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Abstract

This primary research purpose is to develop a lockout tagout system that will prevent accidents and injuries caused by energized machines in Company XYZ. The company has over 5,400 employees, a provider of design, development, and manufacturing services for medical devices, diagnostic and automotive, and consumer products. According to The Occupational Safety and Health Administration data, shows that packaging and wrapping equipment, printing presses, and conveyors account for the highest number of people involved in accidents due to lockout or tag out failures. This research, which covers Company XYZ, a developer of medical equipment, tries to provide solutions and guides on how the company can provide safety and precaution to employees to avoid facing OSHA penalties for violation of the OSHA safety guidelines (Duda, 2019). This study aims at providing a solution to company XYZ, which have been highlighted by OSHA for continuously violating the safety guidelines. This study will focus on Company XYZ. to prove how useful the safety guideline can be of great significance when observed and implemented by the company management.
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Chapter I: Introduction

Organizations are established for different purposes, some to provide goods and other services to people. Every organization sets up its action plan on how the goods and services will be produced or provided. Most organizations give less attention to employee safety since they only focus on making profit. Most organizations management focuses much on reducing operations cost in order to maximize their profit. The focus is sometimes less on employees' training, servicing of the equipment, and only on machinery repairs when they break down. Safety at the workplace is essential despite the company size, whether small or big, because an environment free from injuries and accidents attracts employees and clients. Companies there require random auditing of their processes to ensure safety of employees. With safety measures, the company keeps its employees safe from accidents and equipment safe from unnecessary breakdowns.

Machines are used in small and large companies for production, manufacturing, branding, packaging, and other necessary functions. Due to advancements in technology, machines have slowly taken over and replaced human labor in production industries. This has resulted in a significant decline in demand for human labor due to the industry's invention. Machines are designed to carry out different roles, and they are fast and efficient in their roles. Some of the machines that have significantly influenced the industry include the conveyor belt, heavy fabrication, cranes, lifting machines, and other machines. The demand for machines has increased with every company employing machines to compete effectively with other competitors. The companies thus, hire qualified personnel to operate the machines, others to service, and repair the machine once they breakdown.
Company XYZ has also embraced the use of the machine in the production of medical equipment; being one of the leading companies producing medical equipment, XYZ has invested much in the use of modern technology. The improvement of science and technology has also resulted in advancements in the medical field, where medical equipment is more demanding. Company XYZ is not the only company producing medical equipment; hence, it has adopted the best machinery with great features to compete with other firms effectively. The company has acquired many air compressors, analyzers, automation equipment, injection/extrusion molders, vacuum forming, conveyors, cooling equipment, drilling machines, and other machines that require a specialist to operate because they can cause injuries if one is not careful while operating the machines. To protect the machines operators from accidents resulting from machine logout/Tagout (LOTO), OSHA came out with safety standards to reduce workplace hazards and enhance the workplace standards for both employees and employers.

Company XYZ is the leading manufacturer of various medical equipment products such as the Stent delivery system, Hemostatic valve systems, Electrophysiology 3 D-mapping systems, percutaneous introductions, and other medical products. The company focuses on the production of many medical products since the demand for medication is increasing. The continued development of technology has resulted in Company XYZ focusing on producing the first moving medical products. Most of the production machines require skilled personnel to operate them because they are automatic machines that work depending on the user's desire as they rely on the data feed in for production. However, the company has been hiring a few skilled operators and unskilled personnel to work with skilled personnel. Company XYZ management believes that hiring skilled operators to learn the machine will have a high cost for the company because their wages are high compared to hiring nonskilled machine operators.
Despite adhering to all LOTO standards at the workplace, Company XYZ reports injuries and the workplace. The company has guidelines and safety precautions displayed in every room with a running machine; a huge notice containing safety precaution is at the entrance to remind every employee of the required conduct once they get to their workstation. Company XYZ management and supervisors give unskilled workers roles after a few days in the company, thinking that they have acquired the necessary skills to run the machines. Most of the reported accident cases result from heavy machines, such as conveyors, drilling machines, and automation equipment for example injection/extrusion/blow molders. Company XYZ has reported over 30 cases of injuries and two fatalities caused by running machines since the start of its operation over three decades ago. The most injuries reported include amputations, crushing injuries, lacerations, and abrasions each year.

**Statement of the Problem**

The use of heavy machinery in the Company XYZ industry requires stringent measures to maintain safety standards for an effective lockout/Tagout process to ensure machines and operators’ safety.

**The Purpose of The Study**

The purpose of this study is to develop, improve and effective lockout/Tagout system that will prevent Company XYZ employee and employer sustaining injuries from the running of machines. The machines run 24hours in a day; hence, people operating the machines must be active and free from sleep or any form of sickness to avoid being injured by the running machine. Company XYZ can maintain safety precautions while producing medical equipment, it will help attain a safe environment for all the workers. A safe environment in economics helps in boosting the productivity of the business. By minimizing the number of accidents reported, the
company will significantly reduce the amount of cost used in medical treatment and compensating the injured workers. Most companies are struggling to implement the OSHA act because they try to avoid the additional cost incurred in ensuring safety precautions are adhered to strictly.

Goals of the Study

These are the goals set to improve and make the study efficient and successful.

1. Analyze Company XYZ lockout/Tagout systems and develop an extensive lockout/Tagout plan to ensure all the employees working in the medical production firm. The plan will ensure that the employees at higher risk of being injured by machines are highly protected during the operation times. The personnel involved in servicing and repairing the machine's safety are enhanced to avoid any accident during the repairing process.

