**BINDURA UNIVERSITY OF SCIENCE EDUCATION**

**FACULTY OF COMMERCE**

**DEPARTMENT OF ECONOMICS**



**An analysis of effects of material handling on ergonomics in Bindura manufacturing firms**

**2022**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE**

**REQUIREMENTS OF THE BACHELOR OF SCIENCE (HONOURS)**

**DEGREE IN PURCHASING AND SUPPLY OF BINDURA UNIVERSITY OF**

**SCIENCE EDUCATION. FACULTY OF COMMERCE**

**JUNE 2022**

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# RELEASE FORM: An analysis of effects of material handling on ergonomics in Bindura manufacturing firms

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**DISSERTATION TITLE**:

**DEGREE TITLE*:*** Bachelor of Science Honors Degree in Purchasing and Supply

# YEAR DEGREE GRANTED: 2022

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**DEDICATION**

This dissertation is dedicated to my sister Eresnency and my parents. They motivativated me ,they providing a basic need of my life

# ABSTRACT

# The study's goal is to analyze the effects of material handling systems on ergonomics in Bindura processing firms. A growing number of coincidences are occurring as a result of material handling system abuse. Because of poor material handling systems, there have an increase in job related injuries in Zimbabwe's processing industries. The rate of reported injuries is rapidly increasing, and the cause is the use of manual material handling systems that rely on ergonomic material handling systems. As a result, the learning seeks to analyze whether firms that use manual handling are other vulnerable while other factors remain endless.

# The study makes use of primary information obtained from companies for processing firms in Bindura. Medical injuries are the dependent variable, and the independent variables are average age, average temperature, working hours, safety trainings, presence hazards, protective clothing, and material handling system. The estimation model's results show a negative relationship among material handling systems and medical injuries. As a result, in order to reduce accidents, processing firms should prioritize mechanical handling systems over manual handling systems. As a result, we commend that industrial and health safety continue to contrivance policies such as safety trainings, the use of safety clothing, reducing of working hours per worker, temperatures, and the recruitment of young and active workers.

# 

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# CHAPTER I

## Introduction

Internationally, the performance of enterprises depends heavily on material handling in every field. Although material handling makes up a higher share of the overall manufacturing expenses the value of the finished product is not increased by it. Due to the cost of accidental injuries during material handling, before, during, and after processing, the cost of manufacturing finished product can increase if employee safety and health are not properly managed. I have. The focus of this chapter is to explore the history of research, problem explanations, and goals. It also looks at the reason for or purpose of the study, the research methodology, and the scope of the analysis

## 1.2 Background of Study

Storage and handling are essential for all industrial activities, but they are costly for businesses and account for 12 to 70 percent of total production costs. However, with efficient design and implementation, material handling can reduce production costs by 15 to 30 percent, Sujano and Lashkari (2006). Manufacturing workers who use automated and mechanized material handling systems are less injured than manufacturing workers who primarily use manual processing systems. There is evidence that the number of injuries is declining in industrial facilities where material handling is primarily mechanized and automated.

Toshiki and Okubo (2011) state that this is due to the introduction of accident prevention measures and automation work. While the prevalence of accidents and injuries is declining in developed countries, the prevalence of injuries tends to increase in Asian and African countries where material handling systems are often manual (Sunday time). 09/06/22). Considering the reduction of injuries caused by the mechanization of the material handling system, Cummings (2009) proposed replacing the manual handling system with a mechanical one to create a safer workplace. For example, a common type of musculoskeletal (MD) injury is associated with manual material handling, currently affecting 1 million people in the UK and costing £ 5.7 billion (MHIAwww). mhia.org/et/mhetax.htm). Manual handling during structuring is an enormous cost factor, but it lessens costs in the long run. However, automatic handling of the manual handling is less than manual handling, but it does lead to new harms.

In Zimbabwe, manufacturing company injury-related costs Account for an average of 40% of the Ministry of Labor and Social Affairs' total production costs. Zimbabwe (2012) and this negatively affected the profitability of companies. Common categories of material handling injuries in these businesses include health, first aid, time loss, and exhaustion injuries. These kinds of injuries are primarily caused by health and safety training, employed hours, material handling systems, protecting equipment, average temperature, normal aging, type of work (industry), and lack of sufficient space. There are also other features such as improper lifting, lifting heavy loads, ignoring improper grip, proper or hand spacing (Das2005). For all industries where materials move, managing material flow is one of the key contributors to organizational performance. In the processing industry, materials are handled in different ways before, after, and during storage. Therefore, material handling is an integral part of the manufacturing process and is unavoidable. Material handling is not a direct manufacturing process. Therefore, it does not add value to the final product, but at the cost of Tompkins et al (1996). To minimize service and accidents (Stevenson2001).

However, incorrect material handling has increased the amount of accidents and accident-related expenditures in the majority of manufacturing businesses. While storage and handling are necessary for each industrial process, they are expensive for businesses because they account for between 12 and 70 percent of the overall cost of production Tompkins et al (1996). Material handling can, however, save manufacturing costs by 15% to 30% when it is effectively conceived and applied. Lashkari and Sujano (2006). Therefore, it is crucial that businesses create effective handling mechanisms. The type of material handling system and the frequency of injuries have a strong relationship. Workers in the processing industries who use automated and mechanized material handling systems are less likely to be injured than those who use primarily manual handling systems. There is evidence of a decrease in the number of injuries in industrialized companies where material handling is mainly mechanized and automated; the occurrence of workers killed in work accidents in Japan (including fatal cases) fell from 4.77 per one million employed hours in 1975 to 1.88 in 1995; and there has been no variation in the incidence of accidents in America and Europe for the past 40 years (Okubo and Toshiteru 2011).

Okubo and Toshiki (2011) believe that this is due to the existence of accident prevention measures and the introduction of automation work. The prevalence of accidents and injuries is declining in developed countries, but injuries are rising in Asian and African countries where material handling systems are often manual (Sunday time 09/06/22). According to Cummings (2009), emerging market manufacturers are technically behind and more handling is done manually rather than mechanically, resulting in more frequent damage and cost to the enterprise. Considering the reduction in damages caused by the systematization of material handling systems, Cummings (2009) proposed replacing the manual handling system with a mechanical one to create a safer workplace. For example, a common type of damage, musculoskeletal disorder (MD), is associated with manual material handling and currently affects 1 million people in the UK and costs £ 5.7 billion. (MHIA www.mhia.org/et/mhetax .htm). Manual work has a high initial cost, but it can save you money in the long run. However, mechanical handling of materials is less serious than manual handling, but it does cause new types of injury.

