0.517
First Quarter	-0.35	0.173
Basis – Improper Procedure	-0.32	0.752

Lastly, the regression was run a third time using both direct hire employees and contract employees. To accomplish this objective multiple regression analysis was performed. The total number of safety events involving both direct hire and contract employees was used as the dependent variable, and the other specified variables were treated as independent variables. The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In this regression analysis, variables were added that increased the explained variance by one percent or more as long as the overall regression model remained significant.

In conducting this multiple regression analysis, all of the independent variables were categorical in nature. The variables that had to be restructured as dichotomous variables in preparation for entry into the analysis included the type of facility, quarter of the year, basis of the safety event, and "Body Part" affected. However, whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events, was already dichotomous in nature.

The variable "Type of Facility" has three categories: "Energy", "Chemical", and "Other". Each of these levels of the variable were used to create a dichotomous variable as being a member of the category or not. For example, each response was classified as either "Chemical" (coded "1" or "Not Chemical" (coded "0"), etc.

The next variable, quarter of the year (timeframe), had four categories: "Quarter 1" (January through March), "Quarter 2" (April through June), "Quarter 3" (July through September), and "Quarter 4" (October through December). Each of these levels of the variable "Quarter" of the Year was used to create a dichotomous variable as being a member of the category or not. For example, either the safety event occurred in "Quarter 1" (coded 1) or it did not occur in "Quarter 1" (coded 0), etc.

Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site was already set up as a dichotomous variable and thus it was entered into the analysis.

Regarding the number of injuries with each of the specified bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction), each safety event was recoded such that the basis for the event was either “Water Cut” (coded 1) or it was not “Water Cut” (coded 0). The same was done for each of the other six bases of the safety event. However, when the data were examined, four of the safety event bases had insufficient data to enable them to be entered as an independent variable in the analysis. These bases included “Water Cut”, “Access/Egress”, “Heat Stress”, and “Fatigue”. Consequently, each of these four variables were excluded from the regression analysis. However, “Line of Fire”, “quipment Failure”, and “Improper Procedure” did have adequate data for inclusion in the analysis.

Regarding the number of injuries with body part affected (arm, back, chest, foot, hand, head, leg, and shoulder), each safety event was recoded such that the affected body part was coded either “Arm” (coded 1) or it was not “Arm” (coded 0). The same was done for each of the other eight body parts. However, only “Hand”, “Head”, “Leg”, “Foot”, and “Arm” had enough data for inclusion into the analysis. “Shoulder” and “Back” did not have sufficient data to be included.

The first step in conducting the regression analysis was to examine the bivariate correlations. Two-way correlations between factors used as independent variables and the total number of safety events reported for contract employees are presented in Table 4.37. Two of the sixteen correlations were found to be statistically significant; “Other Company” ($r = 1.93\%$, $p < 0.001$) and “Basis” “ Equipment Failure” ($r = 0.113$, $p < 0.001$).

The second step in conducting the regression analysis was to examine the data for the presence of excess collinearity among the independent variables or that any combination of the independent variables formed a singularity.

Table 4.37. Relationship between Safety Incidents and Selected Demographic Characteristics for Direct Employees and Contract Employees Combined Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	r	p
Energy Company	-0.049	0.093
Chemical Company	-0.310	0.200
Other Company	0.193	<.001
First Quarter	-0.025	0.252
Second Quarter	0.014	0.354
Third Quarter	0.054	0.070
Fourth Quarter	-0.042	0.124
Best Practices	0.036	0.164
Line of Fire	0.011	0.380
Equipment Failure	0.113	0.001
Improper Procedure	0.097	0.004
Body Part - Hand	0.034	0.174
Body Part - Head	0.024	0.257
Body Part - Leg	0.035	0.174
Body Part - Foot	0.014	0.347
Body Part - Arm	-0.003	0.464

Note. n = 742

To ensure that variables entered into the regression analysis did not have excessive collinearity or that any combination of the independent variables formed a singularity, the variance inflation factor (VIF) was examined. According to Hair et al., (2006), “A common cutoff threshold is a tolerance value of 0.10 which corresponds to a VIF value of 10,” (p. 230). The VIF values for this analysis was 1.002 to 1.184. Therefore, there was no excess multicollinearity present in the data.

For direct hire and contract workers combined, “Other Company” and “Equipment Failure” ultimately both ended up in the model. Table 4.38 presents the results of the multiple regression analysis utilizing total safety events as the dependent variable. The variable that entered the regression first was “Other – Company” which explained 3.7% of the variance. “Equipment Failure” explained another 1.1% of the variance. None of the other fourteen variables entered the equation.

Table 4.38. Multiple Regression Analysis between Safety Incident nd Selected Demographic Characteristics for Direct Employees and Contract Employees Combined Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

ANOVA					
Source of Variation		df	MS	F	p
Regression		2	5596.929	18.706	<.001
Residual		221110.662	739		
Total		741			
Model Summary					
Model	R Square	R Square Change	F Change	Sig. F Change	Standardized Coefficients Beta
Other Company	.037	.037	28.648	<.001	.188
Equipment failure	.048	.011	8.475	.004	.105
Variables not in the Equation					
Variables		t		p	
Third Quarter		1.507		0.132	
Fourth Quarter		-1.124		0.261	
Best Practices		1.253		0.210	
Body Part - Back		-1.107		0.269	
Improper Procedure		0.950		0.343	
First Quarter		-0.918		0.359	
Line of Fire		-0.857		0.392	
Body Part - Arm		-0.761		0.447	
Body Part - Head		-0.739		0.460	
Chemical Company		0.639		0.523	
Energy Company		-0.639		0.523	
Second Quarter		0.561		0.575	
Body Part - Hand		-0.498		0.619	
Body Part - Leg		0.341		0.733	
Body Part - Foot		0.215		0.830	

Objective 6

The final objective was to determine if a model exists to explain a significant portion of the variance in the total recordable incidents from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

This objective was also accomplished using multiple regression analyses. The total number of recordables involving direct hire employees of the organization was used as the dependent variable. The other specified variables were all treated as independent variables. The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In these regression equations variables were added that increased the explained variance by one percent or more if the overall regression model remained significant.

In conducting this multiple regression analysis, all of the independent variables were categorical in nature. The variables that had to be restructured as dichotomous variables in preparation for entry into the analysis included the type of "Facility", "Quarter of the Year", "Basis of the Safety Event", and "Body Part" affected. However, whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events, was already dichotomous in nature. Three multiple regression analyses were performed on direct hire workers, contract workers, and a both direct hire and contract workers combined.

The variable "Type of Facility" has three categories: "Energy", "Chemical", and "Other". Each of these variables were used to create a dichotomous variable as being a member of the category or not. For example, each response was classified as either "Chemical" coded "1" or Not Chemical (coded "0"), etc. The next variable, "Quarter of the Year" (timeframe), had four categories: "Quarter 1" (January through March), "Quarter 2" (April through June), "Quarter 3"

(July through September), and “Quarter 4” (October through December). Each of these levels of the variable “Quarter of the Year” was used to create a dichotomous variable as being a member of the category or not. For example, either the safety event occurred in “Quarter 1” (coded 1) or it did not occur in “Quarter 1” (coded 0), etc.

Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site was already set up as a dichotomous variable and thus it was entered into the analysis.

Regarding the number of injuries with each of the specified bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction), each safety event was recoded such that the basis for the event was either “Water Cut” (coded 1) or it was not “Water Cut” (coded 0). The same was done for each of the other six “Bases” of the safety event. However, when the data were examined, four of the safety event bases had insufficient data to enable them to be entered as an independent variable in the analysis. These bases included “Water Cut”, “Access/Egress”, “Heat Stress”, and “Fatigue”. Consequently, each of these four variables were excluded from the regression analysis. However, “Line of Fire”, “Equipment Failure”, and “Improper Procedure” did have sufficient data for inclusion in the analysis.

Regarding the number of injuries with “Body Part” affected (arm, back, chest, foot, hand, head, leg, and shoulder), each safety event was recoded such that the affected “Body Part” was coded either “Arm” (coded 1) or it was not “Arm” (coded 0). The same was done for each of the other eight body parts. However, when the data was examined, “Body Part” did not have enough data to be included.

The first step in conducting the regression analysis was to examine the bivariate correlations. Two-way correlations between factors used as independent variables and the total number of safety events reported for direct hire employees of the organization are presented in Table 4.39. Five of the eleven correlations were found to be statistically significant. The highest correlations with the Total Recordable events were found to be with the category "Other Company" and "Improper Procedure".

To ensure that variables entered into the regression analysis did not have excessive collinearity or that any combination of the independent variables formed a singularity, the variance inflation factor (VIF) was examined. According to Hair et al., (2006), "A common cutoff threshold is a tolerance value of 0.10 which corresponds to a VIF value of 10," (p. 230). The VIF values for this analysis ranged from 1.000 to 1.046. Therefore, there was no excess multicollinearity present in the data.

Table 4.39. Relationship between OSHA Recordables and Selected Demographic Characteristics for Direct Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	r	p
Other Company	0.406	<.001
Third Quarter	0.350	0.173
Improper Procedure	0.176	<.001
Energy Company	-0.101	0.003
Line of Fire	0.098	0.004
Chemical Company	-0.067	0.035
Equipment Fail	0.050	0.087
Best Practices	0.027	0.229
Fourth Quarter	0.017	0.323
First Quarter	0.010	0.392
Second Quarter	0.007	0.421

Note. n = 742

For direct hire workers Table 4.40 presents the results of the multiple regression analysis for direct hire workers utilizing total safety events as the dependent variable. The variable that entered the regression first was "Other – Company". This variable explained 16.4% of the variance in the safety events of direct hire employees. “Improper Procedure” explained an additional 0.9% of the variance in the total number of safety events. None of the other variables entered into the equation.

Table 4.40. Multiple Regression Analysis between OSHA Recordables and Selected Demographic Characteristics for Direct Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

ANOVA				
Source of Variation	df	MS	F	p
Regression	2	64.286	77.392	<.001
Residual	739	.831		
Total	741			

Model Summary					
Model	R Square	R Square Change	F Change	Sig. F Change	Standardized Coefficients Beta
Other Company	.164	.164	145.661	<.001	.386
Improper Procedure	.173	.009	7.788	.005	.095

Variables not in the Equation		
Variables	t	p
Improper Procedure	2.791	0.005
Best Practices	1.82	0.069
Line of Fire	1.384	0.167
Chemical Company	1.341	0.180
Energy Company	-1.341	0.180
Equipment Failure	0.992	0.322
Third Quarter	-0.809	0.419
Fourth Quarter	0.362	0.717
Second Quarter	0.234	0.815
First Quarter	0.206	0.837

The analysis was repeated for contract employees. To accomplish this objective multiple regression analysis was performed. The total number of safety events involving contract employees was used as the dependent variable, and the other specified variables were treated as independent variables. The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In this regression analysis, variables were added that increased the explained variance by one percent or more as long as the overall regression model remained significant.