2. This study will develop a lockout/Tagout training system that focuses on training all the machine operators on how to start, run, and stop the machine safely without being injured. The training process will involve identifying whether a machine fully functional or requires service to avoid a breakdown during production.

3. The study will also develop stringent measures to ensure that Company XYZ has implemented the OSHA safety standards of lockout/Tagout. This will also ensure that the company has adhered to the safety measures during its operations of producing medical products.

4. The study will also develop a routine where every purchase of a sophisticated machine is purchased; the manufacturing company must send specialists to train Company XYZ machine operators for few days to ensure that they learn extensively
about the machine operations. This service will provide insightful knowledge to the Company XYZ operators reducing the lockout/Tagout experienced during the medical equipment process.

5. The study will help develop a system of auditing the LOTO standards in the Company XYZ to ensure that the company adheres to the OSHA act's set rules and guidelines.

**Background and Significance of The Study**

According to Johnson et al. (2019), Companies have been losing employees from accidents that occur at the workplace caused by machines or poor working conditions. OSHA CFR 1910.147 stipulates the lockout/Tagout standards; this agency is responsible for setting up safety and health programs for employees. OSHA is a government agency that gives employees more right to the protection, which include,

- allows employees to get training and information on hazards at their workplace to avoid harm
- allows employees to obtain a review document on work-related injury or illness obtained at the workplace
- employees can call on the OSHA agency to come and inspect their workstation
- protects employees from discrimination at the workplace by their employer

Due to pressure from the OSHA agency on ensuring employees enjoy their rights at the workplace, many organizations have realized employees are essential assets in the company, and their safety increases productivity. This is because the company has incurred more cost and loses more time when their employees are injured; before they recover, they have to pay for medical cover, hire other personnel to replace the injured employee, and pay their compensation. To stop
this kind of extra cost, companies should have a better system to ensure their lockout/Tagout systems function properly. Company XYZ has adopted lockout/Tagout procedures to ensure that the machine operators and every other individual in the company are protected from any harm, whether in processing, packaging, loaders, or transporters.

The company has many sophisticated machines used to produce all the variety of medical products they sell. With a broad market across Europe, America, and Asia, the company must produce quality medical products that best suit their clients. The management of the Company XYZ is striving to improve the internal environment of the company. By ensuring, all employees are free from hazards and are insured in any form of accident. Company XYZ machines and equipment require much caution while handling them, and to ensure this, the company XYZ has precaution notice to remind workers of the dangers involved if one does not follow the guidelines.

**Limitation of the Study**

During the study process on the Lockout/Tagout process, I experienced various limitations, including,

- Lack of cooperation from the XYZ’s Company management occurred since they could not allow full access to their details. Data on the LOTO systems limited since they could not give full data of the accident incidences at their company.
- There has been an under-reporting of the accident cases; firms prefer taking care of the individual involved in the accident and pay their compensation without informing the agency.
- There was a lack of Company technicians to take us through the company machines used to produce medical equipment to understand how they operate. The technicians
would play a significant role in understanding how the medical machines work in the locked and tagged machines.

- Without enough information to guide us in the study, the LOTO information was only pegged to XYZ Company. The unavailability of more details and materials of study would help in understanding the LOTO programs clearly.

**Definition of Terms**

These terms are continuously used in the study and is provided for better understanding.

**Automation equipment.** A computerized machine that does not require human control to work; once feed in with command, they operate till they complete the task.

**Conveyor.** A machine that is used to move things from one place to another.

**Drilling machines.** A machine used for cutting edges, mainly making round holes.

**Electrophysiology 3 D-mapping systems.** A machine used to display the catheter to map the electrical activity in the heart's chambers.

**Hemostatic valve systems.** Have a rotating seal at the end, which is turned open or closed each time a wire or microcatheter/guidewire is introduced or extracted.

**Percutaneous introducers.** An instrument used to insert a catheter into the tube.

**Stent delivery system.** A pusher tube is used to place plastic stents over a guidewire with or without a guiding catheter.
Chapter II: Literature Review

The main purpose of this study is to examine and evaluate the effectiveness of lockout/tagout system and what has been done in the past and to avoid major machine accidents on its premises. In this literature review will cover some of the benefit of following OSHA standard in the workplace, at the same time will discuss how important it is to have lockout/tagout system in order to decrease incident rate and best way to implement effective lockout/tagout procedure in workplace.

Overview of the Problem

Employees have been fighting for safer working conditions for a long time. During industrialization, workers were suppressed to poor working conditions and were never protected from accidents and disasters. On most occasions, companies fail to implement and make changes to guarantee safety for employees because they do not want to incur an extra cost. Since the creation of the Occupational Safety and Health Administration (OSHA) in 1970, the organization has been at the forefront of ensuring that safety measures are implemented within organizations to ensure employees' safety at the workplace (Park et al., 2020). OSHA's main mission is to save workers' lives by preventing accidents and other illnesses due to breakdown in the lockout/tagout systems.

OSHA emphasizes educating the workers to inform them of the risk and aware of potential dangers at the workplace. To implement these plans, OSHA has an excellent working policy on safe and healthy working conditions for workers at the workplace. The workplace policy is simplified in the simplest way possible to ensure that all personnel understand safety and health protection measures. All the OSHA guidelines are contained in the general duty
clause, which forms the workplace lock/tagout standards, which are formed to encourage employees' safety at the workplace.