# In Zimbabwe, manufacturing company injury-related costs average 40% of the Ministry of Labor and Social Affairs' total production costs. Zimbabwe (2012) and this negatively impacted the profitability of these companies. Common types of material handling injuries in these industries include medical, first aid, time loss, and fatigue injuries. These types of injuries are mainly caused by health and safety training, working hours, material handling systems, protective equipment, average temperature, average aging, type of work (industry), and lack of adequate space, There are also other factors such as improper lifting, carrying heavy loads, ignoring incorrect grips, proper or hand spacing (Das2005).

# Table 1.1 below shows estimated statistics for injuries during material handling process in the manufacturing sector in Zimbabwe.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| COMPANY NAME |  | YEAR |  |  |
| 2015 | 2016 | 2017 | 2018 |
| FEM engineering | 10 | 20 | 17 | 30 |
| superfert | 7 | 16 | 13 | 17 |
| Sine winders | 14 | 26 | 13 | 28 |
| Super sausage suppliers | 27 | 30 | 29 | 35 |
| Kingsley board mines | 17 | 19 | 23 | 26 |
| chizkaroni | 19 | 21 | 24 | 25 |
| Bardwell enterprises | 16 | 18 | 21 | 23 |
| Oldtech trading | 9 | 4 | 7 | 10 |

**Table 1.1 shows results that were extracted from primary data however the trend shows that injuries are increasing.**

In accumulation to the occurrence of accidents related to the nature of the material handling system, the material handling industry has measures to promote the health and safety of workers involved in material handling. Occupational safety of workers was promoted by the International Labor Organization (ILO) Convention No. 161 adopted in 1985, Okubo and Toshita (2011). The Convention summaries some significant professional values that nations should adopt. Conventions generally smear together to develop and emerging countries, but a set of standards is implemented and applied taking into account the programs and experience of a particular country. Zimbabwe has signed a treaty and the simple framework of the workplace health scheme is set out in that one law. Consequently, in Zimbabwe, the industry has adopted guidelines to ensure the safety of manufacturing workers. By adopting health and safety measures, all industries are trying to achieve. Compact costs associated with these damages through invention interruptions, medical expenses, and / or worker compensation. As measure of labor policy, education and training are an integral part of manufacturing health policy, allowing employees to recognize potential risks and remove or minimize the occur of injuries. That (2005). In spite of these health and care measures in the country's processing industry, the occurrence of damages remains high

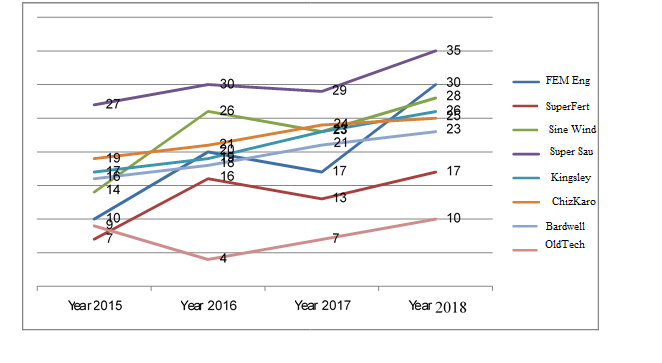
**Figure 1.1 shows increase of injures from 2015 to 2018.**

Figure 1.1 shows the increasing movement of accidents observed in the manufacturing industry from 2015 to 2018. This is due to an inadequate material handling system. Lack of protection training; Obtained protecting wear and long-term figures from Table 1.1.

## 1.2 Statement of the problem

# The number of occupational accidents in Zimbabwe's manufacturing industry has increased from the industry average of 4.3 to over 6.5 NSSA per year (2014). In general, excessive workplace accidents result from ignoring the principles of ergonomics material handling in Mital (1983). The works also shows that manual physical handling schemes expose workers to greater professional risk, Lingard and Rowlinson (1994). Injury reporting rates are rising rapidly, and responsibility lies with the reliance of manual physical handling systems on ergonomic material management systems. Therefore, this study seeks to determine if a manual processing system exposes workers to greater job-related risk, while other belongings remain continuous. Therefore, this will inform policies that advance professional safety.

# **1.3 Research Objectives** overall purpose is to analyze the impact of material handling systems on ergonomics in the Bindura processing industry.

# 1.4 Specific objectives:

1. To assess how employee safety in manufacturing businesses is affected by workshops on health and safety.

2. To determine whether employee safety in manufacturing industry is correlated with average age.

3 Determining the impact of working hours on occupational safety in the manufacturing industry.

4. Determining the effect of average temperature on the safety of manufacturing workers

Industrial sector.

## Research Questions

1. What is the relationship among health and protection exercise workshops in the

Manufacturing industry and the safety of Employees?

1. What is the relationship between the average age of the industry and ergonomics?
2. How does average temperature affect worker safety in manufacturing industry?
3. What issues plays an important role in determination of materials handling system employee safety in manufacturing industries?

## Significance of the study

This study is theoretically and empirically related to the works for understanding material handling systems for the health and safety of Zimbabwe manufacturing workers. To add on, to provide that information to help the state developing policies and labor laws to protect the health and protective of workers, the government has internal issues that affect the safety of manufacturing workers. Beyond the scope of, and therefore the manufacturing industry. In addition, this study informs the manufacturing sector's policies regarding the health and security of material handling workers and contributes to the overall decrease of manufacturing damages.

**1.7 Delimitations/Scope of the study**   
 Research boundaries should be easy to manage and within reach. The survey focuses on 28 selected companies. Focusing on these 28 different companies, you can compare different models. This study aims to determine the impact of material handling systems on employee safety. Multiple regression analysis is used to show effects of safety training, age, temperature, protecting clothes and dangers, and material handling systems affect employee security in validated coincidences.

## 1.8 Assumptions

# 1. Management accepts research at the company as an academic tool that provides feedback on the best ways to provide employees with a healthy and safe environment.

# 2. Respondents' information is accurate, complete and relevant and reliable.

# 3. Data from the companies in Zimbabwe database on the percentage of companies in the manufacturing subsector used on behalf of them shows the structure of the residents.

## 1.9 Limitations

1. Defendants can answer honestly for fear of harassment by their employer. The approach first comes with administrators and gets the approval previously flowing the general staff.

