

A Risk-Based Management Approach in Minimizing Occupational Accidents in Manufacturing Locator Companies in Philippine Special Economic Zones

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Abstract

Safety at work is very important to every industry and minimizing the risk of workplace accidents and injuries is of utmost importance in the discussion of occupational, health and safety (OSH). Increasing density of manufacturing companies as locators in a high-growth export processing zone in Laguna Philippines led to the conduct of this study aimed at analyzing the causes of accidents and assessing the risk factors and OSH practices with the end in view of determining a better approach in OSH management. Actual cases and accounts of occupational accidents, their causes, and resulting injuries were gathered via interviews and survey questionnaires. An assessment was made on the OSH programs, the work environment and organizational factors. The results of the study pointed to the importance of integrating risk management in performing OSH management as non-identification of hazards was found to be a major cause of workplace accidents and injuries. As such, an improved OSH management model was developed with the integration of risk management centered on collaboration among process owners in putting in place a proactive, ongoing process to identify and assess high-priority risks and hazards, the critical element of any effective safety and health program.

Keywords

Occupational Safety and Health (OSH), Risk Management, Locators Occupational Accidents and Injuries

1. Introduction

In the past years, occupational accidents in major and minor industries in the Philippines are always critical. The Philippine government has made efforts to execute safety and health policies through the enforcement of guidelines and conduct site safety seminars and certifications. The government has instituted laws and regulations for the protection of industrial workers. For example, the Philippine Constitution included provisions on the protection and promotion of the workers' welfare. The Philippines' Labor Code also provides for workers' safety and health to promulgate the Occupational Safety and Health Standards for Business and Industry. Nowadays, numerous training, seminars, programs, and practices are promoted by different agencies in the Philippines (government and private) to prevent occupational accidents. Based on the Bureau of Labor and Employment Statistics records in the year 2013, there are 34,579 establishments in the Philippines applying occupational health and safety-related programs and policies. On the other hand, 25,857 establishments availed the OSH related training and seminars, while 34,579 establishments have preventive control activities regarding occupational accident prevention.

Even with these existing programs and practices to prevent occupational accidents, cases of occupational accidents and injuries in the Philippines are still increasing. Rhamani et al. (2013) also stated that despite implementing safety strategies in workplaces, occupational accidents and incidents have increased in parallel to developing industries. Records from the Bureau of Labor and Employment Statistics (BLES) in figure 1 show that in 2011 total occupational accidents in the Philippines increased to 20,846 cases from 17,601 in the year 2009.

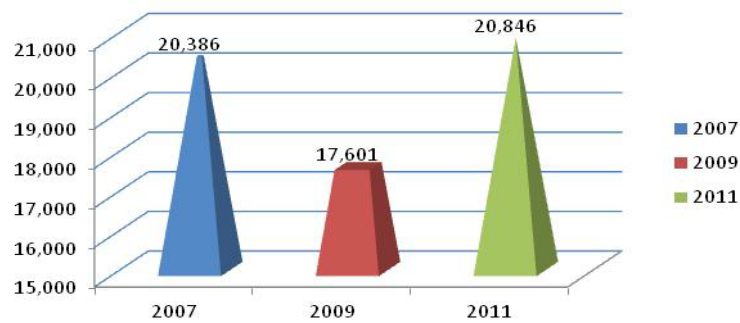


Figure 1. Cases of Occupational Accidents in the Philippines from Year 2007 to 2011

Safety in the workplace is one of the essential issues that cannot be taken lightly. Even a minor accident may cause a severe and massive effect on the organization. Accidents in the workplace occur for several reasons. It may result in minor injury, damage to equipment, or even major injury or death. Sumadsad (2013) stated that preserving human life is an objective that requires no explanation. According to Sison (2003), waste of human resources caused by industrial accidents and occupational illness can be prevented, minimized, or eliminated through the company or agency's safety and health programs and policies. Maintaining the safety and health of the employees should be the task of management. It is believed that a healthy employee works more efficiently, is more productive, and possesses a better work attitude than a sickly one. Hence, this increases the productivity and profitability of the company. Employees need to stay alert and aware at all times to avoid accidents. In contrast, managers need to know the most common causes of workplace accidents and identify the risk factors early to prevent them. A conducive and competitive working environment may help the organization run its daily operation smoothly and successfully achieve its goals.

There are different studies in the Philippines and other developing countries that deal with the prevention of occupational accidents and injuries using the existing programs and practices in occupational health and safety. Occupational accident prevention in other industrialized countries has substantially been discussed in the studies focusing on risk management as an integral part of managing safety in different industries like the mining, construction, transportation, and shipping industries. However, a study on the incorporation of risk-based management in preventing and minimizing occupational accidents in the Philippine manufacturing industry is outside the scope of the existing studies. In this context, the study will seek to answer the following questions:

- a. Does incorporating a risk management approach to safety management will minimize the occupational accidents in the manufacturing industry of Laguna, Philippines?
- b. What risk management strategy is best-suited managing safety that will help reduce occupational accidents in the Philippine manufacturing industry?