**Historical Perspective**

The general duty clause of the United States Occupational Safety and Health Act states that each employer shall furnish each of his employee's employment and a place of employment, which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees. The general duty clause requires all employers to comply with the occupational safety and health standards promulgated on the clause. Employees are also required to comply with the occupational safety and health standards and all rules and regulations in the Act, which apply to his actions and conduct. Efforts to control hazardous energy are made by preventing machines from being energized during the maintenance process.

According to Grund (2017), the creation of The National Safety Council (NSC) by the U.S. Congress ensures that the organization complies with the health and safety standards drafted in the lockout/tagout process guidelines. The NSC has over 55,000 public and private companies whose businesses are related to occupational and health standards. The lockout/tagout systems were created due to factors such as administrative and procedural problems. The American National Standard for Personal Protection published minimum safety requirement guidelines in March 1983. The ANSI guidelines on the LOTO programs have provided the guidelines on the best lockout/tagout programs. On the energy sources. OSHA drafted earlier the operating procedures and good training policies to ensure workers are free from risk. OSHA started an important program to explain why it was necessary to maintain and observe workplace safety measures.
Since the development of the OSHA policy guidelines, most organizations never took the measures with the seriousness they deserved to protect their workers. The guidelines were to be observed by both the employer and the employee since they provide employers with a model for designing, conducting, evaluating, and revising the programs. OSHA provided the guidelines and training of employees to prevent poor lockout/tagout programs. The lockout/tagout standards were developed to prevent more fatalities in the workplace. OSHA believes that after a long process of developing rules and guidelines that will prevent workplace accidents and keep the workplace safe. The Occupational for Safety and Health Agency's objective was to promote cooperative, voluntary, safe, and healthy activities at the workplace, although not every employer supported the LOTO guidelines since they incur more cost in training and implementing the safety guidelines (Azmi & Aziz, 2018).

**Importance of OSHA Program to Control Hazardous Energy**

Continuous advancement of technology in the industrial sector has resulted in ensuring qualified personnel to run and operate the equipment, which involves heavy machinery in the production sector. This heavy machinery in the industrial sector requires high knowledge since either starting, running, closing, or when the machine releases hazardous energy during the repair and maintenance of machines. Many government agencies and labor unions have studied the process of the lockout. These government agencies include the Bureau of Labor Statistics (BLS) of the United States Department of Labor (DOL), OSHA's Office of Data Analysis (ODA), the National Institute of Occupational Safety and Health (NIOSH), OSHA's Office of Experimental Programs (OEP), and OSHA's Office of Mechanical Engineering Safety Standards (OMESS).

In a report done by the Work Injury Report (WIRS) found out the LOTO-related accidents were common in all sectors. However, the LOTO related accidents were more in the
manufacturing sector like Company XYZ. From most of the LOTO Related Accident LRA, common observations were common in all the agencies that studied LRA in industries.

- Most of the employees who had suffered the LRA had not received the LOTO training as recommended by OSHA.
- Most of the injured workers were employees of companies or industries with substandard LOTO programs hence the accident.
- Other victims of LRA were employees of the organizations that lacked compliance with the LOTO safety measure.

Osha Office of Data Analysis (ODA) also researched establishing fatalities related to lockout/tagout systems. ODA's finding on the study indicated that most LOTO–related cases were caused by a lack of proper de-energize energy control while undertaking maintenance, repairs, or the machines' servicing. The office of Data Analysis provided regulations in which industries should undertake during the lockout/tagout standards to decrease the number of fatalities experienced during the LOTO process. National Institute of Occupational Safety (NIOSH) conducted a study to establish the "Guidelines for Controlling Hazardous Energy During Maintenance and Servicing." The study focused on some LOTO –related accidents to determine the measures adopted to prevent LOTO accident cases from occurring. NIOSH research on the guidelines of controlling the LOTO-related cases concluded that accidents could be controllable if the following measures were implemented.

- Effective energy control measures were available at the workplace.
- Accidents could have been avoided if the employees had been trained on the techniques.
United Automobile Aerospace and Agricultural Implement Workers of America (UAW) researched the best precautions to control hazardous energy in industrial settings (Goggins, 2019). The UAW reported the findings on the LOTO-related accident hearing organized by OSHA to develop LOTO guidelines. According to Illankoon et al. (2019), the report by AUW mainly focused on the fatalities that had occurred during the lockout/tagout systems. According to the report, over 80 workers had lost their lives due to the failure to implement the OSHA laws properly. The UAW research came up with the following findings on reducing fatalities due to the LOTO standard's failure. According to UAW findings, the fatalities of the workers occurred due to the following reasons,

- inadequate training on lockout/tagout systems on the workers
- lack of proper lockout/tagout procedures
- lack of proper enforcement on the LOTO procedures

UAW recommended OSHA to implement good measures that will:

- provide adequate training session for employees
- provide proper LOTO procedures that are easy for employees to understand

**Modern Status of the LOTO Program**

Machine operators can forget to switch off a machine after completing a task. According to research conducted by the Center for Agricultural Research Publications, over 80% of workers forgot to put off machines before performing work. The report also reported that significant cases in the U.S. occur due to failure to implement proper lockout/tagout during servicing and maintenance, causing injury or fatality. Despite the formulation of the OSHA guidelines, the number of accidents and fatalities is still taking place according to government agencies' reports and labor movements. American Society of Safety Engineers (ASSE) and American National
Standard Institute (ANSI) groups in 2008 reviewed the LOTO standard, harmonized the standards, and concluded on why the LOTO program fail in an industry, which includes:

- lack of proper training on the LOTO standards on the maintenance and servicing of machines
- failure of the organization to address the various forms of energy in premises.
- lack of proper handling of the machines could harm the people, including hydraulic, thermal machines, and pressurized energy sources.
- existence of substandard LOTO programs in industries.