2. Huge population and sample size population was huge enough for researchers to obtain appropriate information about its composition. However, researchers used the companies in Zimbabwe industry information as a substitution to see the share of companies in each subsector among firms across the sector

## 1.10 Definition of key terms

# The American Material Handling System defines a material handling system as "the movement, storage, management and protection of materials, goods and products in the manufacturing, distribution, consumption and disposal processes". (Mhia.org/learning/glossary). Professional Safety and Health, It is primarily to promote the maximum physical, emotional and social health of workers. It emphases on protecting workers in the workplace from health hazards and factors (with the International Labor Organization). World Health Organization Occupational Health Committee Revised 1950 and 1995)

## 1.11 Organization of the study

# This research is structured as following: Chapter 2 provides an overview of the theoretic and empiric literature. Chapter 3 gives an overview of the analytical methods used in the research. Chapter 4 presents and interpreting the findings. Chapter 5 summarize the research and be responsible for references that are consistent with the discoveries made and proposals for forthcoming research.

## 1.12 Chapter Summary

This chapter providing a brief outline to the entire study. Next, he explained the background of the research, the problem of remarks, and the legitimacy of the research. In this chapter, the prerequisites for the survey, definitions of important terms, the location of the survey, and

Research limits

# CHAPTER II

# LITERATURE REVIEW

## 2.0 Introduction

This chapter, researchers focus on literature reviews, Material handling system for employee safety. This is very important because it gives researchers broader visions into the issue of the importance of physical handling to their employees. Helps to reduce injury at work. In this chapter, researchers focus on theoretic frameworks and empiric evidence, highlighting research goals and answering research questions. Review the literature on the impact of material handling systems on worker’s safety presentation, the impact of safety training on worker’s safety, the connection among minimum age and accidents, and the relationship between temperature and accidents.

## 2.1 Theoretical Framework

For the purposes of this study, we discuss three material handling theories / approaches. These include a system approach to physical handling, a multipurpose classical of operation, assignment and material handling equipment and selection, and an ergonomic approach. These theories / approaches help explain the relationship among physical handling and employee wellbeing and safety.

## 2.2 Ergonomic approach

An ergonomic approach to physical material handling tasks defines a man tasking atmosphere system. A usually accepted means of reducing related damages is to design tasks so that the difficulties of the duties are less than the ability of the people to perform those tasks. Duty design depends in part on the availability of similar data on task requirements and staff capabilities. Proper data generation depends in part on the ability to identify the relevant manual material handling capability parameters.

Force the person to fit into the work of OSHA (2002). This approach focuses on the work environment such as workstations, controls, displays, safety devices, tools, lighting design and function to meet the physical needs of employees and ensure their health and well-being. This approach also requires restructuring or changing the state of the workplace to facilitate work and reduce stressors that cause musculoskeletal disorders (MSDs). In the field of material handling and storage, ergonomic principles may require management such as reducing the size and weight of items to be lifted, installing mechanical lifting aids, pallets and racks: For example, changing the height of. There is no approach that completely eliminates back injuries caused by lifting materials, but this approach allows the company to implement some effective ergonomic programs and train employees with proper lifting techniques. It claims to be able to prevent injuries. This new theory seeks to incorporate the science of adaptation to work or working conditions in order to adapt workers to manual material handling. Occupational Safety and Health Committee Manual (2009). Most importantly, certain steps evaluate and enhance existing manual material handling tasks. Ergonomic risk factors such as B. This assessment more considers awkward postures and repetitive movements.

## 2.3 A system Approach to Materials Handling

Material handling can be seen as a subsystem of a larger system within the enterprise, and other operations contribute to the results of product Mital (1983). A system is a complex entity consisting of many other parts that work together to achieve a goal. In this case, material handling is a subsystem of the manufacturing production system. Material handling itself can also be considered as a system whose subsystem looks like this: The design or method used, the type of material handling equipment used, the various operations required for the equipment used, such as packaging, transportation and storage, and the mode of transportation by raw material suppliers and traders. A common goal aimed at different subsystems is the most cost-effective material handling system solution for Mital (1983) in the industry. However in practice, the system concept of materials handling means the different types of materials handling needed at different parts of an industry and associated suppliers` and customers` end are to be considered in totality. Whilst this model focuses on the selection of a material handling system, most of the studies have focused on material handling equipment optimization, rather than the entire material handling system. Sujono and Lash Kari (2006) proposed a multi objective model for selecting material handling devices (MHD) and allocating material handling transactions to them in flexible manufacturing system (FMS) design. They propose a model that integrates operation allocation (OA) and MHD selection problem. Their work is an extension of Paulo et al. (2002) and Lashkari et al. (2004) Research. The main difference from the previous model is the introduction of new variables and the introduction of new variables that link the choice of machine to perform a manufacturing operation to the material handling requirements of that operation. In addition, it includes all costs associated with material handling operations and sub-operations, as well as the complete reconstruction of constraints that control how material handling equipment is selected and loaded into objective functions. Parameters and decision variables are the key to this model. Therefore, this model analyzes each material handling option and ultimately leads to the selection of the material handling equipment with the lowest material handling cost.

## 2.4 Empirical evidence

Empirical evidence is relevant to previous studies as well as current studies. Show how these studies relate to or differ from current studies and identify knowledge gaps.

According to most OSH studies, high injury rates are mainly due to shortage or non-existing systems. Consequently, applying effectively management can lead to safer building schemes and reduction of the occurrence of injuries and occupational illnesses (Davis and Tomasin1999).

Others According to previous research, an effective way to measure the safety of an organization's employees is to use a combination of quantitative and qualitative safety measures. Jaselskis (1996). To ensure the safety of construction workers, it is necessary to analyze statistical data and various factors. Quantitative measurements include: Downtime and severity levels, and maximum temperatures such as those used for safety training, protective equipment, and corporate accident calculations. The qualitative assessment consists of hazards and poor performance project performance determined by the OHS evaluator. Holmes (1999) investigated a sample of Australian companies and found that small construction companies may not be able to manage H & S risk as effectively as large companies.

According to data from the Australian Bureau of Statistics, the majority of Australian contractors are SMEs, with 97% of general contractors hiring less than 20 and 85% hiring less than 5 VWAs (1998). Holmes commented that SMEs do not feel the need to focus on OHS in their management systems. Instead, they often believe that it is the employee's responsibility to manage risk. This was in contrast to the attitude of large companies that showed that H & S needed to be integrated into the overall management system for all projects within the company. A similar study was conducted by Wilson (2000) and found that safety training depends on the size of the company. He suggested that there was a negative link between safety training and injury. This means that the number of safety meetings, workshops and seminars will reduce injuries. There is also the question of whether SMEs can benefit from higher standards of health and safety practices due to the cost of implementation. Other research by Lingard and Rowlinson (1994) showed that firms having more resources and experience tend to deal with health and safety issues more effectively.