This current study intends to determine two things. First is the management practices in managing occupational accidents. And second, the significant individual, work environment, and organizational risk factors affecting occupational accidents. In addition, this study also intends to develop a risk-based model strategy and safety management policies that will help reduce occupational accidents in the Philippine manufacturing industry.

2. Methodology

2.1 Conceptual Framework

The conceptual framework of this study, as shown in figure 2, focuses on the application of Risk Management in the management of safety in the Philippine manufacturing industry. Occupational accidents have three significant factors: the individual factors (e.g., not using provided PPEs, improper use of PPEs, improper use of tools/equipment, standard work safety deviation, taking process shortcuts, and work safety negligence). The second factor is the work environment (e.g., a worker is exposed to a hazardous work environment, unsafe work conditions, unsafe work operation/process, unsafe tools and equipment, and defective PPEs). The third is the organizational factors (e.g., OSH

related training and management systems). These factors contribute to occupational accidents that will result in occupational injuries (Head, Neck, Back, Arm and Shoulder, Wrist and Hand, Internal Organ, Lower Extremities, and Multiple Body Parts Injury). To be able to determine the significant relationships posited by the conceptual framework, testing of six (6) hypotheses was undertaken, to wit:

H_{1o} : There is no significant relationship between factors of accidents and the occurrence of occupational accidents.

H_{1a} : There is a significant relationship between the factors of accidents and the occurrence of occupational accidents.

H_{2o} : There is no significant relationship between factors of accidents and occupational injuries (Head, Neck, Back, Arm and Shoulder, Wrist and Hand, Internal Organ, Lower Extremities, and Multiple Body Parts Injury).

H_{2a} : There is a significant relationship between factors of accidents and occupational injuries (Head, Neck, Back, Arm and Shoulder, Wrist and Hand, Internal Organ, Lower Extremities, and Multiple Body Parts Injury).

H_{3o} : There is no significant relationship between applied safety programs and practices and occupational accidents.

H_{3a} : There is a significant relationship between applied safety programs and practices and occupational accidents.

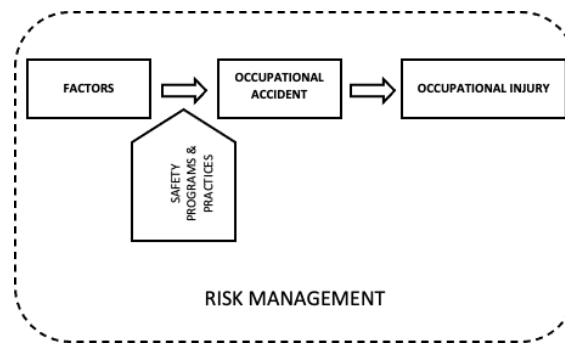


Figure 2. Conceptual Framework

2.2 IPO Framework

The current study also applies an IPO or the input-process-output model to classify the stages of the process and explain the system lifecycle described in the conceptual framework. The IPO model has particular advantages that make it an attractive tool to apply to a system-oriented problem set. First, IPO provides a structured approach for identifying a system's goals and objectives as outputs and how those outputs might be measured to evaluate choices in-process methods. Second, the structured approach of IPO supports a gap analysis for selecting what inputs are required to achieve which outputs.

The IPO model shown in figure 3 represents a system in three stages such as the input, process, and output. The first stage is the inputs modeled as consumables and efforts introduced to a system at the beginning stage of the lifecycle. Outputs are modeled as a result produced by the system. The process is modeled as the conversion of the inputs to the outputs.