According to Dewi (2018), the report of the ANSI and ASSE organization to OSHA, industries practice substandard LOTO programs in industries are exercised through,

- failure of the company to implement appropriate lockout procedure
- lack of proper training for employees on the lockout/tagout systems
- failure by both employers to provide the necessary resources required by OSHA in industrial areas ensures employee safety
- failure by employers to update their LOTO safety measures since the management focuses on profit-making and not employees' safety

Industrial Safety and Hygiene News (ISHN) published an article in May 2000 to review some of the challenges that the OSHA officers had observed during their LOTO audit in most industries in the country. The article only focused on analyzing the factors that largely contribute to the proper implementation of the LOTTO program failures. The factors that led to the failure of the Lotto Programs according to the article, include:

- lack of proper training on the employees on the effective lockout/tagout standards when operating, servicing, and providing maintenance on machines
• inadequate supervision of LOTO programs and procedures, lack of close supervision from the authority fails the LOTO programs since nobody will practice them effectively
• individuals try to find shortcuts on implementing the LOTO programs; the lockout/tagout procedures are to be observed without failure to implement one stage as it may cause to program failure
• lack of proper communication channels is another cause of the LOTO program; communication must follow the same channel and communicated effectively to avoid program failure due to miscommunication or lack of communication
• some industries lack enough enforcement policy to ensure that the LOTO programs are enforced to guarantee all employees' safety and prevent them from accidents
• omission is a significant cause of LOTO program failure since people choose to leave some procedures so that they can implement the process quicker so that they can carry out other functions
• lack of inclusion of all employees during the demonstration on the LOTO programs, management should include all the workers in the training process to avoid biases since failure to include all the employees will result in LOTO program failure since not all employees can operate the machinery

How to Implement the LOTO Program in the Company

Implementing a proper LOTO program in an organization require establishing a better system to ensure a lockout/tagout program. It is crucial to carry out inclusive research on the machine's risk and hazardous analysis and the workers' safety while operating the machine. The International Loss Control Institute (ILCI) developed a causation model with focus mainly on
factors that are likely to cause losses and accidents on the premises to determine the cause that may result in an organization's accident. According to the model, the main factors that are likely to cause LOTO program failure include lack of management control measure, lack of adequate measures to protect the workers, and non-compliance to the organization's LOTO guidelines.

In the above literature review, every organization needs to consider a lockout/tagout policy that nicely suits its criteria. The following must be taken into consideration when deciding the lockout/tagout process for an organization:

- The management must accept the policy being implemented so that it can receive support from the management.
- It is necessary for the employer and the workers to comply with the rules to prevent accidents and fatalities resulting from the lockout/tagout policies' failure.
- The LOTO programs must be standardized to suit the organization effectively.
Chapter III: Methodology

The main purpose of this chapter is explained what kind of method and approach are used to complete this study. This is based on the survey conducted within Company XYZ (see Appendix C). Company XYZ has recorded increase in the number of employees, who has LOTO related injuries due to lack of proper lockout/tagout procedures. And outdated lockout/tagout procedure that does not match every machine (see Appendix A).

To measure and compare any outdate procedure or losses at Company XYZ. The information collected in the research was mainly oriented on machines and equipment used at Company XYZ, where the organization performed the lockout/tagout procedures. The research followed all the question that is used on the survey (see Appendices A and C). using all the available information sources about effective lockout/tagout systems for the study, including checklists, field notes, journals, surveys, documents, and other publication materials on lockout/tagout procedures. The research aimed to identify the lockout/tagout procedures used by XYZ company, identifies the gaps in existence and analyzes past recordable procedures, improve existing lockout/tagout procedure, then establish new lockout/tagout procedures for the Company XYZ to avoid any injuries in the future and meet OSHA standers.

This chapter will show the procedure for information and sample selection, data collection and limitation of the study.

Subject Selection and Description

The process of selecting employees at Company XYZ who were to provide us with useful information about the tagout/lockout programs was not easy. The company has many employees, and we needed to get at least ten employees from every department (see Table 1). The employees had to be experienced who had a deep knowledge of the company's safety programs. Table 1
displays which department and machinery picked in this study. From the 10 departments, we identified 100 employees who provided us with important information about Company XYZ. The research method used to help us determine the tagout/lockout programs is grounded theory approach since this method provides explicit guidelines for conducting qualitative research. Secondly, this research method offers specific strategies for handling the analytic phases of inquiry; lastly, the research method streamlines and integrates data collection and analysis. Grounded theory played a significant role in the research this it helped identify the employees we engaged in the research. Through grounded theory, we were able to identify injured employees from the ineffective LOTO programs existing in the company.

Table 1 shows how many machined get picked from each department to determine best result for this study.