Therefore in a relative sense, larger companies tend to be more committed to safety. It is also possible that OHS regulations which require formal documentation procedures do not fit the traditions, competence and needs of very small companies (Hale and Baram, 1998). Mayhew (1997) points out that light industry often has a high incidence of serious injuries and deaths. He observes that many of them are related to manual processing systems. Analyzing US census data, he found that self-employed people were more than twice as likely to be killed at work. Light industry is generally much smaller than heavy industry and is more likely to be injured due to lack of proper equipment and effective management. Nishgaki (1994) conducted a survey of 35 processing injuries in the United States between 1981 and 1985. In interviews with processing site executives and employees, originate that danger was the major cause of the recurrence of occupational accidents.

Hazard is defined as the situation in which it occurred and is called an incident. Dangers and opportunities interact to create risk. His study suggested that the main causes of OHS failure were inadequate safety education, inadequate guidance, inadequate housekeeping, and intentional violations. According to a survey by Nishgaki (1994), the attitudes of employers and workers play a major role in on-site safety. The results of Nishgaki (1994) show that there is no correlation between hazards and incidents, but managerial involvement accounts for the majority of "hazard" problems. Jaselskis (1996) commented that managers need to be more actively involved in the safety program and, if possible, supervisors should also play an important role in determining the safety performance of the project. ..

According to a survey by Dejoy (1985), safety records reflect senior management's perception of the causes of safety performance. Safety programs are most effective when it involves two-way communication between workers and managers.

However, senior managers often have little direct experience in the field. Therefore, it is difficult for them to meet the needs of workers. Geetha M. Waehrer and TedR. Miller (2005) uses a cross-sectional model to analyze the relationship between occupational accident rates in the United States and occupational safety training, occupational safety practices, and health-conscious employee benefits. He used a two-step regression model to gain rare insights into the impact of training, reward packages, and workplace practices on work-related injury rates. Findings suggest that safety training not only increases reports of injuries and illnesses, but also has a real safety impact in the event of a non-working day accident, especially in smaller organizations. Excessive exercise accidents were resistant to safety training, but formal safety training programs reduced exposure events to toxic substances in manufacturing facilities. It is important to wear protective clothing and use safety equipment to reduce the effects of accidents at construction sites.

However, both Harper (1998) and Holmes (1999) suggested that management suggests that management's commitment is needed to force the wearing of safety devices. Safety devices are often provided, but employees hesitate to wear or ignore them, especially in the light industry. The findings of Harper (1998) show that there is a positive relationship and the coefficients around 0.031455 are weak.

Therefore, providing safety clothing alone does not improve the safety of construction sites, and a corporate culture that promotes its use is also necessary. Workers are usually more aware of the dangers of the workplace than their employers and should be included in the safety program. When they are involved, they can more easily get involved in security programs. Regular field meetings have been shown to help find occupational health and safety issues and solutions and improve accident prevention. Hinze (1988).

Safety committees are often made up of employer, employee, and subcontractor representatives. This facilitates interaction between the parties, improves trust and communication, and leverages the expertise of each party. Safety committees have proven effective in uncovering dangerous practices and problems. Nishgaki (1994) suggested that regular on-site inspections by safety patrols promote workplace safety. Similarly, Hinze (1988) found that the more occupational health and safety managers visit the site, the more secure the site. Pre-construction site reviews help establish areas of concern and later ``tool box`` meetings give the chance for the employee to be involved Harper (1998).

A safety committee helps to promote accident prevention and safe working habits by the employees. Nishgaki (1994) found management commitment should be backed up with means such as hardware (safety equipment) and the continued enforcement by software (standard work procedures, safety regulations). Lingard and Rowlinson (1994), found more sophisticated scheduling methods improve OHS standards, but often they can only be carried out with larger companies because of their expertise and resources. Cost has a role in reducing accidents and improving employee safety. According to Hinze (1988), security is an important issue, but many do not consider it important to the success of a project. A study of injuries in 18 construction projects by Tang (1997) suggested that the higher the investment in safety, the better the safety performance. However, Holmes (1999) points out that time and financial constraints seem to be affecting the route.

Individuals are aware of the risks and need to identify them before construction. Hinze (1988) found that projects where this was the case tended to have higher injury rates. Competitive offer. Contractors typically reduce their work just to win bids, which often means that health and safety are compromised. Employers often think that implementing a security system

Costs more, so security can be the first item to face cost savings. In addition, managers tend to focus on "costly" production, and security isn't useful for production, causing problems when a project exceeds the financial plan. Davies and Tomasin (1999) propose that policy statements deal out by employers need to be clearly understood by employees. The policy statement ought to state how the company is organized in relation to management's health and safety responsibilities and further outline the manager's obligations to provide safety information, training and advice to employees. It is very important to improve the ability of workers and managers to take anticipatory behavior. Jaselskis (1996) recommend that companies set OHS benchmarks. His methodology was established on gathering information about the company's safety policies for determining age, maximum temperature, leave accident rate, and occupational health and safety performance. Another study by Garza (1988) compared safety standards using four pointers: rate of change in experience, rate of reportable incidents, rate of lost work accidents, and indicators of worker's accident

Injuries related to material handling have amplified the cost of material handling. This is not desirable for the processing sector. The extraordinary rates of injuries and claims internationally are acknowledged in the literature (Minnesota Department of Labor 2006; Silue 2006; Zaidman 2003, Webster and Snook 1994. David 1985). These scientists have demonstrated the existence of a high prevalence of accidents due to manual material handling. The Occupational Safety and Health Commission Handbook states that workers' claims for back injuries remain high in the United States. Meanwhile, in the United States, the Bureau of Labor Statistics has found that about 24% of Texas worker compensation claims account for back injuries. The direct and indirect costs related with these violations are significant and account for nearly 40% of the total cost of claiming compensation (WA mining manual processing review).

In South Africa, occupational accidents account for more than 3.5 percentage of gross domestic product (GDP). In totaling to property damage, there are costs of production time, loss of skills, hiring and retraining of alternative workers (South Africa: National Occupational Safety and Health Policy: 2003). In Zimbabwe, the average labor cost in the processing industry is 40 percent. These statistics show that, is essential to develop and apply strategies meant at decreasing the degree and severity of damages in the industrial sector. This is also closely linked to the way material handling systems are designed. These numbers are as high as they look, but with more losses. These include loss of worker income, loss of employer productivity, and the pain, distress, and long-term disability associated with these injuries are all part of the cost (Occupational Health and Safety Commission). Manual). A manual processing analysis of the WA Mining Industry Project found that about two-thirds of manual injuries were serious, with more than 14 working days. Percentage of whole days lost due to manual injury. It should also be noted that inexperienced employees and agents are more likely to have an accident due to their unfamiliarity with the work and need to take that skill into account.