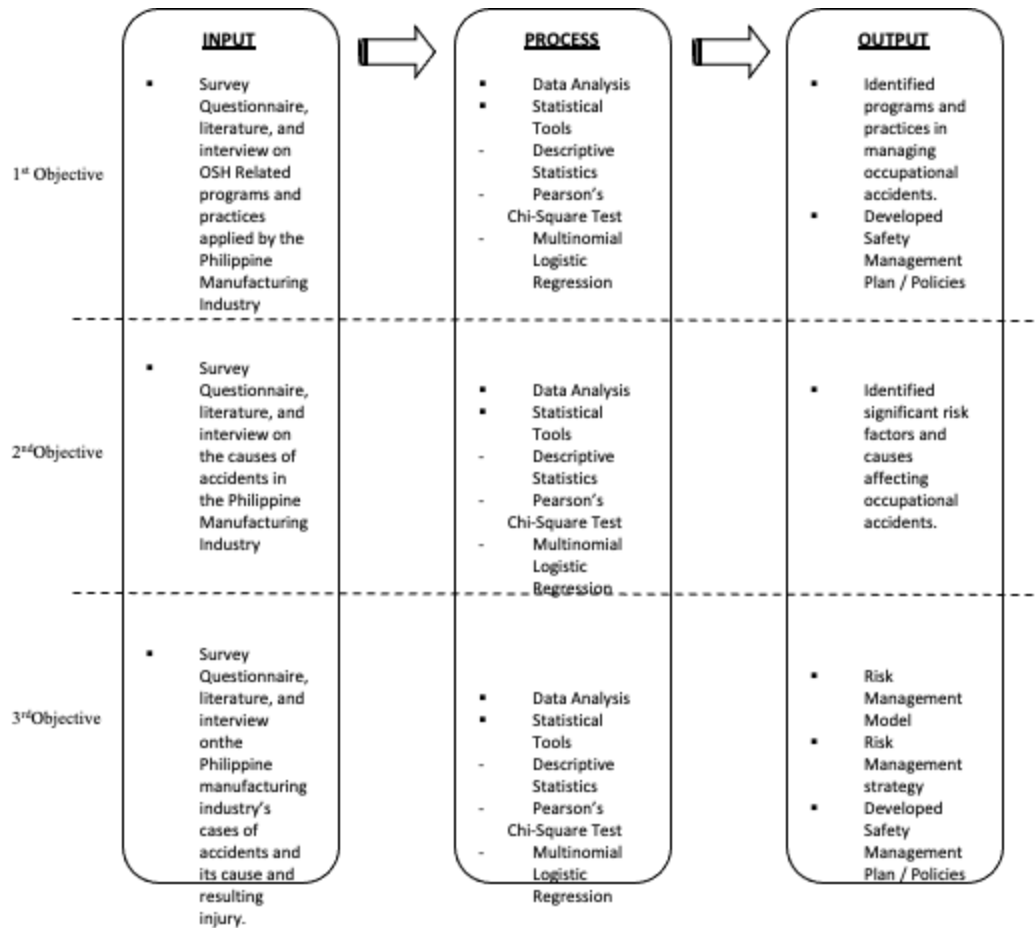


Figure 3. IPO Framework

2.3 Data Analysis

Interviews and survey questionnaires will be conducted to the safety practitioners of manufacturing companies located in Laguna, Philippines, to gather the cases of occupational accidents, their causes and resulting injuries, and the OSH-related programs and practices applied by the subject companies. The first part of the questionnaire is about the demographics of the respondent. Next is for the cases of accidents, their causes, and resulting injuries. And lastly, the last portion of the questionnaire is for the current OSH related programs and practices applied by the subject company.

The frequency of the occupational accidents, their causes, and their resulting injuries will be based on each case of occupational accident listed in the respondent's questionnaire. Each case will be treated as one (1) frequency for the type of accident, cause of the accident, and the resulting injury. The gathered frequencies from the questionnaire will be statistically analyzed to determine the significant risk factors and causes that affect the occurrence of occupational accidents in the Philippine manufacturing industry and the significant relationship between the following:

- a. Factors of occupational accidents and the occurrence of occupational accidents
- b. Factors of occupational accidents and the occupational injuries
- c. Safety programs and occupational accidents

Statistical Package for the Social Sciences (SPSS Ver. 16) will perform statistical computations to analyze the gathered data. The types of data that will be used in the study are the non-parametric data. Dependent variables or the outcome and independent variables or the predictors will be assigned to determine the significant relationship of variables stated in the hypothesis. Descriptive Statistics in SPSS will test the normality of the data, identify the outliers in the data,

and compute the means and standard deviations at a 95% confidence level. Since the type of data used in this study is non-parametric data, Pearson's Chi-square test will be used to determine if the dependent and independent variables are associated and determine the significance of the dependent variables to the independent variables. To predict each dependent variable's outcome based on the values of the independent variables using non-parametric data, Multinomial Logistic Regression will be used.

3. Results and Discussion

Based on the surveys and interviews conducted in this study, occupational safety and health programs, training, and safety practices being applied by the Philippines' heavy manufacturing industries nowadays are identified in table 1. The standard safety program that is being applied nowadays is the management system for Occupational Safety and Health. In this management system, the manufacturing companies follow the concept PDCA cycle. They plan the safety strategies to prevent occupational accidents, implement the strategies, check the safety strategy's effectiveness, and improve the safety strategy when an area for improvement is identified. Some of the safety strategies include workers' orientation on safety and health hazards at work, installation of machine guards on moving parts/equipment, regular inspection and maintenance of equipment, use of safety manuals, and appropriate Personal Protective Equipment (PPEs).

Table 1. Occupational Health and Safety Programs and Practices in the Philippines

| |
|---|
| OSH Management System |
| Environmental Management System |
| Forklift Safety, Ergonomics and Materials Handling Trainings |
| Safety Motivational Programs - No Loss Time Accident (LTA) |
| Fire Safety and EPR Trainings |
| First Aid and Basic Life Support Trainings |
| Regular workplace Inspection and audit |
| Fire Protection System Maintenance and Testing |
| Safety Reminder thru voice over or paging system |
| Conducts of evacuation drill (Fire and Earthquake) |
| Visitor's, Contractor's Safety Orientation |
| Emergency Evacuation Signages |
| Emergency Hotline Number |
| Safety Awareness campaign thru email |
| Radiation Training |
| Forklift Safety Training |
| Emergency Preparedness and Response Training |
| Material Handling and Safe Lifting Training |
| BLS and First Aid Training conducted by Red Cross |
| Electrical and Mechanical Safety Training |
| Appointment of Safety Associate from different business unit |
| Creation and Training for Emergency Response Team from different business unit |
| Work Environment Monitoring for hazardous substance, Noise and Light Exposure (Lux) |
| Basic Occupational Safety and Health Training (DOLE) |