In conducting this multiple regression analysis, all of the variables treated as independent variables were categorical in nature. However, except for whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events, the other variables had to be prepared as dichotomous variables in preparation for entry into the analysis. The variables that had to be restructured as dichotomous included the type of facility, quarter of the year, basis of the safety event, and “Body Part” affected.

The variable “Type of Facility” has three categories: “Energy”, “Chemical”, and “Other”. Each of these levels of the variable were used to create a dichotomous variable as being a member of the category or not. For example, each response was classified as either “Chemical” (coded “1” or “Not Chemical” (coded “0”), etc.

The next variable, “Quarter of the Year (timeframe), had four categories: “Quarter 1” (January through March), “Quarter 2” (April through June),” Quarter 3” (July through September), and “Quarter 4” (October through December). Each of these levels of the variable “Quarter of the Year” was used to create a dichotomous variable as being a member of the category or not. For example, either the safety event occurred in “Quarter 1” (coded 1) or it did not occur in “Quarter 1” (coded 0), etc.

Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site was already set up as a dichotomous variable and thus it was entered into the analysis.

Regarding the number of injuries with each of the specified bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction), each safety event was recoded such that the basis for the event was either “Water Cut” (coded 1) or it was not “Water Cut” (coded 0). The same was done for each of the other six bases of the safety event. However, when the data were examined, four of the safety event bases had insufficient data to enable them to be entered as an independent variable in the analysis. These bases included “Water Cut”, “Access/Egress”, “Heat stress”, and “Fatigue”. Consequently, each of these four variables were excluded from the regression analysis. However, “Line of Fire”, “Equipment Failure”, and “Improper Procedure” did have sufficient data for inclusion in the analysis.

Regarding the number of recordables with “Body Part” affected (arm, back, chest,foot, hand, head, leg, and shoulder), each safety event was recoded such that the affected “Body Part” was coded either “Arm” (coded 1) or it was not “Arm” (coded 0). The same was done for each of the other eight body parts. However, there was insufficient data to include “Body Part” into the equation for contract workers.

The nature of the influence of these two significant variables was such that being classified as “Other Company” tended to result in a higher number of OSHA Recordable events as did use of an “Improper Procedure” when direct hire and contract employees were analyzed together.

The first step in conducting the regression analysis was to examine the bivariate correlations. Two-way correlations between factors used as independent variables and the total number of recordable events are presented in Table 4.41. Only one of the eleven correlations was found to be statistically significant. “Basis - Equipment Failure”, was the only one that was significant.

To ensure that variables entered into the regression analysis did not have excessive collinearity or that any combination of the independent variables formed a singularity, the variance inflation factor (VIF) was examined. According to Hair et al., (2006), “A common cutoff threshold is a tolerance value of 0.10 which corresponds to a VIF value of 10,” (p. 230). The VIF values for this analysis was 1.000 to 1.091. Therefore, there was no excess multicollinearity present in the data.

Table 4.41. Relationship between OSHA Recordables and Selected Demographic Characteristics for Contract Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	r	p
Chemical Company	0.580	0.057
Equipment Fail	0.108	0.002
Line of Fire	0.077	0.180
Energy Company	-0.055	0.066
Second Quarter	0.053	0.076
Improper Procedure	0.044	0.116
Third Quarter	-0.034	0.176
First Quarter	-0.022	0.267
Best Practices	-0.018	0.313
Other Company	-0.011	0.387
Fourth Quarter	0.004	0.457

Note. n = 742

As only Equipment Failure was significant, it was the only variable that could have entered the model. Table 4.42 presents the results of the multiple regression analysis utilizing total safety events as the dependent variable. Equipment Failure explained another 1.2% of the variance.

Lastly, the regression was run a third time using both direct hire employees and contract employees. To accomplish this objective multiple regression analysis was performed.

The total number of recordables involving both direct hire and contract employees was used as the dependent variable, and the other specified variables were treated as independent variables. The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In this regression analysis, variables were added that increased the explained variance by one percent or more as long as the overall regression model remained significant.

Table 4.42. Multiple Regression Analysis between OSHA Recordables and Selected Demographic Characteristics for Contract Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

ANOVA				
Source of Variation	df	MS	F	p
Regression	1	36.854	8.712	.003
Residual	740	4.230		
Total	741			

Model Summary					
Model	R Square	R Square Change	F Change	Sig. F Change	Standardized Coefficients Beta
Equipment Failure	.012	.012	8.712	<.003	.108

Variables not in the Equation		
Variables	t	p
Chemical Company	1.687	0.092
Second Quarter	1.534	0.125
Energy Company	-1.528	0.127
Line of Fire	1.467	0.143
Third Quarter	-1.042	0.298
First Quarter	-0.689	0.491
Best Practices	-0.598	0.550
Other Company	-0.497	0.620
Improper Procedure	0.364	0.716
Fourth Quarter	0.209	0.835

In conducting this multiple regression analysis, all of the independent variables were categorical in nature. The variables that had to be restructured as dichotomous variables in preparation for entry into the analysis included the type of facility, quarter of the year, basis of the safety event, and “Body Part” affected. However, whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events, was already dichotomous in nature.

The variable “Type of Facility” has three categories: “Energy”, “Chemical”, and “Other”. Each of these levels of the variable were used to create a dichotomous variable as being a member of the category or not. For example, each response was classified as either "Chemical" (coded "1" or "Not Chemical" (coded "0"), etc.

The next variable, "Quarter of the Year" (timeframe), had four categories: "Quarter 1" (January through March), "Quarter 2" (April through June), "Quarter 3" (July through September), and "Quarter 4" (October through December). Each of these levels of the variable "Quarter of the Year" was used to create a dichotomous variable as being a member of the category or not. For example, either the safety event occurred in "Quarter 1" (coded 1) or it did not occur in "Quarter 1" (coded 0), etc.

Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site was already set up as a dichotomous variable and thus it was entered into the analysis without needing to be recoded.

Regarding the number of injuries with each of the specified bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction), each safety event was recoded such that the basis for the event was either "Water Cut" (coded 1) or it was not "Water Cut" (coded 0). The same was done for each of the other six bases of the safety event. However, when the data were examined, four of the safety event bases had insufficient data to enable them to be entered as an independent variable in the analysis. These bases included "Water Cut", "Access/Egress", "Heat stress", and "Fatigue". Consequently, each of these four variables were excluded from the regression analysis. However, "Line of Fire", "Equipment Failure", and "Improper Procedure" did have adequate data for inclusion in the analysis.

Regarding the number of injuries with “Body Part” affected (arm, back, chest, foot, hand, head, leg, and shoulder), each safety event was recoded such that the affected “Body Part” was coded either “Arm” (coded 1) or it was not “Arm” (coded 0). The same was done for each of the other eight body parts. However, only “Hand”, “Head”, “Leg”,” Foot”, and “Arm” had enough data for inclusion into the analysis. “Shoulder” and “Back “did not have sufficient data to be included.

The first step in conducting the regression analysis was to examine the bivariate correlations. Two-way correlations between factors used as independent variables and the total number of safety events reported for contract employees are presented in Table 4.43. Nine of the sixteen correlations were found to be statistically significant; “Other Company” (r = 1.47%, p <0.001), “Body Part – Hand” (r=.088, p=.008), “Company – Energy”(r=.085, p=.011), and “Basis Equipment Failure” (r=.084, p=.011) were significant.

Table 4.43. Relationship between OSHA Recordables and Selected Demographic Characteristics for Direct Employees and Contract Employee Combined Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

Variable	r	p
Other Company	0.147	<.001
Body Part - Hand	0.088	0.008
Energy Company	-0.085	0.011
Improper Procedure	0.084	0.011
Equipment Fail	0.081	0.014
Body Part - Back	0.072	0.025
Line of Fire	0.070	0.028
Body Part - Foot	0.068	0.031
Body Part - Leg	0.062	0.046
Body Part - Head	0.055	0.068
Body Part - Arm	0.051	0.082
Second Quarter	0.047	0.102
Third Quarter	-0.043	0.121
Chemical Company	0.023	0.268
First Quarter	-0.013	0.363
Fourth Quarter	0.009	0.405

Note. n = 742

The second step in conducting the regression analysis was to examine the data for the presence of excess collinearity among the independent variables or that any combination of the independent variables formed a singularity. To ensure that variables entered into the regression analysis did not have excessive collinearity or that any combination of the independent variables formed a singularity, the variance inflation factor (VIF) was examined. According to Hair et al., (2006), “A common cutoff threshold is a tolerance value of 0.10 which corresponds to a VIF value of 10,” (p. 230). The VIF values for this analysis was 1.002 to 1.184. Therefore, there was no excess multicollinearity present in the data.

However, only Other Company and Equipment Failure ultimately ended up in the model. Table 44 presents the results of the multiple regression analysis utilizing total safety events as the dependent variable. The variable that entered the regression first was “Other – Company” which explained 2.1% of the variance. “Equipment Failure” explained another 0.5% of the variance. None of the other variables entered the equation.

The nature of the influence of these two significant variables was such that being classified as “Other Company” tended to result in a higher number of OSHA Recordable events as did an “Equipment Failure” when direct hire and contract employees were analyzed together.

Table 4.44. Multiple Regression Analysis between OSHA Recordables and Selected Demographic Characteristics for Direct Employees and Contract Employees Reported by Safety Officers at Industrial Organizational Facilities in the Eight parish Region in Southern Louisiana

ANOVA				
Source of Variation	df	MS	F	p
Regression	2	60.132	10.250	<.001
Residual	120.264	5.867		
Total	741			

(table cont’d.)