**Table 1**

*Machinery Picked for the Study of Lockout/Tagout Procedures*

<table>
<thead>
<tr>
<th>Department</th>
<th>Equipment picked for the study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanroom A</td>
<td>15</td>
</tr>
<tr>
<td>Catheter Dept. II</td>
<td>18</td>
</tr>
<tr>
<td>Catheter Dept. IV</td>
<td>17</td>
</tr>
<tr>
<td>Leads Dept.</td>
<td>10</td>
</tr>
<tr>
<td>Intro Dept.</td>
<td>20</td>
</tr>
<tr>
<td>Micro Dept. I</td>
<td>15</td>
</tr>
<tr>
<td>Micro Dept. II</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>
Instrumentation

Company XYZ had reported several accident cases resulting from the ineffective lockout/tagout programs of the company. The company had some documented cases; the cases were documented for medical purposes and compensation. The accidents were severe since 90% of Company XYZ employees who were involved in accidents did not continue working since they were badly injured, leaving them helpless. The documented information provided a good source for the accident cases in the company. The 100 employees selected to participate in the research and survey questions, also provided information on the number of accidents experienced in the company (see Table 1 and Appendix D). The cases of accidents, as documented, were all due to the poor lockout/tagout programs that existed in the company. The management negligence to install new safety measures and ensure that machines are well maintained and serviced to prevent a breakdown during operational hours. The questions asked to the employees helped in understanding LOTO programs for the company and how the company (see Appendix D). The questions were also oriented in providing information on how the management deals with accident cases that arise in the company resulting from machines and which machinery has most common problem (see Table 1). The safety measures put in place by the company management that aims to prevent accidents from happening (e.g., safety gears, training programs for employees, and other OSHA programs that provide safety for the employees).

Data Collection Procedures

The employees were first informed of the importance of the research and how to answer the LOTO programs' questions. The employees provided the researcher with information by answering the drafted questionnaires, which covered employee safety at Company XYZ and the
LOTO programs existing in the company. The questionnaires were handed over to the researcher once the employees were done answering all the questions (see Appendix A and C). Every employee was given one month to fill on the questionnaire; the duration was also to ensure that every data the employee filled was correct and accurate. The number of accidents the company experiences, the existing LOTO programs, and the number of reported accidents since joining the company and how the Company XYZ management reacted to the issue, and the policies adopted prevent further accidents.

The employees selected to participate in the research were also taught how to fill the questionnaires in the simplified answers to make it easy for the researcher to record the information. Before participating in the research, the employees signed onto the consent letter after informing the management to ensure that every employee was aware that the research was conducted for their own benefit to prevent future accidents relating to poor policymaking and implementation of safety measures. Every employee was given questionnaires in a confidential document to ensure that every employee gives an independent answer. The research was oriented in collecting independent information; every employee was guaranteed privacy and anonymity of the documents as a sign of protection (see appendix A). This study's main purpose was to collect all the crucial data, which focuses on risk factors and causes of accidents for Company XYZ. The study was oriented to understanding why there was a continuous increase in the number of accidents relating to LOTO programs in the company.

**Data Analysis**

The data collected from the study were analyzed using qualitative analysis. The data was analyzed to determine the main caustic factors resulting in accidents in the Company XYZ by using survey (see Appendices A and B). The similarity of the information collected was also
shown that employees had the same experience about their safety as provided by the company. Data analysis was easy to identify the employees who suffered hand injuries, burns, cuts, and various accidents resulting from poor LOTO programs.

**Limitations**

The main limitation of this study is that some participants failed to answer all the questions. They feared compromising with their management despite assuring the employees of their security of anonymity. The use of questionnaires in our research limited the participants in providing clarity to the answers given; the questionnaires did not allow the employees to give an in-depth analysis of the answer. Some of the participants understood the questions wrongly and provided wrong answers, misleading the study. The misunderstanding of the questions resulted in wrong answers, which hindered providing the right information for our study.

**Summary**

This chapter covers the research process used in our research, the quantitative research method, to identify the lockout/tagout systems used in Company XYZ. The chapter involves the selection process of identifying the equipment to be used in the study. The study relied on the use of the primary source of data to accomplish the set goals. The participants were the Company XYZ employees that had record accidents at the company. To obtain their responses, the study identified questionnaires as the most appropriate data collection method. It gave the participants a sense of privacy that encouraged them to be honest in the answers they shared. The questionnaire questions were designed to match the research goals, which helped ensure that the data collected was valid (see Appendices B and C).
Chapter IV: Results

Quantitative research methodology, using the grounded theory approach, was used in this study to design a template for the implementation of a program for the control of hazardous energy in the manufacturing industry. Checklists were utilized to collect data, information, documents, survey, and materials used in this study.

Item Analysis

Appraisal of the current LOTO program for Company XYZ. A detailed appraisal program for the current LOTO program for Company XYZ was conducted to identify the existing gaps, which included:

- The company had inadequate training of the company workers. Company XYZ did not train all the employees on the maintenance of the LOTO programs and offered devoid training programs when demonstrating LOTO skills to the employees.

Figure 1

Employee Training Satisfactory Level

Note. Training feedback from 100 participants.
**Figure 2**

*Effective Responses to Tagout/Lockout Procedure*

![Pie chart showing satisfaction levels for Company XYZ](chart.png)

*Note.* Tagout/Lockout procedure feedback from 100 participants.

- The company also had gaps in addressing energy; the company only had stringent electrical power measures.
  - a. grossly overlooking secondary and residual energy sources like pneumatic, hydraulic, gravitational, thermal, and other pressurized energy sources
  - b. failure to control hazardous energy sources of complex equipment
  - c. overlooking hazardous energy due to a lack of comprehensive hazard analysis
- There was inefficient communication process during change of employees from one shift to another.
- There was limited inventory of updated and quality PPE availability.
- There was lack of effective communication process during the change of shift by employees.
**Figure 3**

*Representation of Different Understandings Pertaining to What Condition is Appropriate for PPE*

*Note.* Condition of Personal Protective Equipment feedback from participants.