The total number of non-fatal occupational accidents gathered were 135 accidents from the year 2013 to 2014. The highest type of occupational accident gathered is the stepping on, striking against, or struck by objects (36%) with an average occurrence of 24 cases per year or 2 cases per month from the year 2013 to 2014. The majority of the accidents are struck against by objects while in the work process and the production area. The proportion of the type of accidents was a foreign body in the eye (16%), fall of a person (11%), caught in or between objects (10%), exposure or contact with harmful substances or radiation (9%), exposure or contact with extreme temperatures (7%), strenuous movement or overexertion (4%), contact with a sharp object (4%), and struck by a falling object (1%). Among the 178 causes of accidents were identified; 28% of the accidents are caused by exposure to hazardous work environments followed by unsafe working conditions (25%) with an average of 24 and 22 occurrences per year. The most frequent result of the accident or part of the body being injured due to the accident is the head part (42%), followed by the wrist and hand being injured (33%).

A significant relationship between accident factors (e.g., individual and work environment factors) and the resulting accident is found to have a $p\text{ value} > 0.05$. The Fall of a person is significant to all factors of accidents. Fall of person is more likely caused by unsafe acts ($p = 0.718$), exposure to the hazardous work environment ($p = 0.703$), and improper use of PPE ($p = 0.614$), which shows lack of awareness of the employees in work safety, proper use of PPEs and the management's initiative to provide a safe work environment for its employees and workers. For struck by falling object accidents, it has been found that it is significant to improper use of PPE ($p = 0.861$), improper use of

tool/ equipment ($p = 0.759$), and defective PPE ($p = 0.721$). For Stepping on, striking against, or struck by objects accident, the Chi-square test shows it has significance to improper use of tool/equipment ($p = 0.877$), exposure to the hazardous work environment ($p = 0.875$), unsafe work operation or process ($p = 0.848$), and other factors of an accident except for not using provided PPE and work safety deviation. Caught in or between objects accident is significant to unsafe act ($p = 0.992$), unsafe work operation or process ($p = 0.876$), and improper use of PPE ($p = 0.642$). Overexertion or strenuous movement it is more likely caused by the unsafe working condition, improper use of PPE ($p = 0.759$), and improper use of tool or equipment ($p = 0.589$). For exposure to or contact with extreme temperature accident, it is significant to unsafe act ($p = 0.817$), unsafe working condition ($p = 0.816$), and improper use of PPE ($p = 0.687$). Exposure to or contact with harmful substances or radiation accident, the test shows it is associated with unsafe work operation or process ($p = 0.808$) and improper use of PPE ($p = 0.656$). For contact with sharp object accident, it is more likely caused by the unsafe working condition, improper use of PPE ($p = 0.759$), improper use of tool or equipment ($p = 0.589$), and unsafe act ($p = 0.537$). Lastly, foreign body in the eye accident is significant to improper use of PPE ($p = 0.530$) and unsafe working conditions ($p = 0.510$). Based on Pearson's Chi-Square Test results shown in table 2 using SPSS, most of the factors or causes of the accident have significance with the cases of occupational accidents. With this, this study's research rejects the first null hypothesis that there is no significant relationship between the factors of accidents and the occurrence of occupational accidents.

Table 2. Results of the Pearson Chi-Square Test for Factors of Accidents and its Accidents

| FACTORS OF ACCIDENT / TYPE OF ACCIDENT | FALLS OF PERSON | STRUCK BY FALLING OBJECT | STEPPING ON, STRIKING AGAINST OR STRUCK BY OBJECTS | CAUGHT IN OR BETWEEN OBJECTS | OVER-EXERTION OR STRENUOUS MOVEMENT | EXPOSURE TO OR CONTACT WITH EXTREME TEMPERATURES | EXPOSURE TO OR CONTACT WITH ELECTRIC CURRENT | EXPOSURE TO OR CONTACT WITH HARMFUL SUBSTANCES OR RADIATION | CONTACT WITH SHARP OBJECT | FOREIGN BODY IN THE EYE |
|--|-----------------|--------------------------|--|------------------------------|-------------------------------------|--|--|---|---------------------------|-------------------------|
| UNSAFE ACT | 0.718 | 0.437 | 0.338 | 0.992 | 0.171 | 0.817 | - | 0.001 | 0.537 | 0.256 |
| NOT USING PROVIDED PPE | 0.199 | 0.656 | 0.006 | 0.236 | 0.434 | 0.199 | - | 0.001 | 0.434 | 0.013 |
| IMPROPER USE OF PPE | 0.614 | 0.861 | 0.059 | 0.642 | 0.759 | 0.687 | - | 0.656 | 0.759 | 0.530 |
| IMPROPER USE OF TOOL/EQUIPMENT | 0.376 | 0.759 | 0.877 | 0.001 | 0.589 | 0.478 | - | 0.434 | 0.589 | 0.269 |
| STANDARD WORK SAFETY DEVIATION | 0.119 | 0.108 | 0.039 | 0.038 | 0.117 | 0.212 | - | 0.168 | 0.342 | 0.052 |
| TAKING PROCESS SHORTCUT | - | - | - | - | - | - | - | - | - | - |
| EXPOSED TO HAZARDOUS WORK ENVIRONMENT | 0.703 | 0.667 | 0.875 | 0.005 | 0.323 | 0.018 | - | 0.039 | 0.063 | 0.001 |
| UNSAFE WORKING CONDITION | 0.081 | 0.044 | 0.311 | 0.039 | 1.000 | 0.816 | - | 0.199 | 1.000 | 0.510 |
| UNSAFE WORK OPERATION/PROCESS | 0.272 | 0.703 | 0.848 | 0.876 | 0.007 | 0.380 | - | 0.808 | 0.007 | 0.171 |
| DEFECTIVE TOOL/EQUIPMENT | - | - | - | - | - | - | - | - | - | - |
| DEFECTIVE PPE | 0.303 | 0.721 | 0.149 | 0.341 | 0.529 | 0.050 | - | 0.362 | 0.254 | 0.008 |