<table>
<tr><th colspan="6">Model Summary</th></tr>
<tr><th>Model</th><th>R Square</th><th>R Square Change</th><th>F Change</th><th>Sig. F Change</th><th>Standardized Coefficients Beta</th></tr>
<tr><td>Other Company</td><td>.021</td><td>.021</td><td>16.256</td><td><.001</td><td>.143</td></tr>
<tr><td>Equipment Failure</td><td>.027</td><td>.005</td><td>4.174</td><td>.041</td><td>.074</td></tr>
<tr><td colspan="6">Variables not in the Equation</td></tr>
<tr><td colspan="2">Variables</td><td colspan="2"><u>t</u></td><td colspan="2"><u>p</u></td></tr>
<tr><td colspan="2">Chemical Company</td><td colspan="2">1.806</td><td colspan="2">0.071</td></tr>
<tr><td colspan="2">Energy Company</td><td colspan="2">-1.806</td><td colspan="2">0.071</td></tr>
<tr><td colspan="2">Body Part - Foot</td><td colspan="2">1.771</td><td colspan="2">0.077</td></tr>
<tr><td colspan="2">Body Part - Back</td><td colspan="2">1.474</td><td colspan="2">0.141</td></tr>
<tr><td colspan="2">Body Part - Hand</td><td colspan="2">1.474</td><td colspan="2">0.141</td></tr>
<tr><td colspan="2">Second Quarter</td><td colspan="2">1.417</td><td colspan="2">0.157</td></tr>
<tr><td colspan="2">Body Part - Leg</td><td colspan="2">1.317</td><td colspan="2">0.188</td></tr>
<tr><td colspan="2">Third Quarter</td><td colspan="2">-1.183</td><td colspan="2">0.237</td></tr>
<tr><td colspan="2">Line of Fire</td><td colspan="2">1.173</td><td colspan="2">0.241</td></tr>
<tr><td colspan="2">Improper Procedure</td><td colspan="2">1.097</td><td colspan="2">0.273</td></tr>
<tr><td colspan="2">Body Part - Arm</td><td colspan="2">0.96</td><td colspan="2">0.337</td></tr>
<tr><td colspan="2">Body Part - Head</td><td colspan="2">0.551</td><td colspan="2">0.582</td></tr>
<tr><td colspan="2">First Quarter</td><td colspan="2">-0.52</td><td colspan="2">0.603</td></tr>
<tr><td colspan="2">Fourth Quarter</td><td colspan="2">0.294</td><td colspan="2">0.769</td></tr>
<tr><td colspan="2">Best Practices</td><td colspan="2">0.175</td><td colspan="2">0.861</td></tr>
</table>

CHAPTER 5: SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Summary

The primary purpose of this study was to determine the influence of selected organizational, demographic and safety practice factors on the number and types of injuries within the industrial facilities in eight parishes in southern Louisiana. To accomplish this purpose, the following specific objectives were formulated to guide this research study:

1. To describe the responses of the participating safety officers on the type of industrial organizational facilities in the eight parishes on the following selected measures regarding workplace injuries:

(a) Describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred;

(b) Describe the number of safety events (injuries, illnesses, and first aids) reported by the safety officers at the industrial organizational facilities;

(c) Describe the number of safety events (injuries, illnesses, and first aids) reportedby the safety officers at the industrial organizational facilities overall and during each quarter of the year;

(d) Describe the responding safety offices at the industrial organizational facilities regarding whether or not the site developed best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities;

(f) Describe the number of each type of OSHA recordable event (deaths, time away from work, job transfer, and other) and the number of safety events (injuries, illnesses, and first aids) (overall and for direct employees and contractor employees) as reported by the safety officer at each industrial organizational facility.

2. Describe the injuries at the industrial organizational facilities as reported by safety officers on the following selected characteristics:

(a) Basis (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction) of the injury;

(b) Body part injured (hand, head, leg, foot, arm, chest, back and/or shoulder).

3. Compare the number of safety events illnesses, first aids, and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities that affected direct employees with the number of safety events and OSHA recordable events that affected contractor employees.

4. Determine if a relationship exists between number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers at the industrial organizational facilities and the following characteristics of safety event and OSHA recordable event:

(a) Type of facility;

(b) Quarter in which the event occurred;

(c) Basis of the event; and

(d) Body part affected by the event.

5. To determine if a model exists to explain a significant portion of the variance in the number of safety events (injuries, illnesses, and first aids) from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site; and

(e) Number of injuries by body part affected.

6. To determine if a model exists to explain a significant portion of the variance in the type of OSHA recordables from the following measures:

(a) Type of facility;

(b) Quarter (timeframe) in which injury occurred;

(c) Number of injuries with each of the following bases (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction);

(d) Whether or not the safety officer reported that they have established best practices (or have specific plans to do so) based on the most common recordable events seen at the site;

(e) Number of injuries by body part affected.

The dependent variables of this study were the number and types of injuries that occurred to workers in industrial manufacturing plants in south Louisiana. The target population for this study is industrial manufacturing plants. The accessible population was industrial manufacturing plants in the eight parishes surrounding Baton Rouge, Louisiana. The sample was 100% of the defined accessible population.

The instrument used to collect data for this study consisted of a researcher-designed, computerized, recording form. The specific variables to be measured were selected based on the review of literature, logical argument, and the information that was obtainable from a database. The information from the databases were downloaded into a file, which served as the research instrument. The variables include quarter, type of safety event (OSHA recordable, illnesses, and first aids cases), Type of employee (direct hire employee or contract employee), basis of injury (water cut - plant injury, line of fire, access/egress, heat stress, fatigue, equipment failure or improper use of equipment, improper procedure use or violation, body part(s) affected (hand, head, leg, foot, arm, chest, back, or shoulder) and whether or not best practices based on the most common recordable seen at the site have been developed.

Data collection came from contact with industry trade association to determine if they are were to share their data. The data received by the researcher is being maintained in a confidential manner. Transferring information from the databases onto a computerized recording form designed by the researcher is the method that was used to collect the data.

Specific demographic and descriptive variables were selected according to the research questions presented in this study. Variables were systematically retrieved from the initial database, and a new file was established.

Summary of Findings

Company Type

The first part of the objective was to describe the industrial organizational facilities on the type of facility (primary function) in which the events occurred. Frequencies and percentages were used since the variables are categorical in nature. Most respondents had a primary function relating to Chemicals (n = 475, 64.3%). “Energy” (n = 235, 31.8%) was the next largest category, and the smallest was the category of “Other” (n = 29, 3.9%).

Number of Safety Events Reported

The number of each type of safety event (injuries, illnesses, and first aids) reported by the responding safety officers in the facilities among the direct hire employees of the organization was analyzed. For direct hire workers, most reports, 73.5% (n= 538) indicated there were no (0) injuries at their facilities during the previous reported timeframe. The mean number of “Injuries” was 0.42, (SD = 1.008) for direct hire employees, and the number ranged from a low of 0 to a high of 15. For contract workers, the majority 77% (n = 551) of responding safety officers indicated there were no (0) “Injuries” at their facilities during the timeframe reported. The mean number of “Injuries” was 0.50, (SD = 2.3), with range from a low of 0 to a high of 51. For direct hire and contract workers combined, the majority 58.9% (n = 432) of responding safety officers indicated there were no (0) “Injuries” at their facilities during the timeframe reported. There were 23.9% (n = 175) with one reported injury, 110 (n = 15.0%) with two to four “Injuries”. The mean number of “Injuries” was 0.91, (SD = 2.789), and with range from a low of 0 to a high of 55.

Regarding the number of work-related “Illnesses” reported among direct hire employees of industrial organizational facilities in eight parishes of southern Louisiana, the majority (n = 695, 95.2%) of safety officers reported that there were no work-related “Illnesses” during the reported timeframe. The mean number of work-related “Illnesses” reported for direct hire workers was 0.07 (SD = .369) and ranged from 0 to 4. Regarding the number of work-related “Illnesses” reported among contract employees of industrial organizational facilities in eight parishes of southern Louisiana, the majority (n = 701, 97.9%) of safety officers reported that there were no work-related “Illnesses” during the reported timeframe. The mean number of work-related “Illnesses” reported was 0.03 (SD = 0.228) and ranged from 0 to 3. Regarding the number of work-related “Illnesses” reported among both direct workers and contract employees of industrial organizational facilities in eight parishes of southern Louisiana, the majority (n = 687, 93.9%) of safety officers reported that there were no work-related “Illnesses” during the reported timeframe. The mean number of work-related “Illnesses” reported was 0.10 (SD = 0.476) and ranged from 0 to 6.

The third area of safety events examined was “First Aids”. The mean number of “First Aid” safety events for direct hire workers was 3.31 (SD = 6.162) and ranged from a low of 0 to a high of 50. When first aid safety events were examined, the category with the highest number of responses was zero (n = 263, 36.6%). The category with the second highest number of responses (n = 192, 26.7%) was the “2 - 4” category. The mean number of “First Aid” safety events for contract workers was 6.48 (SD = 13.903) and ranged from a low of 0 to a high of 190. When first aid safety events were examined, the category with the highest number of responses was still zero (n = 228, 32.3%). The category with the second highest number of responses (n = 131, 18.6%) was the “2 - 4” category, and the third highest category was one response (n = 103, 14.6%). The mean number of “First Aid” safety events for direct hire and contractor workers combined was 9.6 (SD = 16.129) and ranged from a low of 0 to a high of 190. When “First Aid” safety events were examined, the category with the highest number of responses was zero (n = 153, 21.13%). The category with the second highest number of responses (n = 147, 20.30%) was the “2 - 4” category, and the third highest category was 11 -20 responses (n = 104, 14.4%).

Number of Safety Events Reported by Quarter

The third part of the first objective examined the number of injuries during each quarter of the year. The largest portion of the incidents occurred in the “First Quarter” (n = 190, 25.9%). However, all the quarters had roughly similar frequencies of incidents, the “Second

Quarter" (n = 180, 24.5%), third quarter (n = 180, 24.5%), and "Fourth Quarter" (n = 185, 25.2%).

Best Practices

Whether or not the site developed best practices based on the most common recordable events seen at the site (or plan to do so), of the responses provided by the responding safety officers, 61.7% (n = 282) of the responses reflected that the site developed best practices based on the most common recordable events seen at the site (or plan to do so), and 38.3% (n = 175) responded that their site did not develop best practices based on the most common recordable events seen at the site (or plan to do so).

OSHA Recordables

The fifth part of first objective was to describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) as reported by the responding safety officers at the industrial organizational facilities. The majority 99.6% (n= 729) of responding safety officers indicated there were no (0) fatalities at their facilities during the corresponding quarter. Regarding the number of instances of "Time Away" from work reported, the majority (n = 629, 85.7%) reported that there was no of "Time Away" from work. Regarding the number of instances of "Job Transfers" reported, the majority (n = 622, 85%) reported that there were no "job transfers". Regarding the number of "Other" recordables reported, the majority once again (n = 527, 72.0%) reported that there was no of "Time Away" from work. The recordable events reported slanted towards the smaller numbers for the most part. There were two incidents (0.3%) of single deaths reported, 82 instances (11.2%) of a single injury involving "Time Away" from work; 87 (11.9%) injuries involving "Transfers"; and 527 (17.8) injuries listed as "Other".

Safety Events by Direct Employee or Contract Employee

The last part of the first objective was to describe the number of each type of OSHA recordable event (death, time away from work, job transfer, and other) and the number of safety events (overall and for direct employees and contractor employees) as reported by the responding safety officers at the industrial organizational facilities. This objective analyzed the frequencies of the safety events. Since these results are essentially looking at the frequencies of direct employee or contract employee together the results also are very much skewed towards the lower numbers reported with zero (0) reported events being the highest reported result for both OSHA recordable events and safety events.

Objective 2

The second objective of the study was to describe the OSHA recordable injuries at the industrial organizational facilities as reported by safety officers on the following selected characteristics:

(c) Basis (water cut, line of fire, access/egress, heat stress, fatigue, improper procedure, and equipment malfunction of the injury.

(d) Body part injured (hand, head, leg, foot, arm chest, back and/or shoulder).

Frequencies and percentages of injuries in each of the categories identified comprised the analysis used to accomplish this objective. A total of 112 OSHA recordable events were reported by the responding safety officers. When these “Injuries” were described on the “Basis” of the injury, the most frequently reported “Basis” was “Line of Fire” with more than one third of the injuries reported by the safety officers (n = 41, 36.6%). The second most frequently reported “Basis” for the injury was “Improper Procedure” (n = 34, 30.3%). “Equipment

Malfunction" was reported by more than 10% of the responding safety officers (n = 24, 21.4%) times.