# CHAPTER III

## Methodology

### **Introduction**

The purpose of this study is to analyze the effect of material handling systems on ergonomics in Bindura processing industry. The previous chapter dealt with theoretic and empiric evidence of material handling systems for worker safety in the manufacturing industry. This chapter describes the methodology used to carry out this study. Describes the procedure for conducting the survey. First, I will explain the research design used. The data source is clarified and the theoretic model, model conditions, approximation model, and variable validation are explained.

## 3.2 Research Design

This study used quantitative analysis with regression analysis to analyze the impact of material handling systems on promoting employee health and safety in the workplace. The sample size is selected. Measurable methods test and validate already established theories about how and why the phenomenon occurs. Research is relatively reduced because the results are independent of the researcher. However, the limitation of quantitative research is that it provides numerical explanations, fairly detailed explanations, and generally less detailed explanations of human cognition, thereby limiting the results.

## 3.3 Survey target population.

Researchers are trying to identify the impact of material handling systems on worker safety in bindura manufacturing industry. Therefore, the total population is made up of all bindura manufacturers. Researchers chose bindura because it is a small town and therefore has a higher risk of injury when handling materials (15% of Bindura manufacturing plants, according to CZI statistics). In contrast, Bulawayo's factories account for 35%). The population surveyed exceeds about 38, heavy industry exceeds 10, and light industry exceeds 29. Light industry is the activity of producing relatively high unit value items using a modest amount of partially processed material. For example, it is a complex industrial organization that employs skilled and skilled workers and produces large quantities of products such as SuperFert. The CZI list was used as a substitution to provide insights into the configuration of bindura manufacturers.

## 3.4 Sample size

The sample size comprises of 8 of the approximately 28 heavy and light industry companies. Researchers have used cluster sampling to ensure that key manufacturing departments are well represented. Using the CZI member database, we selected the companies to sample to ensure that the samples are balanced and representative of the population. Heavy industry goes far beyond light industry, with 75 percent of the samples being heavy industry 25% being light industry.

## 3.5 Sampling Procedures

# For the purposes of this study, it was not possible to collect data from all companies in the study because it would be expensive and wasting time to collect data from the entire residents. Therefore, extract samples to make sure the samples are not biased due to inter-company heterogeneity. Cluster sampling was chosen for sample selection because it is cheaper, faster, and easier to compare samples from the entire residents when using simple randomly sample. The residents is separated into two collections within the processing industry. Two batches have been recognized: heavy industry and light industry. Random samples were run on each cluster.

# A simple random sample was taken at each layer. Samples were randomly selected from the sample frames. After assigning a number to another frame, I generated a random. A simple random system was selected because it is simple and inexpensive, and researchers believe it can estimate the associated sampling error. Using simple sampling, we assumed that the population of social resources was relatively uniform with respect to the random variables of the study. Random sampling equalizes the likelihood that every element in the entire residents will be included in each hierarchy. However, sampling causes the sampling units to be unevenly distributed throughout the site.

# The questionnaire addressing the health and safety managers of each chosen firm to signify manufacturing levels, as it has more brief data on the organization's health and safety issues. The questionnaire to each respondent collects data about variables that can lead to injury. Surveys were usually used because the results can be quantified quickly and easily by the investigator or someone else.

## 3.6 Theoretical model

# Researchers are trying identifying the impact of material handling systems on worker safety at Harare manufacturers. To build the injury function enhanced by the material handling system used by the company, the study borrowed the 1960 Skyhook model to investigate the relationship between injury and worker safety in American manufacturing. Rice field. To ration the association between injury and worker safety, researchers needed to involve all variables that could affect worker safety in order to develop the next model. In this model, some variables are omitted, such as B. watery floor, not easy to detect, etc.

# The model can be specified as follows (3.1)

Injury = f (Xi)

I= f (WKH, AT, AA, S, L, Xn) Were:

I = injury

A = average age

S = safety

L = lighting

WKH = working hours

AT = average temperature

## 3.7 Model specification

To find the relationship between an injury and the material handling system

Apply regression analysis to describe and evaluate the connection between two or many variables that one usually depends on. In this regression model, the dependent variable (in this case, injury) is affected by working hours, available space, industry, average age, average temperature and material handling system, protective training, defensive equipment, and the presence of danger.

# I= f (WKH + AT + AA + ST+ PE+PH+MHS) (3.2)

Where: I = injury

MHS = material handling system

WRK = working hours per day

AT = average temperature

AA = average age

ST= safety training workshops

PE = protective equipment

PH =presence hazards

I is the dependent variable. This part is called the deterministic part (WKH + AT + AA + ST + PE + PH + MHs) and μ is called the stochastic part of the model. The random error term (μ) is included in the model to represent the variation of the dependent variable that is not explained by the independent variables used in the model. Capture other factors that affect injuries that are not included in the model.

Dummy variables are variables used to represent a qualitative effect on an economic model. The material handling system D1 takes a value of 0, which means that the material handling system is manual, and a value of 1 to reflect that it is mechanical. Protective clothing D2 has a value of 1 to indicate no protective clothing and a value of 0 to indicate that there is protective clothing. Industry D3 indicates that a value of 1 is a heavy business and a value of 0 is a simple business. These are dummy variables in the study.

The final model will then be specified as below:

# I= β0 + β1WKA+ β2 AT+ β3AA+ β4ST+β5D1+ β6D2+ β7D3+ et (3.3)

Where D1 = 1 (when material handling is manual)

D1 = 0 (otherwise)

D2 =1(no protective clothing)

D2 =0(otherwise)

D3 =1(light manufacturing)

D3 =0 (otherwise)

## 3.7 Justification of Variables

# Injury

Injuries were applied as a dependent variable since they are the best degree of worker safety when doing material handling at a manufacturer. Injuries are injuries, losses, or injuries caused or inflicted on a person. There are different injuries, including health injuries, chief aid injuries, period loss injuries, and weakness injuries.

In this study, researchers use medical injuries since they are disposed to injury. However, damages can be dignified by the number of hours worked per day, a minimum age, workshop training and material handling system, average temperature, safety clothing, and dangerous situations. Minimum age of worker.