The significant relationship between the factors or causes of accidents and their resulting injuries have been found to be $p > 0.05$. Test results show that head injury is more likely caused by exposure to a hazardous work environment ($p = 0.839$), unsafe working conditions ($p = 0.804$), and improper use of tools or equipment ($p = 0.706$). For back injury, it is significant to the factors of accident; improper use of PPE ($p = 0.830$), improper use of tool or equipment ($p = 0.706$), and defective PPE ($p = 0.660$). Arm and shoulder injury is associated with unsafe work operation or process ($p = 0.808$), improper use of PPE ($p = 0.656$), and work safety deviation ($p = 0.641$). Unsafe acts, defective PPE, and not using provided PPE is significant to wrist and hand injury with values of $p = 0.956$, $p = 0.724$, and $p = 0.594$, respectively. Lastly, for lower extremities injury, it is more likely caused by exposure to hazardous work environment ($p = 0.899$), work safety deviation of the worker ($p = 0.650$), and improper use of PPE ($p = 0.564$). Based on the results, the most frequent cause of injury is the not using the provided PPE, improper use of PPE, improper use of tool or equipment, defective PPE, unsafe working conditions, and work safety deviation. It shows that the manufacturing industry still lacks workers' awareness of occupational safety and health and the importance of PPEs. It also shows that the management must focus more on providing their workers a safe workplace and quality PPEs. With these results, the second null hypothesis of the study is rejected: there is no significant relationship between accidents and occupational injuries. Results of the Pearson Chi-Square Test for Factors of Accidents and its Resulting Injuries are shown in Table 3.

Table 3. Results of the Pearson Chi-Square Test for Factors of Accidents and its Resulting Injuries

| | HEAD | NECK | BACK | ARM & SHOULDER | WRIST AND HAND | TRUNK OR INTERNAL ORGAN | LOWER EXTREMITIES | WHOLE BODY OR MULTIPLE SITES EQUALLY INJURED |
|---------------------------------------|-------|------|-------|----------------|----------------|-------------------------|-------------------|--|
| UNSAFE ACT | 0.025 | - | 0.339 | 0.048 | 0.956 | - | 0.423 | - |
| NOT USING PROVIDED PPE | 0.056 | - | 0.584 | 0.257 | 0.594 | - | 0.549 | - |
| IMPROPER USE OF PPE | 0.086 | - | 0.830 | 0.656 | 0.330 | - | 0.564 | - |
| IMPROPER USE OF TOOL/EQUIPMENT | 0.706 | - | 0.706 | 0.434 | 0.061 | - | 0.311 | - |
| STANDARD WORK SAFETY DEVIATION | 0.038 | - | 0.004 | 0.641 | 0.150 | - | 0.650 | - |
| TAKING PROCESS SHORT CUT | - | - | - | - | - | - | - | - |
| EXPOSED TO HAZARDOUS WORK ENVIRONMENT | 0.839 | - | 0.193 | 0.018 | 0.204 | - | 0.899 | - |
| UNSAFE WORKING CONDITION | 0.804 | - | 0.215 | 0.521 | 0.191 | - | 0.054 | - |
| UNSAFE WORK OPERATION/PROCESS | 0.010 | - | 0.061 | 0.808 | 0.114 | - | 0.467 | - |
| DEFECTIVE TOOL/EQUIPMENT | - | - | - | - | - | - | - | - |
| DEFECTIVE PPE | 0.583 | - | 0.660 | 0.362 | 0.724 | - | 0.238 | - |

Results of the Pearson's Chi-Square Test show that the Occupational Safety and Health Programs applied by the manufacturing industry today have a significant relationship to occupational accidents. Results show the significance of OSH Programs to stepping on, striking against or struck by objects ($p = 0.630$), caught in or between objects ($p = 0.547$), falls of person ($p = 0.430$), and struck by falling object ($p = 0.338$). This shows that the OSH Programs being applied today by the manufacturing industries in Laguna are still not enough in preventing occupational accidents. Based on Pearson's Chi-Square Test result, the third null hypothesis is rejected that there is no significant relationship between applied safety programs and practices and occupational accidents. Results of the Pearson Chi-Square Test between Occupational Safety and Health Programs and Occupational Accidents are shown in Table 4.