In addition to describing the safety events on their "Basis," the events were also described on the "Body Part" that was affected by the injury. The "Body Part" that was reported as affected by the injury most frequently was the worker's hand (n = 37, 24.8%). The "Body Part" that was reported as affected second most frequently was the worker's "Arm" (n = 25, 16.8%) and the third most frequently cited "Body Part" was the worker's back (n = 20, 13.42%).

Objective 3

The third objective of the study was to compare the number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) reported by safety officers that affected direct employees with the number of safety events and OSHA recordable events that affected contractor employees at industrial organizational facilities in the eight parish region in south central Louisiana. To accomplish this objective, the independent t-test statistical procedure was used to compare the mean number of each category of safety event and OSHA recordable injury reported by safety officers at industrial organizational facilities for direct employees and contractor employees. An a priori significance level of .05 was established by the researcher. Of the nine variables that were compared by type of employee (direct and contractor), three were found to be significantly different. The safety event that was found to have the highest degree of difference by type of employee was "First Aid" ($t_{df = 699} = 6.683$, $p < .001$). The mean number of "First Aid" events reported for contractor employees (Mean = 6.53, SD = 13.953) was found to be significantly higher than the number of First Aid safety events reported for direct employees of the facilities (Mean = 3.05, SD = 5.633). "Overall Safety Event" measurement of "First Aid," "Illness," and "Injury" had the second highest degree of difference by type of employee ($t_{df = 717} = 6.015$, $p < .001$). The mean number of "Overall Safety Events" reported for contractor employees (Mean = 6.90, SD = 15.263) was found to be significantly higher than the number of "Overall Safety Events" reported for direct employees of the facilities (Mean = 3.54, SD = 6.212). The third significant difference was found for "Illnesses" and the number of "Illnesses" reported for direct employees (Mean = 0.07, SD = 0.366) was found to be significantly higher for than for contractor employees (Mean = 0.03, SD = 0.229) ($t_{df = 713} = 2.844$, $p = .005$). No significant differences were found for "Total Injuries" or any of the other categories of the OSHA recordable events by type of employee.

Objective 4

Facility

The first variable examined for relationships with the number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) as reported by the safety officers at the industrial organizational facilities was the type of facility as defined by their primary function. Three types of facilities were identified in the responses of the safety officers, specifically "Chemical", "Energy", and "Other". These comparisons were made using the one-way analysis of variance procedure with the Tukey's post hoc multiple comparison procedure for identifying specific differences in means when a significant ANOVA was found. A total of nine comparisons were made of which at least one statistically significant difference was found by type of facility for eight of the safety events and OSHA recordables.

The comparison that was found to have the highest degree of significant difference was "Total of All Injuries, Illnesses, and First Aids" ($F_{df=2,730} = 14.338$, $p < .001$). The Tukey's Post Hoc Multiple Comparison procedure was used to determine the specific groups that were significantly different among three types of facilities examined. The “Other” type of facility was found to have a significantly higher (Mean = 27.41) number of total injuries, “Illnesses”, and first aids than both the “Chemical” and “Energy” facilities which were not found to be significantly different from one another. There were no differences in the means between “Energy” and “Chemical”. However, there were significant differences between “Energy” and “Chemical” versus “Other” companies when we looked at “Total Injury”, “Total Illness”, “Total First Aids”, “Illness” and “First Aids”, “Total All Recordables” – “Transfers”, and “Total All Recordables”.

Quarter

The second variable examined for relationships with the number of safety events (injuries, illnesses, first aids) and OSHA recordable events (deaths, time away from work, job transfer, and other) as reported by the safety officers at the industrial organizational facilities was the quarter in which the event occurred. However, there were no significant differences by quarter among any of the comparisons.

Basis

In order to determine if a relationship existed between the number of safety events (injuries, illnesses, and first aids) and OSHA Recordables (deaths, transfers, time away from work and other) and the “Basis” of the safety event/OSHA Recordable, the researcher determined the most effective statistical methods to examine these possible relationships was to compare the number of each of the types of safety events/ OSHA recordables by categories of the identified “Basis” of the event using an independent t-test analysis for the procedure. The number of reported “Bases” in several of the different categories was insufficient to conduct a statistical analysis; these included “Water Cut;” “Access/Egress;” “Heat;” and “Fatigue.”.

However, three of the “Bases” (line of fire; equipment failure; and “improper procedure) did have adequate data to measure possible relationships.

When these comparisons were made by whether or not “Line of Fire” was the “Basis” for the safety event, only one of the nine comparisons was found to be statistically significant. The total of “All Recordables” (which included deaths, transfers, days away from work, and other) was found to be significantly higher ($t_{df = 730} = 2.020$, $p = .044$) for those who reported “Line of Fire” as the basis for the events (Mean = 1.06, SD = 1.706) than for those who did not report Line of Fire as the ”Basis” for the event (Mean = 0.48, SD = 1.678). No other safety events/OSHA Recordables were found to be significantly different.

When these comparisons were made by whether or not “Equipment Failure” was the “Basis” for the safety event, only two of the nine comparisons was found to be statistically significant. “Recordables – Other” was found to be significantly higher ($t_{df=730}$-2.297, p=.022) for those who reported “Equipment Failure” as the basis for the events (Mean = 1.33, SD=1.528) than for those who did not report “Equipment Failure” as the “Basis” for the safety event (Mean – 0.48, SD = 1.682). The “All Recordables” (which included deaths, transfers, days away from work, and other) was found to be significantly higher ($t_{df = 732} = 2.246$, $p = .022$) for those who reported “Equipment Failure” as the basis for the events (Mean = 2.10, SD = 2.095) than for those who did not report Equipment Failure as the ”Basis” for the event (Mean = 0.87, SD = 2.468). No other safety events/OSHA Recordables were found to be significantly different.

When these comparisons were made by whether “Improper Procedure” was the “Basis” for the safety event, four of the nine comparisons were found to be statistically significant. Total first aids was found to be significantly higher ($t_{df = 722} = 2.543$, $p = .011$) for those who reported “Improper Procedure” as the basis for the events (Mean = 17.03, SD = 22.715) than for those who did not report “Improper Procedure” as the ”Basis” for the event (Mean = 9.29, SD = 15.741). The total of “All Injuries, Illnesses, and First Aids” (was found to be significantly higher ($t_{df = 734}$ = 2.630, p = .009) for those who reported “Improper Procedure” as the basis for the events (Mean = 18.93, SD = 23.133) than for those who did not report “Improper Procedure” as the ”Basis” for the event (Mean = 10.11, SD = 17.457). The total of “Recordables - Other” was found to be significantly higher ($t_{df = 730}$ = 1.961, p = .050) for those who reported “Improper Procedure” as the basis for the events (Mean = 1.10, SD = 1.235) than for those who did not report “Improper Procedure” as the ”Basis” for the event (Mean = 0.48, SD = 1.675). The total of “All Recordables” (which included deaths, transfers, days way from work, and other) was found to be significantly higher ($t_{df = 732}$ = 2.288, p = .022) for those who reported “Improper Procedure” as the basis for the events (Mean = 1.93, SD = 1.624) than for those who did not report “Improper Procedure” as the ”Basis” for the event (Mean = 0.87, SD = 2.468). No other safety events/OSHA Recordables were found to be significantly different.

“Body Part”

This part of the objective analyzed safety events based on the “Body Part” affected. When these comparisons were made by whether or not “Hand” was the ““Body Part”” involved in the safety event, only two of the nine comparisons were found to be statistically significant, “Total All Recordables – Other” and total of “All Recordables “ Recordables - Other” was found to be significantly higher ($t_{df = 730}$ = -2.283, p = .023) for those who reported “Hand” as the “Body Part” for the events (Mean = 1.21, SD = 1.853) than for those who did not report Hand as the ““Body Part”” for the event (Mean = 0.48, SD = 1.671). “All Recordables” was found to be significantly higher ($t_{df = 732}$ = -2.399, p = .017) for those who reported “Hand” as the “Body Part” for the events (Mean = 2.00, SD = 2.419) than for those who did not report

Hand as the ""Body Part"" for the event (Mean = 0.86, SD = 2.459). No other safety events/OSHA Recordables were found to be significantly different.

Comparisons of the head, leg, foot, and arm revealed no significant differences in the means of safety events that involved those body parts or not.   The total of "All Recordables - Other" was found to be significantly higher ($t_{df = 730} = 2.242$, $p = .025$) for those who reported "Back" as the "Body Part" for the events (Mean = 1.54, SD = 2.504) than for those who did not report back as the ""Body Part"" for the event (Mean = 0.49, SD = 1.661). No other safety events/OSHA Recordables were found to be significantly different regarding the "Back".

Objective 5

To accomplish the objective of determining if a model exists explaining a significant portion of the variance in the number of safety events (injuries, illnesses, and first aids) multiple regression analysis was performed. Three multiple regression equations were conducted: for direct hire employees, contractor employees and direct hire and contractor workers combined. The total number of safety events involving workers was used as the dependent variable, and the other specified variables were treated as independent variables. The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In this regression analysis, variables were added that increased the explained variance by one percent or more as long as the overall regression model remained significant.

The variables, type of facility, quarter of the year, basis of the safety event, and "Body Part" affected, had to be prepared as dichotomous variables in preparation for entry into the analysis except for whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events which was already dichotomous. Some of the Basis did not have enough data to enter the equations. "Body Part" affected only had enough data when both sets of workers were combined and even then, shoulder and back still had insufficient data.

The first step in conducting the regression analysis was to examine the bivariate correlations. For direct hire employees, six of the eleven correlations were found to be statistically significant. The highest correlation with the number of safety events was found to be with the variable “Other Company Type” ($r = 68.0$, $p<.001$). The second highest correlation with the total number of safety events for “Direct Hire” employees was the basis “Improper Procedure” ($r = .21$, $p < .001$). The third highest correlation with Company Type was “Chemical” ($r = -.20$, $p < .001$). Three additional variables were found to be significantly related to the total number of safety events reported for the direct hire employees. These variables included “Line of Fire” ($r = .10$, $p - .002$), company type “Energy” ($r = .08$, $p = .016$), and occurring in the “Third Quarter” ($r = .07$, $p = .032$) of the year. For contract employees, three of the eleven correlations were found to be statistically significant; they were “Improper Procedure” ($r=.21$, $<.001$), “Equipment Failure” ($r=.15$, $p=<.001$), and “Line of Fire” ($r=.10, p=.002$). And, for both direct employees and contract workers combined, two of the sixteen correlations were found to be statistically significant; “Other Company” ($r = 1.93\%$, $p <0.001$) and “Basis Equipment Failure ($r = 0.113$, $p <0.001$). The data was examined to see if there was excess collinearity among the independent variables or that any combination of the independent variables formed a singularity, and this was not an issue. The variance inflation factor (VIF) was examined; there was no excess multicollinearity presented in the data for any of the equations.