**Figure 4**

*Understanding of Safety Measures*

*Note.* Satisfaction and understanding company safety measures.

Company XYZ must consider the above recommendation when planning to implement a standardized LOTO program, to avoid any incident and other negative experiences.
Satisfactory Results

The results that follow shows the response of 100 participants in a local survey. Consistency of training should be a priority when bringing in new employees, however nearly half (50%) of company XYZ express poor experiences during orientation. Negative feedback highlights low prioritization for proper procedures. While responding to the survey under half of the employees (30%) described satisfactory level guidance, leaving them with good understanding but no experience or acceptable supervision. Taking into account the fluctuation of incoming and outgoing persons, surveys were also handed out to company veterans making up less than one third of the company (20%), giving positive responses to their own experiences either similar or the same as the training given today. The data collected for figure 1 is important for management to take into consideration while reconstructing an updated guide for new employment training.

Tagout/Lockout

Many companies if not all including XYZ have installed safety measures to keep workers safe, one being Tagout/lockout. Specific to machines with moving mechanics Tagout/Lockout allows any qualified personal to work on a machine while cutting complete power. Careless action has previously resulted in injury, making it mandatory that all employees receive proper training. Figure 2 shows that majority of the staff (90%) felt unsatisfied unsure, or that training greatly needed improvement. The remaining percentage (10%) felt satisfied due to experience and or previous training though a different employer. This showed that the company needs to immediately initiate a safety procedure such as Lockout/Tagout.
**Condition of PPE**

OSHA standards regulate and help keep a company running effectively, setting standards for different areas of safety such as PPE. Companies operating in forms of general industry, maritime, and construction are required to follow guidelines set up for the safety of employees. Employers are responsible for training employees on when to use protection equipment, what kind to use, and how to properly care for the equipment. Negligence of training and proper maintenance can result in dangerous levels of exposure, allowing injury to occur. Figure 3 showed that over half of the staff (80%) felt that the condition of the provided PPE was bad or needed replacement. This exposes high levels of concern relating to OSHA standards and this require immediate evaluation and correction to lower the risk of injury.

**Understanding/Communication of Safety Measures**

Communication regarding safety is a key element in all companies, upon employment every employee is handed a safety guidebook as well as orientation. Figure 4 slightly showed that under half of received responses (40%) were satisfied, expressing understanding of safety procedures and communication with management. Many employees stated that they are able perform different procedures safely and accurately, while bulk responses (60%) did not agree. Common concerns for most employees are that they did not understanding the proper steps to follow if ever needed. The pie chart displayed in figure 4 showed high possibility for injury, leaving management to develop completely new training course for all existing and new employees.

**Summary of Results**

The overall responses to the survey handed to both new and veteran staff, revealed multiple gaps in four different categories of questions. Figure 1 gives management a good guide
of what exactly needs to be changed, based on firsthand accounts. This will ensure smooth
transition from training to full time employee. Full time employees are also required to
understand safety regulations and specific protocols this includes LOTO while being able to
appropriately operate PPE. Strong evidence indicates that company XYZ needs mass
improvement in each subject including use and understanding of all equipment.

**Written Standard LOTO Policy**

From the lockout/Tagout gaps identified at Company XYZ, it was necessary to draft a
standard policy that will guide the company in the proper implementation of the programs. The
legal system the company should draft to guide the LOTO programs should include the
following programs:

- General Overview of the LOTO programs when drafting the LOTO program for
  Company XYZ should ensure that the regulations being implemented conform to the
  OSHA regulation of safety policy at the workplace.

- Definition of terms used in the lockout/Tagout procedures will help clarify
  employees. Without a clear understanding of words, workers may apply the wrong
  lockout/Tagout procedure resulting in an accident.

- Authorized personnel and affected individuals, when putting all measures to place,
  the measures should consider all individuals to avoid specific training individuals and
  leaving other individuals. Such policies are contributors to accidents during the
  implementation of lockout/Tagout programs.

- Hazard Analysis, on the standard policy, this section should address the compressive
  hazard analysis and risk assessment. This will help in the proper use of the
lockout/Tagout procedures to reduce the accidents associated with hazards caused by inappropriate LOTO procedures.

- In special situations, this section in the standard policies discussed three crucial aspects to a successful LOTO program at the Company XYZ, which included,
  - handling the LOTO procedures during the end of a shift by employees or a change of shift recommended by the management without prior notice
  - removal of LOTO equipment by employees that lacks background knowledge of the installation of the equipment, which results in poor implementation of the uninstallation process, resulting in an accident or damage to the machine
- Performance of LOTO procedures by contractors, do not allow the employees to acquire the knowledge of implementing the LOTO procedures at the workplace.
- Policy Audits, this section on the standard policy identifies the importance of regular audits on the OSHA policies to ensure that companies adhere to guidelines on the safety policy measures at the workplace.

**Equipment for LOTO Program Study**

Company XYZ has over 200 heavy industrialized equipment used in the production of medical equipment. In the LOTO study program, 100 types of equipment were enrolled in different company departments. The equipment was selected using a stratified random selection method from the departments to avoid selecting similar equipment from the same departments, which would hinder the company equipment's LOTO program study (see table 1).