The median age is a figure that represents a series of numbers and is a function of it. As workers grew older, they became less healthy, less productive, and less energy. Since injuries and average age are in a positive relationship, it is expected that injuries will increase with age. It is maintained by (European Agency for Safety and Health-http://osha.europa.eu 2005). Employee working hours. According to theory, as the average daily working hours of an employee increases, there is a positive relationship between the employee's working hours and the injured, and the employee may be working overtime, it is important to pay attention to the number of working hours. Beyond normal hours per day can affect employee concentration in the workplace and lead to serious coincidences and damages protective education.

Safety education works can be described as obtain skills through educating. Training improves the quality of material handling and improves injury mitigation, as many skills are acquired rather than inherited. (European Agency for Safety and Health – http: //osha. Europa 2005) when employees handle materials, they also need to be trained in the use of equipment and proper handling techniques. To notify employees about accidents or health hazards, especially regarding exact task. Then, there is a negatively link among train and injuries, and the more workers who participate in mental wellbeing and safety training and remind them of the firm code of conduct, the less injury is minimizing (Wilson2000).

**Minimum temperature**if the temperature is too high or the humidity is too high, the physical climate (temperature, humidity, ventilation) will affect the workers at the manufacturing site, making them tired faster and more liable to damage. Therefore, there is a positive connection among temperature and damage. The other side, when the temperature is low, the elasticity of muscles and joints reduces. This toughness also maximizes chance of injury. Hotness tires workers, sweat makes it more difficult to hold tools and requires stronger force. The cold weather can make employees' fingers numb and difficult to hold (European Agency for Safety and Health-http: //osha.europa.eu 2005). Regression analysis uses dummy variables to examine qualitative variables or nominal scales. In this study, researchers determine the impact of material handling systems on worker safety at Harare manufacturers. Dummy variables assume D1 = 1 (with manual material handling) and D1 = 0 (mechanical), D2 = (without protective device) and D2 = (other), D3 = light industry, D3 = (heavy industry) increase. The constants β0, β1, β2, β3 and β4 are the parameters of the econometric model. These describe the direction and strength of the relationship between the accident and the explanatory variables used to determine the collection in the model.

# Presence of Hazards

Hazard is a state that threatens life, health, property, and the environment to some extent. Various risks in the workplace also pose a risk to the mental wellbeing and safety of people in the workplace (mhia.org/learning/glossary). These contain biological factors, physical factors, adverse ergonomic conditions, allergens, a complex network of safety risks, and a wide range of psychosocial risk factors. Therefore, the workplace must be free from perceived dangers. In addition to the employee's right to report such hazards, managers must carry out regular inspections for the existence of such hazards. Risk assessment is a careful examination of what can be harmful to people in the workplace. You can then make a decision as to whether adequate precautions have been taken or if further action is needed to prevent harm (Nishgaki1994). The challenge is to eliminate, or at least reduce, the potential for accidents, injuries, and illnesses resulting from work activities and work. Error term.

This is a random variable that represents all parts of the data generation process that are not captured by the econometric model, and using the error term, the relationships between the variables are said to be stochastic. Stochastic relationships predict the price value of the variable being described.

## 3.8.1 Autocorrelation test

## The autocorrelation test is performed using the Durbin-Watson test static. This is:

## D = 2 (1-p) where p = Σ\_t\_t-1

## Σ\_t-12

## Where p is the correction factor.

## 3.9.2 Heteroscedasticity test

The purpose of this test is to see if there is a systematic relationship between the residual sum of squares and the explanatory variables. In the presence of autocorrelation, the OLS estimator is unbiased and consistent, but inefficient. For example, the estimated variance is not minimal. To detect the presence of heterogeneity, run White's test using a common F-statistic test to see if the regression is significant. If the fecal score is greater than 0, accept H0 with homoscedasticity.

## 3.9.3 Multicollinearity:

Perform a multicollinearity test of the missing data to observe one of the dependent or independent variables. It should be noted that multicollinearity reduces the accuracy of the estimator because it makes it difficult to separate the effect of one explanatory variable on the dependent variable from the other. The covariance matrix is ​​used for testing

Multicollinearity. The deciding criterion is to reject the null hypothesis by claiming that there is strong evidence of multicollinearity when the value of the coefficient variable is less than 0.8.

## 3.11 Sources of Data

Data from the researcher's primary material was used in this study because the secondary data was not available. Primary data was collected using researcher-created questionnaires and made available to respondents from each manufacturer (H & S managers of interviewed companies). Questionnaires are the most widely used method for collecting primary data (Waters, 1997). Data collection methods commonly used in quantitative research include telephone interviews, private surveys, and observations. This study benefited from a quantitative study because it could be used to query injury variables and better understand how material handling affects the safety of employees of the company. This meant the respondents' deep motives and emotions. Compared to collecting data using interviews, surveys can collect large amounts of information.

## 3.11 Ethical considerations

After obtaining approval from Bindura State University, researchers used the approval letter

Obtained the permission of a sole proprietorship and conducted the investigation. Participant

Identification and subsequent questionnaire distribution will follow. Participants were assigned a

Leaflet that fully explained the purpose and flow of the survey before responding to the questionnaire to ensure that informed consent was filled. Then I signed the consent form. Participants

Right to refuse participation will be respected. To ensure anonymity, the names of

Participants were not included in the survey. Researchers also maintained the confidentiality of participants by preventing the information collected from being shared or accessed by others.

## 3.12 Summary of Chapter

This chapter is intended to outline the steps to be followed when conducting a survey, while providing an assessment of material handling systems for the safety of workers at Harare manufacturers. is. This chapter described study design, data collection methods and procedures, theoretical models, model specifications, and their rationale. Finally, we have outlined ethical considerations. The results are shown in the next chapter.

# CHAPTER IV

# DATA PRESENTATION AND INTERPRETATION OF RESULTS

## 4.0 Introduction

This chapter presents and analyses the information collected from the manufacturing sector in Bindura through questionnaires, observations and annual reports. The researcher would see that it makes no sense to conclude that of material handling systems has a significant impact in promoting employee health and safety in the workplace without use of actual data to do some empirical tests. In this study regression analysis used in order to answer the research questions in chapter one and to realize if there is relationship between material handling and ergonomics. In this chapter, the main focus of presentation and analysis of data are Injury (I), Average Age (AA), Material Handling System (MHS), working hours per day (WKH), Average Time (AT), Safety Training Workshops (ST), Protective Equipment (PE) and Presence Hazards (PH) where the outcomes of empirical tests will show the bases of conclusion drawn. Econometric views (E-Views) software will be used for data analysis through Ordinary Least Squares (OLS).