For direct hire employees, the variable that entered the regression first was “Other – Company”. Considered alone this variable explained 46.0% of the variance in the safety events of direct hire employees. Three additional variables explained an additional 1.5% of the variance in the total number of safety events. They were “Third Quarte”r, “Improper Procedure”, and whether or not the site had best practices (or planned to).

For contract workers, the only variable that entered the regression was “Equipment Failure”. This variable explained 2.4% of the variance in the safety events of contract employees. No other variable entered the model.

When direct hire and contractors were combined, “Other Company” and “Equipment Failure” ultimately both ended up in the model. The variable that entered the regression first was “Other – Company” which explained 3.7% of the variance. Equipment Failure explained another 1.1% of the variance. None of the other fourteen variables entered the equation.

Objective 6

To determine if a model exists to explain a significant portion of the variance in the total recordable incidents multiple regression analyses was used. Three multiple regressions were conducted; one for direct hire workers, one for contract workers and one with both direct and contractor workers combined. Total number of recordables involving direct hire employees of the organization was used as the dependent variable. The other specified variables were all treated as independent variables. The researcher used stepwise entry of the independent variables due to the exploratory nature of the study. In these regression equations variables were added that increased the explained variance by one percent or more if the overall regression model remained significant.

The variables, type of facility, quarter of the year, basis of the safety event, and “Body Part” affected, had to be prepared as dichotomous variables in preparation for entry into the analysis except for whether or not the site established best practices (or have specific plans to do so) based on the most common recordable events which was already dichotomous. Some of the

“Basis” did not have enough data to enter the equations. “Body Part” affected only had enough data when both sets of workers were combined and even then, shoulder and back still had insufficient data.

The first step in conducting the regression analysis was to examine the bivariate correlations. Five of the eleven correlations were found to be statistically significant for the direct hire. The highest correlations with the “Total Recordable” events were found to be with the category “Other Company” and “Improper Procedure”. For the contract workers, only one of the eleven correlations were found to be statistically significant. “Basis - Equipment Failure”, was the only one that was significant. When direct hires and contract workers were combined nine of the sixteen correlations were found to be statistically significant; “Other Company” (r = .147%, p <0.001), “Hand” (r = .088, p = .008), “Energy Company” (r =.085), p = .011), “Equipment Failure” (r = .081, p = 014), ““Improper Procedure”” (r = .084, p = .011), “Back” (r = .072, p = .025), “Line of Fire” (r = .070, p = .028), “Foot” (r = .068, p = .031), “leg” (r=.062, p = .046) were significant. To ensure that variables entered into the regression analysis did not have excessive collinearity or that any combination of the independent variables formed a singularity, the variance inflation factor (VIF) was examined, and there was no multicollinearity presented in the data.

Regarding direct hires, the variable that entered the regression first was “Other – Company”. Considered alone this variable explained 16.4% of the variance in the safety events of direct hire employees. “Improper Procedure” explained an additional 0.09% of the variance in the total number of safety events. None of the other variables entered into the equation.

Concerning contractor workers only Equipment Failure ultimately ended up in the model. Equipment Failure explained 1.2% of the variance. None of the other eleven variables entered the equation.

When both direct hires and contract workers were analyzed, only “Other” company and “Equipment Failure” ultimately ended up in the model. The variable that entered the regression first was “Other – Company Type” which explained 2.1% of the variance. “Equipment Failure” explained another 0.5% of the variance. None of the other 15 variables entered the equation.

Conclusions, Implications and Recommendations

The researcher has derived the following conclusions, implications, and recommendations based on the findings of this study:

Conclusion One

Based on the results of the study, the researcher concluded that the industrial organizational facilities in eight parishes southern Louisiana had attained a good safety record. This is based on 112 recordables reported from 769 responses from safety offices based on records that likely encompass a large number of workers.

However, the potential implication of this conclusion is there is still room for improvement in the area of preventing safety events. For example, the three reported deaths were unacceptable. The researcher recommends that organizations still make strides towards ensuring the workplace is safe for all employees.

The researcher further recommends that future research focus on site level safety best practices. When safety officers were asked if their site had established best practices (or planned to) for the most common recordable that occurs on their sites, 38.3% responded that their site did not develop best practices based on the most common recordable events seen at the site (or plan to do so). Additionally, the established best practices should go beyond just current most common recordable but include any area where there is reasonable possibility for an injury, illness or death.

Conclusion Two

The “basis” of injuries in industrial organizations in south Louisiana are very diverse. This conclusion is based on the finding that, “Line of Fire” 36.6%, “Improper Procedures” 30.4% and “Equipment Malfunction” 21.4% comprise the majority of safety events. These three bases make up 88.4% of the instances. This finding is surprising because the literature, Bunting, et al., 2017, indicated that falls would likely be one of the most prevalent types of injury sustained at the workplace. Injuries due to falls would typically be represented as access/egress. Additionally, potential fall hazards are typically the number one reported finding in OSHA inspections in recent years. The expectation was that a primary basis would be access egress (falls) however, the findings were much more diverse.

The potential implication of this conclusion is there are many types of potential hazards that are not being adequately addressed by organizations or the workforce. A variety of hazards may not be getting addressed such as “Line of Fire”, which is essentially an unintended impact between two objects, which can include a worker and an object. Organizations can consider reducing the time intervals for maintenance. Additionally, all workers need to understand the work, safety procedures and how to make the safest decisions to ensure they are completing their assignments.

Based on this conclusion the researcher recommends organizations should focus additional attention on preventing safety events that originate from a multitude of sources. Equipment and tools when at elevations should be secured to prevent unintended falling.

Organizations must ensure any tool, equipment or nonpermanent item at an elevation or with a potential to dislodge or move independently is secured so there is not a significant impact if it comes into contact with a worker unintentionally. Based on the conclusion, the research also recommends that organizations pay greater attention to not only ensuring the workers are tied off, when they are working at elevations, but also that all tools, equipment and other items are secured. They also should ensure that when moving large items or mobile equipment, a spotter should be used if the driver or operator does not have a clear vantage point to see the path forward as well as any other items or workers who could intersect the path. Both direct hire and contract workers need to know the processes to ensure all workers remain safe yet also be accountable for correctly following and administering established policies. The employer has an obligation to ensure that all equipment is well maintained and in good working order. Organizations should consider expanding the requirements included in a 360-walk-around conducted when heavy or moveable equipment that can cause significant damage or injuries is being prepared for use.

The researcher further recommends that future research focus on employee behavior and reactions since there is an element of preventability with each of the three most frequent bases for safety events. With regard, specially to the basis of “Improper Procedure” the safety events in theory could be eliminated with the correct combination of conscientious workers who are educated in how to perform the work correctly and are motivated to perform the work correctly. Continued research could also branch out to further the knowledge base with regard to causation and prevention by looking at a meta-analysis of previous root cause analysis that focuses on certain types of injuries.

Conclusion Three

The third conclusion had to do with the relatively high instances of "First Aids". Specifically, contract workers have a much higher rate of first aid incidents than direct hire employees. While events of "First Aid were prominent for both direct hire workers and contract workers, the results were significantly higher for contract workers. This conclusion is based on the finding that, the safety event that was found to have the high degree of difference by type of employee. The mean number of "First Aid" events reported for contractor employees (Mean = 6.53, SD = 13.953) was found to be significantly higher than the number of First Aid safety events reported for direct employees of the facilities (Mean = 3.05, SD = 5.633).

The potential implication of this conclusion pertains to transient workers. While minor injuries are bound to occur, the minor injuries appear to be much more prevalent with the contract workers. The reason that the numbers are higher with contract workers is most likely multifaceted and may stems from the likelihood that the work is occurring in a temporary location or the workers themselves may be less experienced or committed. However, when an employment relationship is very temporary in nature, the offer of health insurance or the benefits of a standard health insurance, even if benefits are being administratively offered by the employer plans are often not formulated to cover short-term workers. Therefore, a short-term worker is less likely to carry health insurance, and hence less likely to seek out health care. Consequently, the transient worker is less likely to receive routine health care and monitoring. If they are having a medical related issue that they would like a medical professional to treat or diagnose, a transient worker is more likely to address it in the workplace so that the initial appointment and over the counter medications are procured as the cost of the employer rather than an expense that the employee needs to pay for themselves out of pocket. For example, if an employee is having general soreness in an area or has a wound from an insect bite, the employee may strongly desire to have medical care to ensure it is a contained issue and not something that will get worse without care. Additionally, many first aids are not necessarily items that can be traced to a specific source. Employers may accept these costs if they are not constant, frequent occurrences by the same employee. While some of these instances, may not be truly workplace related, there is a benefit for the employer to ensure the issue is addressed. By resolving the issue, the employer is provided a data point regarding the fitness for duty of the employee as well as history regarding the issue, if it persists.

The researcher further recommends that future research focus on exploring reliable health care options as well as a possible relationship between health care and safety incident rates in the work places.

Conclusion Four

The fourth conclusion of this study is that illness is more common among direct hire workers than contract workers. Regarding the number of work-related "Illnesses" reported among direct hire employees of industrial organizational facilities in eight parishes of southern Louisiana, the number of "Illnesses" reported for direct employees (Mean = 0.07, SD = 0.366) was found to be significantly higher than for contractor employees (Mean = 0.03, SD = 0.229) ($t_{df = 714} = 2.844$, $p = .005$).

This conclusion logically makes sense because direct hire workers are more likely to work in the same environment for longer timeframes while a contract worker is more likely to be more mobile. If there is a constant hazard, the direct hire worker is more likely to consistently come across in the completion of their assigned tasks. They are often exposed to all things at the worksite for longer periods of time.

The possible implication of this conclusion is that organizations should pay attention to the factors that could cause illness over time. There is also an opportunity for organizations to pay attention to the continued health and wellbeing of direct hire workers throughout their careers. The tenure of long-term workers also provides for an opportunity to offer continued health care for workers to ensure they are well enough to perform their duties in a safe manner. This can be done with regularly scheduled fit for duty medical exams. If a practice such as incorporating medical exams for current employees is implemented, the organization must plan it out well and set specific criteria for when the associates are evaluated to ensure they are not opening up an opportunity to be perceived as discriminating against older workers or workers with certain perceived disabilities. However, the employers need to be cognizant to avoid accepting the possible claims of illness due to general health decline that is more a function of time and advancing age or lifestyle choices rather than job site conditions.

The researcher further recommends that future research focus on methods to monitor employee health and wellbeing throughout the employee's entire career. This could also encompass a study that looks at wellbeing through employee benefit packages and workplace safety together and throughout a prolonged timeframe.

Conclusion Five

The time of year had no influence on the number of safety events. This conclusion is based on the finding that comparisons were made using the one-way analysis of variance procedure. There were no significant differences by quarter among any of the comparisons.

The researcher further recommends that future research should focus on weather as it relates to safety incident rates. A deeper exploratory study that reviews actual conditions present could have more value since looking at timeframe in quarters or seasons provides an averaging out of the extreme weather days. A different avenue that further research could also explore is whether and how holiday events influence both safety incidents and productivity.