**Training Manuals Developed for Authorized Personnel**

As the standard LOTO, policy states it is the employer's responsibility to provide a training program on the Lockout/Tagout procedures. It is Company XYZ responsibility to
provide LOTO training for the employees, write LOTO procedures on the equipment, acquired quality equipment that adheres to the OSHA requirement, and ensure that the work environment is conducive for the employees. Company XYZ should also ensure that only authorized individuals have access to the equipment. The authorized employees are supposed to take annual refresher training and audit programs. Such training activities and audits will help implement the LOTO programs for the equipment, and the number of accidents resulting from the lockout/Tagout process will minimize significantly. The company should keep appropriate documentation of the employees who participated in the training session. Through recording keeping, Company XYZ will access the workers and allocate them roles according to their ability. Workers who never participated in the training will not be allowed to operate the heavy equipment.

**Hazard Analysis and Risk Assessment**

Thorough hazard analysis and risk assessment were carried out for all the equipment and machines available at the Company XYZ. A hazard analysis and risk assessment were conducted for all 100 types of equipment identified to be used in our study. The analysis included details on the energy sources that the equipment has, location of the control points, methods of controlling the energy sources, the energy control devices used, and the appropriate personal protective equipment (PPE) required and indicated in the checklist (see Appendices A and B).

**Written LOTO Procedures**

The LOTO procedures were designed for each piece of equipment specific to and tailored after the hazard analyses and risk assessment performed on the respective machine and equipment.
Audited LOTO program

According to Company XYZ policies, the LOTO program will be audited on an annual basis, and the audit information will include the following items:

- Each LOTO procedure is still relevant to the specific equipment it was designed for.
- Appropriate LOTO devices are available for the control of specific energy sources.
- The list of personnel authorized to perform LOTO procedures is reviewed to be current and updated.
- The previous year, iv. LOTO-related accidents have been reviewed, and appropriate corrective measures instituted to avert recurrence.

Summary

This chapter covers the process used in the research to identify the quantitative research method for the lockout/tagout systems used in Company XYZ. The chapter involves the selection process of identifying the equipment’s to be used in the study.
Chapter V: Discussion, Conclusion, and Recommendation

The purpose of this study to update and create new lockout/tagout procedure to make sure Company XYZ work safely without any incident. Unintentional release of hazardous energy in maintaining, repairing, or servicing heavy industrialized equipment and machines is a significant cause of injuries and personnel deaths and damage to equipment and facilities in industrial settings. In 1989, OSHA introduced a regulation for controlling hazardous energy, popularly known in industry as Lockout/Tagout (LOTO).

Discussion

During this study, the LOTO program of Company XYZ was evaluated to identify existing gaps and implement such measures as policy frameworks, processes, and procedures to standardize the plan to reflect industry best practices. The data, information, documents, and materials were collected using checklists. The checklists were used in appraising the current LOTO program of Company XYZ which include designing and writing a standardized LOTO policy, designing a practical training manual for personnel, conducting a hazard analysis and risk assessment on machines and equipment, developing firm LOTO procedures for every piece of equipment and the annual auditing of the entire LOTO program.

A detailed analysis of the completed checklists revealed some significant findings, some of which include:

- An appraisal of the current LOTO program showed that there were gaps in the Company XYZ LOTO programs.
- The training was designed to include hands-on demonstrations, ensuring that the person has a practical application of LOTO program concepts during the training sessions.
• The comprehensive hazard analysis and risk assessment that was performed on every piece of equipment selected for examination on the LOTO programs to ensure no hazardous energy sources was omitted.

• LOTO procedures designed for every piece of equipment were tailored after hazard and risk assessment results to ensure that no hazardous energy source was omitted.

• The purpose of the annual audit was to ensure, among other things, that the LOTO policy is current and updated and that the authorized staffs receive the updated information on the Lockout/Tagout processes.

Conclusions

To ensure that a properly implemented program to control hazardous energy in a manufacturing company does not fail due to gaps, standardized policy frameworks must be drafted, and a comprehensive process put in place. At the same time, the LOTO procedures must be adequate and updated in Company XYZ. Techniques such as reviewing the current program with comprehensive risk and hazard assessment are instrumental in identifying gaps and determining factors that cause LOTO programs to fail in the organizations. Processes such as adequate LOTO training programs for personnel and designing comprehensive LOTO procedures helped close the gaps identified and develop a firm LOTO policy for the organization.

Recommendations

Lockout/Tagout procedure should be developed and used within company XYZ to ensure all authorized and affected employees are trained to achieve their goals. Company XYZ must work to attained OSHA certification and also VPP (Voluntary Protection Program)

The following recommendations are made regarding this study:
• Concerted efforts must be made by all stakeholders to ensure that LOTO policies and procedures are standardized.

• Comprehensive hazard analysis and risk assessment must be performed on every equipment or machine before designing their LOTO procedures. The hazard analysis must be thorough and must not omit secondary and residual energy sources.

• LOTO training programs must be designed to be customized for a particular facility and include hands-on demonstrations.

• The use of tagout in place of lockout devices must be discouraged and never used to perform LOTO procedures.

• Authorized personnel must be discouraged from using shortcuts or skipping vital steps when performing LOTO procedures.

• Adequate supervision of LOTO programs and procedures, and enforcement of LOTO policies by designated personnel.

• Effective communication is required while performing all LOTO related procedures and activities.

• Standards need immediate evaluation and correction to greatly lower the risk of injury.

There are several potential opportunities for further studies in designing and implementing programs to control hazardous energy. In a world driven by information technology and the crucial roles that checklists played in this study, the design of electronic LOTO checklists (e-checklists) will be useful tools for safety and maintenance personnel. Taking a step further, mobile applications may be designed for the checklists to limit the burden of going about with laptops, which are much bigger than cell phones.
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Appendix A

Hazard Analysis & Risk Assessment for LOTO

To determine all energy sources for each piece of equipment, all questions must be answered. Both actual and potential sources of energy need to be considered when responding to the questions. If the question does not apply, write N/A in the blank. Circle "yes" or "no" or fill.