Table 4. Results of the Pearson Chi-Square Test between Occupational Safety and Health Programs and Occupational Accidents

| | FALLS OF PERSON | STRUCK BY FALLING OBJECT | STEPPING ON, STRIKING AGAINST OR STRUCK BY OBJECTS | CAUGHT IN OR BETWEEN OBJECTS | OVER-EXERTION OR STRENUOUS MOVEMENT | EXPOSURE TO OR CONTACT WITH EXTREME TEMPERATURES | EXPOSURE TO OR CONTACT WITH ELECTRIC CURRENT OR RADIATION | EXPOSURE TO OR CONTACT WITH HARMFUL SUBSTANCES | CONTACT WITH SHARP OBJECT | FOREIGN BODY IN THE EYE |
|--------------|-----------------|--------------------------|--|------------------------------|-------------------------------------|--|---|--|---------------------------|-------------------------|
| OSH Programs | 0.430 | 0.338 | 0.630 | 0.547 | 0.092 | 0.027 | - | 0.001 | 0.005 | 0.001 |

In estimating the risk of resulting accidents based on the factors or causes of accidents, the occupational accidents were assigned as the dependent variables or the outcome. The causes of accidents as the independent variables or predictors. Results of the Multinomial Logistic Regression are shown in Table 5. For unsafe acts, the type of accident that will more likely happen is the contact with a sharp object followed by struck by a falling object. For not using provided PPE, the type of accident that may happen is caught in or caught between objects followed by struck by falling objects. In improper use of PPE, the estimated accident to happen is struck by a falling object and followed by stepping on, striking against, or struck by objects. For work safety deviation, caught in or between objects and struck by a falling object is more likely to happen. Exposure to a hazardous work environment may result in caught in or between objects accident. The unsafe working condition will more likely result in struck by falling object accident. For unsafe work operation or process, to be caught in or caught between object accidents may happen. For defective PPE, the estimated accident to happen is to be caught in or caught between objects.

To estimate the risk of the injuries resulted from the cases of occupational accidents, the resulting injury was assigned as the dependent variable and the occupational accident as the independent variables or the predictors. Results of the Multinomial Logistic Regression for this analysis are shown in Table 6.

Table 5. Multinomial Logistic Regression Results for Factors of Accidents and its Resulting Accidents

| | FALLS OF PERSON | STRUCK BY FALLING OBJECT | STEPPING ON, STRIKING AGAINST OR STRUCK BY OBJECTS | CAUGHT IN OR BETWEEN OBJECTS | OVER-EXERTION OR STRENUOUS MOVEMENT | EXPOSURE TO OR CONTACT WITH EXTREME TEMPERATURES | EXPOSURE TO OR CONTACT WITH ELECTRIC CURRENT | EXPOSURE TO OR CONTACT WITH HARMFUL SUBSTANCES OR RADIATION | CONTACT WITH SHARP OBJECT | FOREIGN BODY IN THE EYE |
|---------------------------------------|-----------------|--------------------------|--|------------------------------|-------------------------------------|--|--|---|---------------------------|-------------------------|
| UNSAFE ACT | 0.038 | 1.999 | 0.209 | -30.029 | -13.307 | -0.196 | 0.000 | 1.141 | 1.939 | -1.632 |
| NOT USING PROVIDED PPE | -15.739 | 16.435 | -15.526 | -43.778 | -12.132 | 1.312 | 0.000 | 1.619 | -14.610 | 2.256 |
| IMPROPER USE OF PPE | -15.809 | 29.457 | 17.137 | -16.038 | -0.257 | -14.369 | 0.000 | -16.064 | -15.251 | -13.584 |
| IMPROPER USE OF TOOL/EQUIPMENT | -15.122 | 0.215 | -0.208 | -13.486 | -14.580 | -14.016 | 0.000 | -14.296 | -12.786 | -14.618 |
| STANDARD WORK SAFETY DEVIATION | -15.589 | 33.717 | 1.331 | -29.336 | 2.089 | -14.359 | 0.000 | -14.706 | -13.277 | -14.970 |
| TAKING PROCESS SHORT CUT | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EXPOSED TO HAZARDOUS WORK ENVIRONMENT | -0.332 | 15.988 | 0.323 | -44.983 | -0.330 | 1.258 | 0.000 | -1.512 | -15.198 | 1.056 |
| UNSAFE WORKING CONDITION | 0.251 | 32.622 | 0.651 | -31.511 | 1.149 | -0.591 | 0.000 | -0.147 | 1.231 | -1.001 |
| UNSAFE WORK OPERATION/PROCESS | -15.736 | 18.120 | 0.254 | -30.365 | 2.851 | -14.714 | 0.000 | 0.573 | 3.224 | -15.369 |
| DEFECTIVE TOOL/EQUIPMENT | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| DEFECTIVE PPE | -15.714 | -15.431 | -1.631 | -43.772 | -14.148 | 1.496 | 0.000 | -13.955 | 3.170 | 1.671 |

Based on the results, the fall of a person's accident will most probably result in injury in the lower extremities of the body and followed by arm and shoulder injury. The least resulting injury from falling is the wrist and hand injury. Struck by a falling object accident is more likely will result in head injury. Stepping on, striking against, or struck by objects will result in arm and shoulder injury, wrist and hand injury, and injury in the body's lower extremities. Caught in or between objects accidents is more likely will result in wrist and hand injury. For overexertion or strenuous movement, back injury and injury in the body's lower extremities are expected to happen. Arm and shoulder injury, injury in the lower extremities of the body, and wrist and hand injury are estimated to happen when exposed to or in contact with extreme temperature. For exposure to or contact with harmful substances or radiation, wrist and hand injury and injury in the body's lower extremities are more likely to happen. For contact with a sharp object and foreign body in the eye, head injury is the estimated accident.