## 4.1 Empirical analysis

Empirical analysis carried out to show the outcomes which indicates the degree on which Injury (I), Average Age (AA), Material Handling System (MHS), Working hours per day (WKH), Average Time (AT), Safety Training Workshops (ST), Protective Equipment (PE) and Presence Hazards (PH) determine workers` safety in the manufacturing sector of Bindura in Mash Central Province using time series data from January 2019 to June 2021. The main assumption is that, the time series variable are stationary, therefore it is difficult to carry out the Augmented Dickey Fuller Unit root test. All variables are then presented in log form for the reason to get rid of variability in statistics set.

## 4.2 Descriptive Statistics

Descriptive statistics be responsible for the suggestion that this model have no extreme values and the data set is open from the effect of outliers as shown by the table 1 below. Across all eight variables there are small standard deviations and range across and the small range indicates that observations are gathered around their means, intends that there is no extreme behaviour within variables. Kurtosis and Skewness are also measured confirming acceptable ranges of the used data.

Table 1: Descriptive statistics of all the used variables in the study

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **I** | **AT** | **AA** | **MHS** | **PE** | **PH** | **ST** | **WKH** |
| **Mean** | 11.46000 | 12.55000 | 15.23333 | 12.83000 | 14.02000 | 5.730000 | 4.500000 | 6.070000 |
| **Median** | 11.15000 | 12.80000 | 15.00000 | 12.90000 | 14.00000 | 5.750000 | 4.000000 | 6.000000 |
| **Maximum** | 13.10000 | 16.00000 | 18.00000 | 15.00000 | 18.00000 | 7.000000 | 7.000000 | 7.200000 |
| **Minimum** | 9.750000 | 10.00000 | 10.00000 | 11.00000 | 10.00000 | 4.500000 | 3.000000 | 5.000000 |
| **Std. Dev.** | 1.102380 | 1.951966 | 2.149632 | 1.186752 | 2.079854 | 0.797907 | 1.167077 | 0.653452 |
| **Skewness** | 0.144657 | 0.344836 | -0.614758 | 0.401847 | -0.280753 | 0.396193 | 0.264756 | 0.245394 |
| **Kurtosis** | 1.734756 | 1.903936 | 3.164697 | 2.475030 | 2.522864 | 1.933173 | 2.035731 | 2.008707 |
| **Jarque-Bera** | 2.105682 | 2.096253 | 1.923543 | 1.151895 | 0.678686 | 2.207495 | 1.512747 | 1.529419 |
| **Probability** | 0.348945 | 0.350594 | 0.382215 | 0.562172 | 0.712238 | 0.331626 | 0.469366 | 0.465469 |
| **Sum** | 343.8000 | 376.5000 | 457.0000 | 384.9000 | 420.6000 | 171.9000 | 135.0000 | 182.1000 |
| **Sum Sq. Dev.** | 35.24200 | 110.4950 | 134.0067 | 40.84300 | 125.4480 | 18.46300 | 39.50000 | 12.38300 |
| **Observations** | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |

The table 4.1 above give the synopsis of the descriptive statistics, which include minimum and maximum values and other measures of dispersion underlining the absence of outliers. The Injury, material handling system and safety training workshops variables have the averages 11.46, 12.83 and 4.5 respectively. AA and PE variables depicted negative skewness whilst the rest are positively skewed. Presence Hazards and Working hours per day has the smallest standard deviation of 0.797907and 0.653452 indicating the lowest variability and highest reliability amongst these variables in explaining the variations in the occurrence of accidents and incidents in the manufacturing sector in Bindura. In addition, PE has an average of 14.0200 which implies that the 14.02% of the recorded accidents in the manufacturing sector is attributed to inadequate provision of protective equipment at the work place.

## 4.3 The results of model diagnostic test

## 4.3.1 Autocorrelation

The test was done using the Durbin Watson statistics. The presence of autocorrelation can be identified when the value of Durbin Watson is greatly deviate from the rule of thumb 2. The Durbin Watson done against the null hypothesis that there is no autocorrelation in the model and the alternative hypothesis that there is autocorrelation in the model. The estimated results shows a value of 1.33 which is less than the rule of thumb 2 and the researcher become indecisive and resort to the LM Test.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | |  |  |  |  |  | |  |  |  |  |  | | F-statistic | 0.287815 | Prob. F(2,20) | | 0.6632 | | Obs\*R-squared | 0.974588 | Prob. Chi-Square(2) | | 0.431 |   *Table 4.2: Breusch-Godfrey Serial Correlation LM Test:* |  |

*[Source: primary data]*

The table 4.2 above shows the probability F value 0.6632 for the LM test, which is greater than 0.1 at 10% level of significance hence, the researcher failed to reject the null hypothesis and conclude that the model is free from autocorrelation

## 4.3.2 Multicollinearity

Multicollinearity is a situation were by independent variables are extremely interrelated. The table 4.3 below indicates the absence of multicollinearity in the estimated model since all the variable have values below the rule of thumb 0.8. This implies that the relationship among the explanatory variable is not strong, that is the influence of one variable to the other is easy to establish.

**Table 4.3: The correlation matrix**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **I** | **AT** | **AA** | **MHS** | **PE** | **PH** | **ST** | **WKH** |
| **I** | 1.000000 |  |  |  |  |  |  |  |
| **AT** | -0.128200 | 1.000000 |  |  |  |  |  |  |
| **AA** | 0.303398 | 0.365454 | 1.000000 |  |  |  |  |  |
| **MHS** | 0.187036 | 0.023594 | 0.148281 | 1.000000 |  |  |  |  |
| **PE** | 0.247763 | -0.273327 | 0.230300 | 0.122968 | 1.000000 |  |  |  |
| **PH** | 0.237609 | -0.022029 | -0.273617 | 0.060560 | 0.037651 | 1.000000 |  |  |
| **ST** | 0.435536 | -0.006811 | 0.108584 | 0.143156 | 0.112227 | -0.242545 | 1.000000 |  |
| **WKH** | 0.322352 | 0.107191 | 0.471575 | -0.011250 | 0.260774 | -0.029298 | 0.228339 | 1.000000 |

## 4.3.3 Heteroscedasticity Test

The researcher made the use of White Test in order to estimate the existence of the heteroscedasticity in the specified model. The null hypothesis being the error terms are heteroscedasticity as highlighted earlier in chapter three against the alternative hypothesis that the error terms are homoscedastic. The researcher can fail to accept the null hypothesis

When the p-value in relation to the f-test statistic is significant at 10% thus significant level less than 0.1.