Conclusion Six

The type of facility "Other" had more safety events and OSHA recordable injuries than "Chemical" and "Energy" companies. This conclusion is based on the ANOVA. The "Other" type of facility was found to have significantly higher for "Total Injury", "Totally Illness", "Total First Aids", "Total Injury", "Illness" and "First Aids", "Total All Recordables – Transfers", and "Total All Recordables". The only variable where there was not a significant difference was deaths. The number of "Total Injuries", "Illnesses", and "First Aids" is greater than that the numbers for the "Chemical" and "Energy" facilities. Additionally, the regression model for direct hire employees reflects that "Other – Company" explained 46.0% of the variance in the safety events. While three additional variables, "Third Quarter", "Improper Procedure", and whether or not the site had "Best Practices" (or planned to), explained an additional 1.5% of the variance in the total number of safety events, therefore the variable "Other" company cannot be ignored.

The potential implication of this conclusion is that there is an opportunity for companies in industries outside of chemical and energy manufacturing to improve with regard to workplace safety. While there is often commentary on energy and chemical companies being dangerous places to work, their safety incident rates were lower than the other companies; therefore, it appears the industries do well at managing and mitigating many of the potential risks. "Other" company types may find it beneficial to mirror some of the practices utilized within the chemical and energy sectors. Based on the researcher's experience, chemical and energy sectors have somewhat more stable industry standards when it comes to employee selection, including standards for criminal background checks, medical exams, intensive on boarding and site orientation. Subsequently, once the worker is brought on to the work location, there are robust rules, processes and a constant effort to focus on health and safety.

The researcher further recommends that future research should look at specific industries for opportunities to ensure that workplace is safe. Future research further should also look at individual facility and manufactures since each location presents its own set of safety challenges.

REFERENCES

Abdelhamid, Tariq S. and Everett, John G. Identifying Root Causes of Construction Accidents Journal of Construction Engineering and Management. (2000).

Alexander, M., Cox, S., Cheyne, A., 1994. Safety culture within a UK based organization engaged in offshore hydrocarbon processing. In: Proceedings of the 4th Conference on Safety and Well-being at Work, Centre for Hazard and Risk Management, Loughborough, pp. 64–75.

Ankrah, N.A., 2007. An investigation into the impact of culture on construction project performance. PhD Thesis, University of Wolverhampton.

Asilian-Mahabadi, Hajizadeh, Hassanzadeh-Rangi, Bastani, Khavanin, Bagher Mortazavi, Modeling the Factors Affecting Unsafe Behavior in the Construction Industry from Safety Supervisors' Perspective Journal of Research in Health Sciences 2014; 14(1): 29-35.

Bartel, Ann P. and Thomas, Lacy Glenn. Direct and Indirect Effects of Regulation: A New Look at OSHA's Impact In: The Journal of Law & Economics. 28(1):1-25; The University of Chicago Press, 1985. Language: English, Database: JSTOR Journals.

Bobick, TG; Stanevich, RL; Pizatella, TJ; Keane, PR; Smith, DL. Preventing Falls through Skylights and Roof Openings. In: Professional Safety, Vol. 39, No. 9, pages 33-37, 10 references, 1994, Database: TOXNET TOXLINE.

Bondy, J., Lipscomb, H. J., Guarini, K., & Glazner, J. (2005). Methods for using narrative text from injury reports to identify factors contributing to construction injury. American Journal of Industrial Medicine, 48(5), 373−380.

Breaking: OSHA announces top 10 violations for FY 2017. (2017, September 26) Safety.BLR.Com https://safety.blr.com/workplace-safety-news/safety-administration/OSHA-and-state-safety-compliance-enforcement/Breaking-OSHA-announces-top-10-violations-for-FY-2/. Retrieved October 4, 2017.

Building, E.C., 1987. Construction Safety. Building Advisory Service, London.

Bunting, Jessica; Branche, Christine; Trahan, Chris; Goldenhar, Linda. A national safety stand-down to reduce construction worker falls. In Special Issue: Papers from the 2015 National Occupational Injury Research Symposium, Journal of Safety Research. February 2017 60:103-111 Language: English. DOI: 10.1016/j.jsr.2016.12.005, Database: ScienceDirect.

CDC. Retrieved July 8, 2018, From www.cdc.gov/wisards/oiics/.

Cheyne, A., Cox, S., Oliver, A., Toma´s, J.M., 1998. Modelling safety climate in the prediction of levels of safety activity. Work and Stress 12 (3), 255–271Chi, Chia-Fen; Chang, Tin-Chang; Ting, Hsin-I Accident patterns and prevention measures for fatal occupational falls in the construction industry. In Ergonomics in Building and Construction, Applied Ergonomics. 2005 36(4):391-400 Language: English. DOI: 10.1016/j.apergo.2004.09.011, Database: ScienceDirect.

Chi, Seokho and Han, Sangwon. "Analyses of systems theory for construction accident prevention with specific reference to OSHA accident reports" International Journal of Project Management (2013) 31 1027 – 1041.

Chiang, Y., 2009. Subcontracting and its ramifications: a survey of the building industry in Hong Kong. International Journal of Project Management 27, 80–88.

Choudhry, Rafiq M. "Behavior-based safety on construction sites: A case study" Accident Analysis and Prevention. (2014) 70 14–23.

Cigularove K.P., Chen P.Y., Rosecrance, J. The effects of error management climate and safety communication on safety: A multi-level study. Accident Analysis and Prevention 42 (2010) 1498–1506.

Cinamor Silva Pessoa Melo de Souza, Dr. José Antônio da Silva Souza. Business Management Dynamics Vol.6, No.7, Jan. 2017, pp.19-26 ©Society for Business and Management Dynamics Security Management Benefits at Work in Monitoring Individual Protection Equipment (IPE) and Collective Security Systems (CSS), Procedures and Methods in Industry Construction .

Contingent and Alternative Employment Arrangements, February 1999. Retrieved December 1, 2018, From https://www.bls.gov/news.release/history/conemp_12211999.txt.

Contingent and Alternative Employment Arrangements — May 2017. Retrieved December 1, 2018, From https://www.bls.gov/news.release/pdf/conemp.pdf.

Cooper, M.D., 2000. Towards a model of safety culture. Safety Science 36, 111–136.

Cordaro, Tressi L. "OSHA Announces Top Ten Violations" The National Law Review. Lewis, Jackson P.C. (2017) source: https://www.natlawreview.com/article/osha-announces-top-ten-violations.

Davidson, Wallace N. III, Worrell, Dan L., and Cheng, Louis T.W., "Are OSHA Penalties Effective?" Business and Society Review. (2001) 25-28 .

Dekker, S.Z.W., Long, R., Wybo, J.L., 2016. Zero vision and a western salvation narrative. Safety Science 88, 219–223.

https://www.bls.gov/news.release/conemp.nr0.htm.

DiDomenico A; Gielo-Perczak K; McGorry RW; Chang CC. Effects of simulated occupational task parameters on balance. Applied Ergonomics, May2010; 41(3): 484-489. 6p. (Journal Article) ISSN: 0003-6870 PMID: 19926072, Database: CINAHL Complete.

DOL Agencies. Retrieved October 28, 2018, From https://www.dol.gov/general/jobs/dol-sub-agencies.

Dov, Z. Safety climate and beyond: A multi-level multi-climate framework. Safety Science 46 (2008) 376–387. https://doi.org/10.1016/j.ssci.2007.03.006.

Estill, Cheryl F. Morata, Thais, Schnor, Terri R.; Materna, Barbara. Addressing the Hazards of Temporary Employment. A joint Session of the NORA Manufacturing Sector and Services Sector Councils. (2015) December 14, 2018, https://blogs.cdc.gov/niosh-science-blog/2015/06/16/temp-workers/.

Experience Modification Rating - The EMR, EMOD and XMOD. November 15, 2017, https://workcompconsultant.com/experience-modification-rating-workers-compensation-emod-emr.htm.

Fagan, K. M. and Hodgson, M. J. Under-Recording of Work-Related Injuries and Illnesses: An OSHA Priority. Journal of Safety Research 60 (2017) 79–83.

Fall Prevention Training Guide A Lesson Plan for Employers OSHA 3666-04 2014 A Guide for Employers to Give Fall Prevention Training to Workers Occupational Safety and Health Administration U.S. Department of Labor. Retrieved December 28, 2018, From https://www.osha.gov/Publications/OSHA3666.pdf.

Fang, Dongping. Chen, Yang; Wong, Louisa. Safety Climate in Construction Industry: A Case Study in Hong Kong. Journal of Construction Engineering & Management. Jun2006, Vol. 132 Issue 6, p573-584. 12p. 10 Charts. DOI: 10.1061/(ASCE)0733-9364(2006)132:6(573). , Database: Science & Technology Collection.

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

Federal OSHA Complaint Handling Process, Retrieved June 2, 2017. From https://www.osha.gov/as/opa/worker/handling.html.

Findley, M., Smith, S., Kress, T., Gregory, P., Enoch, K., Safety Program Elements in Construction., Professional Safety. Feb2004, Vol. 49 Issue 2, p14-21.

Firenze, R.J., 1978. The Process of Hazard Control. Kendall/Hunt, NY. Fisher, R.A., 1954. Statistical Methods for Research Workers. Oliver and Boyd, Edinburgh, UK.

French, S., Bedford, T., Pollard, S., Soane, E., 2011. Human reliability analysis: a critique and review for managers. Safety Science 49, 753–763.

GBRIA About Who We Are. Retrieved October 15, 2016, from http://gbria.org/community.html.

Geller, E.S., 2001. Behavior-based safety in industry: realizing the large-scale potential of psychology to promote human welfare. Appl. Prev. Psychol. 10 (2), 87 105.

GPO. Retrieved October 28, 2017. From https://www.govinfo.gov/content/pkg/CFR-2011-title29-vol9/pdf/CFR-2011-title29-vol9-part1960.pdf.

Greenwood, M., Woods, H., 1919. The incidence of industrial accidents upon individuals with special reference to multiple accidents. Tech. rep., Industrial Fatigue Research Board, London.

Glazner, J., Bondy, J., Lezotte, D. C., Lipscomb, H. J., & Guarini, K. (2005). Factors contributing to construction injury at Denver International Airport. American Journal of Industrial Medicine, 47(1), 27−36.

Glazner, J., Borgerding, J., Lowery, J. T., Bondy, J., Mueller, K. L., & Kreiss, K. (1998). Construction injury rates may exceed national estimates: evidence from the construction of Denver International Airport. American Journal of Industrial Medicine, 34(2), 105−112.

Gray, Wayne B., and Mendeloff, John M., "The Declining Effects of OSHA Inspections on Manufacturing Injuries, 1979 – 1998" Industrial and Labor Relations Review, Vol. 58, No 4, July 2005 571 -587.

Gray, Wayne B. and Scholz, John T. Does Regulatory Enforcement Work? A Panel Analysis of OSHA Enforcement. Law & Society Review. 27(1):177-213; Law and Society Association, 1993.