Table 6. Multinomial Logistic Regression Estimates for Occupational Accident and its Resulting Injury

| | HEAD | NECK | BACK | ARM & SHOULDER | WRIST AND HAND | TRUNK OR INTERNAL ORGAN | LOWER EXTREMITIES | WHOLE BODY OR MULTIPLE SITES EQUALLY INJURED |
|---|---------|-------|--------|----------------|----------------|-------------------------|-------------------|--|
| FALLS OF PERSON | -4.196 | 0.000 | 0.000 | 16.464 | 13.752 | 0.000 | 18.186 | 0.000 |
| STRUCK BY FALLING OBJECT | 19.928 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -18.052 | 0.000 |
| STEPPING ON, STRIKING AGAINST OR STRUCK BY OBJECTS | -3.416 | 0.000 | 0.000 | 15.506 | 16.020 | 0.000 | 15.322 | 0.000 |
| CAUGHT IN OR BETWEEN OBJECTS | -4.749 | 0.000 | 0.000 | 0.000 | 18.096 | 0.000 | 0.000 | 0.000 |
| OVER-EXERTION OR STRENUOUS MOVEMENT | -19.298 | 0.000 | 19.068 | 0.000 | 0.000 | 0.000 | 18.052 | 0.000 |
| EXPOSURE TO OR CONTACT WITH EXTREME TEMPERATURES | -4.431 | 0.000 | 0.000 | 16.089 | 15.986 | 0.000 | 16.666 | 0.000 |
| EXPOSURE TO OR CONTACT WITH ELECTRIC CURRENT | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| EXPOSURE TO OR CONTACT WITH HARMFUL SUBSTANCES OR RADIATION | -2.351 | 0.000 | 0.000 | 0.000 | 14.782 | 0.000 | 16.443 | 0.000 |
| CONTACT WITH SHARP OBJECT | -19.298 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| FOREIGN BODY IN THE EYE | 18.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Identified hazards are assessed in terms of the criticality of their harmful effect and ranked in order of their risk-bearing potential. They are often assessed by experienced personnel or by utilizing more formal techniques and through analytical expertise. The severity of consequences and the likelihood (frequency) of hazards are determined

as shown in tables 8 to 9. If the risk is considered acceptable, the operation continues without any intervention. If it is not acceptable, the risk mitigation process is engaged.

Once potential hazards have been identified, apply the risk assessment program to these hazards. This consists of systematically assessing the hazards against Risk Assessment Matrix and Risk Index Table as shown in Figure 4, which determines the appropriate response required to protect workers' health and safety on site.

When a hazard is identified, the risk associated with it is determined by looking at the likelihood (or frequency) of the hazard, the hazard's potential consequence, and the hazard's risk rate.

Table 7. Likelihood of the Hazard

| Likelihood | |
|----------------|--------------------------------------|
| Almost Certain | - Happens every time we operate |
| Likely | - Happens regularly (often) |
| Possible | - Has happened (occasionally) |
| Unlikely | - Happens irregularly (almost never) |
| Rare | - Improbable (never) |

Table 8. Consequences of the Hazard

| Consequence | |
|---------------|---------------------------------|
| Catastrophic | - Fatal |
| Major | - Permanent disability |
| Moderate | - Medical/hospital or lost time |
| Minor | - First aid or no lost time |
| Insignificant | - No injury |

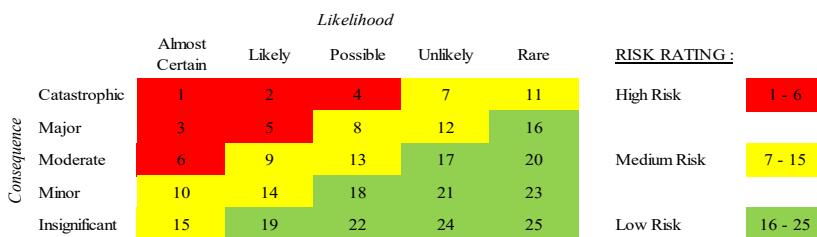


Figure 4. Risk Assessment Matrix

Once the hazard has been identified and risk-rated, check the developed risk index table shown in table 9 for the possible results of the hazard considered in controlling the hazard (e.g., elimination or reduction of the hazard). We must place the highest possible control once the hazard is identified, its resulting accident and resulting injury. In selecting a control for an identified hazard, always choose the highest measure of control possible shown in table 10.