1. Does this equipment have any of the following?
   a. Electric power (including battery)? YES/NO
      if yes, Motor Control Center (MCC) or power panel and breaker number _________________
      Does it have a lockout device? YES/NO
      Battery location: _________________________________
   b. Mechanical power? YES/NO

Mark each type of energy source that applies:

1. Engine driven? YES/NO
   If yes, switch or key location: ___________________________
   Is lockout device installed? YES/NO
   If no, method of preventing operation: ___________________

2. Spring loaded? YES/NO
   If yes, is there a method of preventing spring activation? YES/NO
   If no, how can spring tension be safely released or secured? ______________________________

3. Counter weight(s)? YES/NO
   If yes, does it have a method of preventing movement? YES/NO
   If yes, can it be locked? YES/NO
   If no, how can it be secured? ________________________________
4. Flywheel? YES/NO

If yes, does it have a method of preventing movement? YES/NO

If no, how can it be secured? ___________________________________________________

c. Hydraulic power? YES/NO

If yes, where is the location of main control/shut off valve? ____________________________

Can control/shut off valve be locked in "off" position? YES/NO

If no, where is the location of closest manual shutoff valve? ________________

Does manual shutoff valve have lockout device? YES/NO

If no, what is needed to lock valve closed? ___________________________________________

Is there a bleed or drain valve to reduce pressure to zero? YES/NO

If no, what will be required to bleed of pressure? ________________________________

d. Pneumatic energy? YES/NO

If yes, where is the location of main control/shut off valve? _________________

Can control/shut off valve be locked in "off" position? YES/NO

If no, where is the location of closest manual shutoff valve. _________________

Does manual shutoff valve have lockout device? YES/NO

g. Gravitational Energy? YES/NO

If yes, where is the location of the main control/shutoff device? _________________

Is there a device to restrain or control the gravitational energy? YES/NO

If no, what will be required to control or restrain the gravitational energy? ______________

Can the device restrain or control the gravitational energy to be locked in a position that will prevent the gravitational energy from being released? YES/NO

h. Other Sources of Energy?
Are there any other actual or potential energy sources? YES/NO

If yes, where is the location of main control/shutoff valve? ________________

Can control/shutoff valve be locked in an off or closed position? YES/NO

Is there a way to drain or bleed of pressure? YES/NO

If no, how can energy be controlled or neutralized? ________________

Is personal protective clothing or equipment needed to protect employees from the energy source? YES/NO

If yes, what equipment is needed? ________________________________

If no, what is needed to lock valve closed? ________________________
Appendix B

Observation Survey Form

<table>
<thead>
<tr>
<th>Company XYZ. lockout/tagout systems</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

**Observation of LOTO programs**

<table>
<thead>
<tr>
<th>Question</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Did someone review the lockout/tagout notice?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the person shutdown the machine using right procedures?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the responsible person apply required lockout devices, locks and tags?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the person identify, isolate and deactivate all energy sources?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the person obtain all the required locks, lockout devices and tags</td>
<td></td>
<td></td>
</tr>
<tr>
<td>needed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the person drain safely the stored residue energy in devices?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Release of LOTO**

<table>
<thead>
<tr>
<th>Question</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the person upon completion of work, inspect area for potential hazards?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensure safety of equip/area (guards replaced)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the person remove locks, lockout devices and tags?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the person return the system to fully functional?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the person notify affected employees in the area of impending equipment start up?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**

---

Trainer Name:  

Trainer I.D NO.  

Signature
Appendix C

Questions asked at Company XYZ for analyze the study

a) How does management ensure safety in this company?

a) What type of training on lockout/tagout program provided?

b) How does management document and maintain PPE condition?

c) How can management support effective communication between employees?

d) How does management provide support to you as the Safety Coordinator?

e) How happy are you with the support you get from your immediate manager?

f) Do you have an update lockout/tagout standard been issued for this company?

 g) How many times this company been cited by OSHA for violations related to lockout/tagout standard?

h) How many times in year OSHA visited company XYZ for inspection?

i) What type of training on lockout/tagout program provided?

j) Has any employee been involved an incident including machinery?

k) Do you keep any recordable incident in the past?

l) How you encourage your staff to work safely?
Appendix D

Definition of Terms

Affected employee: An employee who is required to operate, use, or be in the area where a machine or equipment could be locked or tagged out for service or maintenance.

Authorized employee: An employee who locks or tags out a machine or equipment to do service or maintenance.

Can be locked out: An energy-isolating device that can be locked in the “off” or “safe” position.

Employer: An employer is any person, firm, corporation, partnership, business trust, legal representative, or other business entity.

Energized: Connected to an energy source or containing residual or stored energy.

Lockout: Placing a lockout device on an energy-isolating device using an established procedure to ensure the machine or equipment cannot be operated until the lockout device is removed.

Lockout device: A device that uses a positive means, such as a key or combination lock, to hold an energy-isolating device in the “safe” or “off” position.

Normal production operations: Using a machine or equipment for its intended production function.

Primary authorized employee: An authorized employee who has overall responsibility for meeting the lockout/Tagout procedures requirements.

Service and maintenance: Activities such as constructing, installing, setting-up, adjusting, inspecting, modifying, maintaining, and servicing machines or equipment.