Griffin, M.A., Neal, A., 2000. Perceptions of safety at work: a framework for linking safety climate to safety performance, knowledge, and motivation. Journal of Occupational Health Psychology 5, 347–358.

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

Haddon, W., Suchman, E., Klein, D., 1964. Accident Research: Methods and Approaches. Harper & ROW, New York.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (2006). Multivariate data analysis.

New Jersey: Prentice Hall International, Inc.

Hallowell, M., Hinze, J., Baud., Wehle. 2013. Proactive Construction Safety Control: Measuring, Monitoring, and Responding to Safety Leading Indicators. Journal of Construction Engineering and Management. American Society for Civil Engineers.

Halpin, J.F., Zero Defects – A New Dimension in Quality Assurance. McGrawHill, New York. 1966.

Haviland, Amelia M.; Burns, Rachel M.; Gray, Wayne B.; Ruder, Teague; Mendeloff, John. A new estimate of the impact of OSHA inspections on manufacturing injury rates, 1998-2005. American Journal of Industrial Medicine; Nov 2012; 55; 11; p964-p975.

Heinrich, H., 1932. Industrial Accident Prevention, first ed. McGraw Hill, New York.

Heinrich, H., Petersen, D., Ross, N., 1980. Industrial Accident Prevention, fifth ed. McGraw-Hill, New York.

Hide, S., Atkinson, S., Pavitt, T., Haslam, R., Gibb, A., Gyi, D., Duff, R., Suraji, A., 2003. Causal factors in construction accidents. HSE Books, Suffolk.

Hinze, J., Russell, D.B., 1995. Analysis of fatalities recorded by OSHA. J. Constr. Eng. Manage. 121 (2), 209–214.

Ho, D,. Ahmed, S., Kwan, J. Min, F., Site Safety Management in Hong Kong. Journal of Management in Engineering. Vol. 16 Issue 6 (2000).

Hofmann, D.A., Mark, B., 2006. An investigation of the relationship between safety climate and medication errors as well as other nurse and patient outcomes. Personnel Psychology 59, 847–869.

Hofmann, David A., Morgeson, Frederick P., 1999. Safety-Related Behavior as a Social Exchange: The Role of Perceived Organizational Support and Leader-Member Exchange. Journal of Applied Psychology 84, 286–296.

Hood, John. OSHA's trivial pursuit. Policy Review. Summer95, Issue 73, p59. 6p. 1 Black and White Photograph, 1 Graph. , Database: Military & Government Collection.

Hsiao H; Simeonov P Preventing falls from roofs: a critical review. Ergonomics, 2001 Apr 15; 44(5): 537-561. 25p. (Journal Article - review, tables/charts) ISSN: 0014-0139 PMID: 11345496, Database: CINAHL Complete.

Huber, Gregory Alain. The craft of bureaucratic neutrality: interests and influence in governmental regulation of occupational safety. Cambridge, [England]; New York : Cambridge University Press, 2007. viii, 256 p. : ill. ; 24 cm. Language: English, Database: Louisiana State University.

ILO, 2001. The Construction Industry in the Twenty-First Century: Its Image, Employment Prospects and Skill Requirements. ILO, Geneva.

Independent contractors made up 6.9 percent of employment in May 2017. June 21, 2018. Retrieved December 1, 2018. https://www.bls.gov/opub/ted/2018/independent-contractors-made-up-6-point-9-percent-of-employment-in-may

2017.htm?page_id=1205&description=Body%25252525252CUkraine%252525252540vatlive.com&fwp_paged=3%25252525252F.

Ismail, Zubaidah; Doostdar, Samad; Harun, Zakaria. Factors influencing the implementation of a safety management system for construction sites. In Safety Science. 2012 50(3):418-423 Language: English. DOI: 10.1016/j.ssci.2011.10.001, Database: ScienceDirect.

Ismail, F., Hashim, A.E., Zuriea, W., Ismail, W., Kamarudin, H., Baharom, Z.A., 2012. Behaviour based approach for quality and safety environment improvement: Malaysian experience in the oil and gas industry. Procedia-Soc. Behav. Sci. 35, 586–594.

Janicak, Christopher A. Fall-related deaths in the construction industry. Journal of Safety Research. Spring98, Vol. 29 Issue 1, p35. 8p. 4 Charts. , Database: Science & Technology Collection.

Jebelli, Houtan; Ahn, Changbum R.; Stentz, Terry L. Fall risk analysis of construction workers using inertial measurement units: Validating the usefulness of the postural stability metrics in construction. In Safety Science. April 2016 84:161-170 Language: English. DOI: 10.1016/j.ssci.2015.12.012, Database: ScienceDirect.

Johnson, Stephen E. "The predictive validity of safety climate" Central Washington University, 2401 33rd Ave SE, Puyallup, WA 98374, USA Journal of Safety Research 38 (2007) 511 – 521.

Jørgensen, Kirsten. "Prevention of ''simple accidents at work'' with major consequences" Safety Science 81 (2016) 46–58 Special Issue Article: Learn & train for safety.

Kerr, W., 1950. Accident proneness of factory departments. Journal of Applied Psychology 34, 167–170.

Kerr, W., 1957. Complementary theories of safety psychology. Journal of Social Psychology 45, 3–9.

Kjellen, U., 1984a. The deviation concept in occupational accident control – I: definitions and classification. Accident Analysis and Prevention 16, 289–306.

Kjellen, U., 1984b. The deviation concept in occupational accident control – II: data collection and assessment of significance. Accident Analysis and Prevention 16, 307–323.

Kjellen, U., 1984c. The role of deviations in accident causation and control. Journal of Occupational Accidents 6, 117–126.

Khanzode, Vivek V., Maiti, J., Ray, P.K. "Occupational injury and accident research: A comprehensive review" Safety Science. (2012) 50 1355–1367.

Ko, Kilkon, Mendeloff, John, and Gray, Wayne. (2010) The Role of Inspection Sequence in Compliance with the US Occupational Safety and Health Administration's (OSHA) standards: Interpretations and Implications. Regulations & Governance, 4, 48-70.

Lafourche Parish Government Employment and Workforce Housing Assessment Revised Draft - Version 2 December 2015. Retrieved July 23, 2018, From http://www.lafourchegov.org/home/showdocument?id=26538.

Lipscomb, H. J., Li, L., & Dement, J. M. (2003). Falls among union carpenters. American Journal of Industrial Medicine, 44(2), 148−156.

Leigh, J. P. (2011). Economic burden of occupational injury and illness in the United States. Milbank Quarterly, 89(4), 728–772.

Leigh, J. P., & Du, J. (2012). Are low wages risk factors for hypertension? European Journal of Public Health, 22(6), 854–859.

Li, Heng; Lu, Miaojia, Hsu, Shu-Chien; Gray, Matthew; Huang, Ting. “Proactive behavior-based safety management for construction safety improvement” Safety Science 75 (2015) 107-117. https://doi.org/10.1016/j.ssci.2015.01.013.

Lin, Ken-Yu; Tsai, Meng-Han; Gatti, Umberto C.; Je-Chian Lin, Jacob; Lee, Cheng-Hao; Kang, Shih-Chung. A user-centered information and communication technology (ICT) tool to improve safety inspections. In Automation in Construction. December 2014 48:53-63 Language: English. DOI: 10.1016/j.autcon.2014.08.012, Database: ScienceDirect.

Luria, Gil and Yagil, Dana. Safety perception referents of permanent and temporary employees: Safety climate boundaries in the industrial workplace. Accident Analysis and Prevention 42 (2010) 1423–1430.

MacCollum, D. V. "Time for change in construction safety. 'Prof. Safe 35(2),17-20. (1990).

MacCollum, D. V. Inherently Safer Design. Professional Safety. Vol. 51 Issue 5, p26-33. (2006).

Manu, Patrick; Ankrah, Nii; Proverbs, David; Suresh, Subashini. (2013) Mitigating the Health And Safety Influence of Subcontracting in Construction: The Approach of Main Contractors. International Journal of Project Management 31 (1017 - 1026).

Manuele, F.A. (2003). On the Practice of Safety (3rd ed.). New York: John Wiley & Sons.

Manuele, F.A. (2011, Oct.). Reviewing Heinrich: Dislodging two myths from the practice of safety. Professional Safety, 56(10), 52-61.

Marucci-Wellman, H.R., Courtney, T. K., Corns, H.L., Sorock, G.S. Webster, B.S., Wasiak, R., Noy, Y.I., Matz, S., Leamon, T.B. “The direct cost burden of 13 years of disabling workplace injuries in the U.S. (1998–2010): Findings from the Liberty Mutual Workplace Safety Index” Journal of Safety Research 55 (2015) 53–62. https://doi.org/10.1016/j.jsr.2015.07.002.

Mason, Krystal L.; Retzer, Kyla D.; Hill, Ryan; Lincoln, Jennifer M. Occupational Fatalities Resulting from Falls in the Oil and Gas Extraction Industry, United States, 2005-2014.

MMWR: Morbidity & Mortality Weekly Report. 4/28/2017, Vol. 66 Issue 16, p417-421. 5p. 1 Diagram, 2 Charts, 1 Map. DOI: 10.15585/mmwr.mm6616a2. , Database: Academic Search Complete.

Mathis, Terry L. “Zero Accidents Does Not Equal Safety Excellence” EHS Today. January 2013. December 31, 2018, https://proactsafety.com/articles/zero-accidents-does-not-equal-safety-excellence.

Mayhew, C., Quinlan, M., 1997. Subcontracting and occupational health and safety in the residential building industry. Industrial Relations Journal 28, 192–205.

McCaffrey, David P. AN Assessment of OSHA's Recent Effects on Injury Rates. Journal of Human Resources. Winter83, Vol. 18 Issue 1, p131-146.

McDonald, Mary Anne; Lipscomb, Hester J.; Bondy, Jessica; Glazner; Judith, “Safety is everyone's job:” The key to safety on a large university construction site” Journal of Safety Research (2009) 40; 53–61.

Mearns, K., Whitaker, S.M., Flin, R., 2003. Safety climate, safety management practice and safety performance in offshore environments. Safety Science 41, 641–680.

Mendeloff, John and Gray, Wayne B. “Inside the Black Box: How do OSHA Inspections Lead to Reductions in Workplace Injuries?” Law & Policy, Vol. 27, No. 2, April 2005. 219 - 239. ISSN 0265–8240.

Mitropoulos, P., Cupido, G., Namboodiri, M., 2009. Cognitive approach to construction safety: task demand-capability model. Journal of Construction Engineering and Management 135 (9), 881–889.

Mitropoulos, P., Abdelhamid, T.S., Howell, G.A., 2005. Systems model of construction accident causation. Journal of Construction Engineering and Management 131 (7), 816–825.

Mushtaq, F. and Chung P.W.H., A systematic Hazop procedure for batch processes, and its application to pipeless plants Journal of Loss Prevention in the Process Industries 13 (2000) 41–48.

Musck, T. OSHA’s Top 10 Most Cited Violations for 2016. Safety and Health Magazine. Retrieved from http://www.safetyandhealthmagazine.com/articles/14927-2016-oshas-top-10-most-cited-violations.