Table 9. Risk Index Table

| RISK | RESULTING INJURY | CONTROL |
|---|--|--|
| FALLS OF PERSON | ARM & SHOULDER, AND LOWER EXTREMITIES INJURY | PROVIDE PROTECTION (PPE) FOR ARM, SHOULDER AND LOWER EXTREMITIES |
| STRUCK BY FALLING OBJECT | HEAD INJURY | PROVIDE PROTECTION (PPE) FOR HEAD |
| STEPPING ON, STRIKING AGAINST OR STRUCK BY OBJECTS | ARM & SHOULDER INJURY, AND WRIST AND HAND INJURY | PROVIDE PROTECTION (PPE) FOR ARM, SHOULDER, WRIST, AND HAND |
| CAUGHT IN OR BETWEEN OBJECTS | WRIST & HAND INJURY | PROVIDE PROTECTION (PPE) FOR WRIST AND HAND |
| OVER-EXERTION OR STRENUOUS MOVEMENT | BACK, AND LOWER EXTREMITIES INJURY | PROVIDE PROTECTION (PPE) FOR WRIST AND HAND |
| EXPOSURE TO OR CONTACT WITH EXTREME TEMPERATURES | ARM & SHOULDER INJURY | PROVIDE PROTECTION (PPE) FOR ARM & SHOULDER |
| EXPOSURE TO OR CONTACT WITH HARMFUL SUBSTANCES OR RADIATION | WRIST & HAND INJURY | PROVIDE PROTECTION (PPE) FOR WRIST AND HAND |
| CONTACT WITH SHARP OBJECT | HEAD INJURY | PROVIDE PROTECTION (PPE) FOR HEAD |
| FOREIGN BODY IN THE EYE | EYE INJURY | PROVIDE PROTECTION (PPE) FOR EYES |

Table 10. Hierarchy of Hazard Control

| | | |
|---------|----------------|---|
| Highest | Elimination | - Is it possible to eliminate the hazard altogether? |
| ↓ | Substitution | - Is it possible to replace the substance or, equipment with something less hazardous? |
| | Isolation | - Is it possible to stop persons from interacting with the hazard? |
| | Engineering | - Where people have to interact with a hazard, is it possible to engineer a less hazardous solution |
| | Administrative | - Is it possible to lessen the exposure of people through changing the way the job is done? |
| Lowest | PPE | - Is PPE appropriate to the type, level of hazard and has it been selected correctly? - Last resort |

4. Conclusion

Different agencies promote numerous training, seminars, programs, and practices in the Philippines to prevent occupational accidents. However, with these existing programs and practices to prevent occupational accidents, cases of occupational accidents and injuries in the Philippines are still increasing. Also, despite the safety strategies in the workplaces, occupational accidents and incidents have been increasing.

This study identified the significant factors or causes of accidents affecting the occupational accidents in the Philippine heavy manufacturing industry through the statistical analysis. The factors that significantly contribute are exposure to hazardous work environments followed by unsafe working conditions and unsafe acts like not using the provided PPEs. This result shows that despite the existing safety programs and practices being applied today, the risks of occupational accidents in the heavy manufacturing industry are high. The safety programs and practices being implemented are not enough to prevent occupational accidents in the Philippine manufacturing industry. In line with this, the author of the study finds that performing management of risks of occupational accidents is a great help in reducing occupational accidents. Risk management and safety management are both critical in preventing occupational accidents.

Occupational accident in the Philippine manufacturing industry was in level which still can be prevented. Therefore, most common occupational accidents and factors should be prevented with the cooperation of Occupational Safety and Health programs and Risk Management. To reduce occupational accidents in the Philippine heavy manufacturing industries, integration of Risk Management strategies in the planning stage of the Occupational Safety and Health Programs where hazards and risks of accidents are assessed will significantly help. Risk Management is to continually allow us to identify and assess work hazards, implement controls to remove or reduce the risk to the lowest possible level and review these hazards to ensure they are maintained at the lowest reasonable risk. The risk management process will consistently identify hazards by applying the process to all of the activities. Risk assessments should be undertaken if one of the following events occurs:

1. Before setting up and using any new premises as a place of work.
2. When planning/designing work processes.
3. Before installation, erection, commissioning, or alteration of the plant.
4. Whenever changes are made to the workplace and the system or work process
5. Before hazardous substances are introduced into a place of work or process.
6. When new or additional health and safety information relevant to our business becomes available.

5. Recommendation

Occupational safety and health programs, training, and safety practices applied by the Philippines' heavy manufacturing industries nowadays are identified in this study. Accident prevention begins with a clear understanding of factors that play vital roles in their causation; the study identified the significant factors of accidents affecting occupational accidents and the association of the factors of accidents with the resulting accidents and injuries. Estimated risks of the factors of accidents, their resulting accidents, and injuries were also identified in this study. Further study can be conducted to determine the causes or factors contributing to the identified significant occupational accidents and their resulting accident and injuries.

The study focused on the cases of non-fatal occupational accidents gathered from the heavy manufacturing industries in the Philippines. Future researchers may perform a study that will cover occupational accidents from the small and medium manufacturing industries, including fatal accidents and near-miss accidents in the study.

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Bibliographies

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