Ng, S. Thomas; Cheng, Kam Pong; Skitmore, R. Martin, “A framework for evaluating the safety performance of construction contractors” Building and Environment (2005) 40 1347–1355.

The National Institute for Occupational Safety and Health (NIOSH). Retrieved January 9, 2018, From https://www.cdc.gov/niosh/about/.

Occupational Injury and Illness Classification System, Retrieved July 9, 2018, From https://wwwn.cdc.gov/wisards/oiics/.

Oliveira, A. M. S. & Pilon, V. A. Avaliação dos fatores intervenientes no uso de EPI's pelos trabalhadores da construção. III SIBRAGEC – Simpósio Brasileiro de Gestão e Economia da Construção. São Carlos, SP: UFSCar, 2003.

Olson, R., Austin, J., 2001. "ABCs for lone workers: a behavior-based study of bus drivers". Prof. Saf. 46 (11), 20–25.

OSHA 3143 Informational Booklet on Industrial Hygiene. Retrieved July 26, 2016, From https://www.osha.gov/Publications/OSHA3143/OSHA3143.htm.

OSHA ACT 1970. Retrieved December 29, 2018. From https://www.osha.gov/laws-regs/oshact/section5-duties.

OSHA ACT 1970. Retrieved November 2, 2016. From https://www.osha.gov/laws-regs/oshact/completeoshact.

OSHA Laws and Regulations. Retrieved October 28, 2017, From https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=11264&p_table=STANDARDS.

OSHA General Recording Criteria 1904. Retrieved September 19, 2017, from https://www.osha.gov/laws-regs/regulations/standardnumber/1904/1904.7.

OSHA Standard 1910. Retrieved May 1, 2017, From https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.151.

OSHA Standard Interpretations. Retrieved September 19, 2017, From https://www.osha.gov/laws-regs/standardinterpretations/2016-08-23.

Pellicer, E., Carvaja, G., Rubio, M., & Catala, J., "A Method to Estimate Occupational Health and Safety Costs in Construction Projects". KSCE Journal of Civil Engineering (2014) 18(7); 1955-1965.

PR Newswire. (2018, December 13). OSHA Releases Top 10 List of Most Frequently Cited OSHA Standards for FY 2018. PR Newswire US. Retrieved from http://libezp.lib.lsu.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=n5h&AN=201812130300PR.NEWS.USPR.UN01049&site=eds-live&scope=site&profile=eds-main.

Probst, T.M., 2004. Safety and insecurity: exploring the moderating effect of organizational safety climate. Journal of Occupational Health Psychology 9, 3–10.

Probst, T. M. and Estrada, A. X., Accident under-reporting among employees: Testing the moderating influence of psychological safety climate and supervisor enforcement of safety practices In Safety Climate: New Developments in Conceptualization, Theory, and Research, Accident Analysis and Prevention 2010 42(5):1438-144. https://doi.org/10.1016/j.aap.2009.06.027.

Probst, T.M., Petitta, L., and Barbaranelli, C. Comparing recall vs. recognition measures of accident under-reporting: A two-country examination Accident Analysis and Prevention. 2017 106:1-9. https://doi.org/10.1016/j.aap.2017.05.006.

Reichers, A.E., Schneider, B., 1990. Climate and culture: An evolution of constructs. In: Schneider, B. (Ed.), Organizational Climate and Culture. Jossey-Bass, San Francisco, pp. 5–39.

Rentsch, J.R., 1990. Climate and culture: interaction and qualitative differences in organizational meanings. Journal of Applied Psychology 75, 668–681.

Robertson, L. (1992). Injury Epidemiology. Oxford University Press.

Robertson, Leon S. (2015). Injury Epidemiology: Fourth Edition. Lulu Books.

Rosenman, K. D., Kalush, A., Reilly, M. J., Gardiner, J. C., Reeves, M., Luo, Z., et al. (2006). How much work-related injury and illness is missed by the current national surveillance system? Journal of Occupational and Environmental Medicine, 48(4), 357−365.

Rubio-Romero, J. C.; Rubio, M. C.; García-Hernández, C. Analysis of Construction Equipment Safety in Temporary Work at Height. Journal of Construction Engineering & Management. Jan2013, Vol. 139 Issue 1, p9-14. 6p. 1 Color Photograph, 2 Diagrams, 2 Charts, 7 Graphs. DOI: 10.1061/(ASCE)CO.1943-7862.0000567., Database: Science & Technology Collection.

Schein, E.H., 1992. Organizational Culture and Leadership, second ed. Jossey-Bass, San Francisco. Seo, D.C., 2005. An explicative model of unsafe work behavior. Safety Science 43, 187–211.

Seabury, S. A., Scherer, E., O'Leary, P., Ozonoff, A., & Boden, L. (2014). Using linked federal and state data to study the adequacy of workers' compensation benefits. American Journal of Industrial Medicine, 57(10), 1165–1173.

Shaw, L., Sichel, H., 1971. Accident proneness. International Series of Monographs in Experimental Psychology, vol. II. Pergamon Press, Oxford.

Snowden, D., 2000. Cynefin: a sense of time and space: the social ecology of knowledge management. In: Despres, C., Chauvel, D. (Eds.), Knowledge Horizons: The Present and the Promise of Knowledge Management. Butterworth-Heinemann, Oxford, pp. 237–266.

Snowden, D.J., Boone, M.E., 2007. A leader's framework for decision making. Harvard Business Review, 1–7.

Sua, Xing; Panb, Jing; and Grintera, Mark. Procedia Engineering 118 (2015) 290 – 295 1877-7058 (http://creativecommons.org/licenses/by-nc-nd/4.0/). Peer-review under responsibility of organizing committee of the International Conference on Sustainable Design, Engineering and Construction 2015 doi: 10.1016/j.proeng.2015.08.429 ScienceDirect Available online at www.sciencedirect.com International Conference on Sustainable Design, Engineering and Construction Improving Construction Equipment Operation Safety from a Human-centered Perspective.

Tam, Vivian W.Y; Shen, L.Y.; Kong, Joseph S.Y. Impacts of Multi-Layer Chain Subcontracting on Project Management Performance. International Journal of Project Management. Volume 29, Issue 1, January 2011, Pages 108-116. https://doi.org/10.1016/j.ijproman.2010.01.005.

Tomlinson, Randy, "Root-Cause Analysis Analyze, Define & Fix" Professional Safety September 2015 www.asse.org 52-53.

Viscusi, W. Kip. The structure and enforcement of job safety regulation. Law & Contemporary Problems , Autumn1986, Vol. 49, p127-150, 24p; DOI: 10.2307/1191653, Database: Index to Legal Periodicals & Books Full Text (H.W. Wilson).

Viscusi, W. Kip. Employment hazards: an investigation of market performance / W. Kip Viscusi. Cambridge: Harvard University Press, 1979. viii, 311 p.; 24 cm. Language: English, Database: Louisiana State University.

Weil, David, "If OSHA is So Bad, Why is Compliance So Good?" RAND Journal of Economics. Vol 27, No 3 Autumn 1996 pp 618-640.

Williamson, Ann M., Feyer, Anne-Marie; Cairns, David; Biancotti, Deborah; "The Development of A Measure of Safety Climate: The Role of Safety Perceptions and Attitudes 1" Safety Science Vol. 25. No. 1-3, pp. 15-27, 1997.

Wong, F., So, L., 2002. Restriction of the multi-layers subcontracting practice in Hong Kong—is it an effective tool to improve safety performance of the construction industry? In: Rowlinson, S. (Ed.), Proceedings of Triennial Conference of CIB W099, 7th–10th May 2002. Hong Kong.

Zhang, M., Fang, D., 2013. "A continuous behavior-based safety strategy for persistent safety improvement in construction industry". Autom. Constr. 34, 101–107.

Zhou, Quan; Fang, Dongping; Wang, Xiaoming. "A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience" Safety Science 46 (2008) 1406–1419.

Zhu, Zhenhua; Park, Man-Woo; Koch, Christian; Soltani, Mohamad; Hammad, Amin; Davari, Khashayar. Predicting movements of onsite workers and mobile equipment for enhancing construction site safety. In Automation in Construction. August 2016 68:95-101 Language: English. DOI: 10.1016/j.autcon.2016.04.009, Database: ScienceDirect.

Zohar, D., 1980. Safety climate in the industrial organizations: theoretical and applied implications. Journal of Applied Psychology 65, 96–102.

Zwetsloot, G.I., Aaltonen, M., Wybo, J.-L., Saari, J., Kines, P., Beeck, R.O., 2013. The case for research into the zero accident vision. Safety Science 58, 41–48. http://dx.doi.org/10.1016/j.ssci.2013.01.026.

Zwetsloot, G.I., Kines, P., Wybo J., Ruotsala, R., Drupsteen, L., Bezemer R.A., Zero Accident Vision Based Strategies in Organizations: Innovative perspectives. Safety Science 91 (2017) 260–268. doi.org/10.1016/j.ssci.2016.08.016.

Zwetsloot, G.I., Kines, P., Wybo J., Ruotsala, R., Drupsteen, L., Merivirta,. Bezemer R.A. The importance of commitment, communication, culture and learning for the implementation of the Zero Accident Vision in 27 companies in Europe. Safety Science Volume 96, July 2017, Pages 22-32. https://doi.org/10.1016/j.ssci.2017.03.001.

APPENDIX: INSTITUTIONAL REVIEW BOARD APPROVAL

ACTION ON EXEMPTION APPROVAL REQUEST

LSU

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu
lsu.edu/research

TO: Sarah Ragona
Agricultural & Extension Education and Evaluation

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: July 10, 2018

RE: **IRB#** E11124

TITLE: Factors Influencing Safety Performance among Industrial Manufacturing Plants in Louisiana

New Protocol/Modification/Continuation: New Protocol

Review Date: 7/10/2018

Approved ___X___ **Disapproved** __________

Approval Date: 7/10/2018 **Approval Expiration Date:** 7/9/2021

Exemption Category/Paragraph: 4a

Signed Consent Waived?: N/A

Re-review frequency: (three years unless otherwise stated)

LSU Proposal Number (if applicable):

Protocol Matches Scope of Work in Grant proposal: (if applicable)

By: Dennis Landin, Chairman ____________________

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc. Approvals will automatically be closed by the IRB on the expiration date unless the PI requests a continuation.**

* *All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

VITA

Sarah Ragona is a current resident of Baton Rouge, LA, earned her Bachelor of Arts degree in Business Administration with a focus in Accounting from the Louisiana Tech University in 2003. She immediately began graduate studies at Louisiana Tech University and earned a Master of Science degree in Industrial/Organization Psychology in 2004. She worked in the Human Resources Department of the Louisiana Department of Transportation and Development for several years and then as the Human Resources Director for the Louisiana Workforce Commission before completing her education. She is expected to receive her Doctorate in Philosophy from LSU in August 2019.

She is currently the Human Resources Corporate Compliance Manager for an industrial contractor.