**Table 4.4: Heteroscedasticity (White Test)**

|  |  |
| --- | --- |
| F-statistic 2.1953426 | Prob. F(21,8) 0.2118 |
| Obs\*R-squared 25.73352 | Prob. Chi-Square(21) 0.3215 |
| Scaled explained SS 22.25382 | Prob. Chi-Square(21) 0.4582 |

*[Source: E views 7.1 statistical package]*

The above table 4.4 shows the F-test p-value of 0.2118 from the white test and the figure is greater than 0.1 and insignificant at 10% level hence this implies that there is no enough evidence to reject the null hypothesis and conclude that the error terms are homoscedastic and valid.

## 4.4 Estimation of the Equation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |
|  |  |  |  |  |
|  |  |  |  |  |
| **C** | **3.471028** | **2.857070** | **1.214891** | **0.2373** |
| **D** | **0.620272** | **0.07223** | **2.785704** | **0.0273** |
| **AT** | **-0.170421** | **0.098541** | **-1.729439** | **0.0977** |
| **AA** | **0.243747** | **0.103599** | **2.352804** | **0.0280** |
| **MHS** | **0.026996** | **0.143407** | **0.188246** | **0.8524** |
| **PE** | **-0.016688** | **0.090055** | **-0.185307** | **0.8547** |
| **PH** | **0.663247** | **0.227115** | **2.920308** | **0.0079** |
| **ST** | **0.461099** | **0.151131** | **3.050978** | **0.0059** |
| **WKH** | **0.070334** | **0.299786** | **0.234615** | **0.8167** |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.840645 | Durbin-Watson stat | | 1.237014 |
| Adjusted R-squared | 0.808123 |  | |  |
| F-statistic | 3.413574 |  | |  |
| Prob(F-statistic) | 0.012680 |  | |  |

**Table 4.5: Estimation of Equation**

The R squared should be at least 0.70 that is 70% for a model to be considered fit for the purpose. The model under the study is considered being fit since it recorded a positive 0.840645 R squared. This simply means 84% of the differences in the occurrence of ergonomics is being explained by the explanatory variables in the models that is Average Age (AA), Material Handling System (MHS), Working hours per day (WKH), Average Time (AT), Safety Training Workshops (ST), Protective Equipment (PE) and Presence Hazards (PH). After accounting for the lost degrees of freedom, a strong correlation was identified through the adjusted R squared value of 0.808123, which is considered lower than the actual R squared. The probability f-statistics of 0.012680 provide sufficient evidence that the model is correctly specified at 1% level of significance. In addition, this has the notation that explanatory variables are appropriate in the clarification of the dependent variable.

## 4.5 Interpretation of Results

### **4.5.1 Average Time (AT)**

The coefficient for this variable is -0.170421 from the table 4.5 of results estimation and the value shows a negative relationship between average working time and injuries of workers. The p-value of 0.0977shows a statistical significance at 1% level. It is therefor, a percentage in average time a worker is considered to be at the work place is accompanied by about 10% increase in the rate of injuries.

### **Average Age (AA)4.5.2**

The table 4.5 above depicts a 0.243747 coefficient for average age, which is a positive relationship between the explanatory variable AA and Injuries. The variable has a p-value of 0.0280, which is statistically significant at 5%. Ceteris paribus, this implies that average age is 24% likely to reduce the injury rate.

### **4.5.3 Material Handling System (MHS)**

The coefficient for MHS variable is 0.026996 and the value depicts a positive relationship with the dependent variable that is Injury. This implies that a percentage in material handling systems will increase injuries with a 3% margin.

### **4.5.4 Protective Equipment (PE)**

The table 4.5 above shows a negative relationship between PE and Injury occurrence with -0.016688 being the coefficient for the variable. The negative regression coefficient simply means there is a tradeoff between the independent and dependent variable that translate to a 1% decrease in the provision of protective equipment will increase injuries with 2%.

### **4.5.5 Presence Hazards (PH)**

From the table 4.5, PH have a positive coefficient of 0.663247 and a p-value of 0.0079, which is statistically significant at 5% level. This however, mean a percentage chance in the present hazards increase injuries with 66% at the work place.

### **4.5.6 Safety Training Workshops (ST)**

The variable ST has a positive regression coefficient of 0.461099, which explain the positive relationship between the explanatory variable and the dependent variable Safety training workshop. A percentage change in safety training workshops result in 46% decrease in occurrence of injuries in the manufacturing sector in Bindura. The variable also have a p-value of 0.0059, which is statistically significant at 5% level.

### **4.5.7 Working hours per day (WKH)**

The results suggest that the coefficient of 0.070334 shows that WKH has a positive relationship with the recorded injuries. This implies that if working hours increased by 1%, injuries will go up by 7% on average. Klapper & Love (2004) postulated that increased working hours result in an increase in number of injuries recorded. The results of this research indicated that the WKH has statistically significant at 10% significance level; with a probability value of 0.8167 which is greater than 0.1.

### **4.5.8 Dummy (D)**

The results indicated that the coefficient of 0.620272 representing the dummy for Bindura manufacturing sector and is significant in explaining variations in occurrence of injuries in different scenarios. For each percentage increase in the value of the dummy leads to 62% increases in rate of injuries. This means that the sector has maximizes its operation without accounting for the injuries. The variable has a p-value of 0.0273 indicating the statistically significant at 10% significant level and this proved that there is positive relationship between the explanatory variables and the dependent variable.

## 4.6 Discussion of the results

The estimated equation depicted results which shows positive relationship between explanatory variables and the dependent variable. These results are highly related to Jeshtar (2020), who proposed that there is a positive relationship between poor working conditions and occurrence of incidents and injuries. Manufacturing firms that ill-treat their workers in form of long working hours, they are most likely to record large number of injuries since workers will end up doing their jobs unwillingly just to complete the shift. Lee (2019) also added that firms which mainly use manual means of handling the products and materials are mostly likely to be negatively affected by damages caused by poor handling by the workforce.

In addition, the study also highlighted the existence of a negative relationship between Average time and occurrence of injuries. These findings are related to the literature by Herbert (2015) who revealed that prolonged working time will result in fatigue and low productivity of workers and they ended up being reckless through entering the prohibited places to evade the duty.

The model however, depicted a positive relationship between training workshops and the occurrence of injuries. According to Hilton (2016), when manufacturing firms invest more in training of workers about their health and safety against industrial ergonomics the companies are likely to record few injuries during the financial year. This is because the workers are being equipped with the much needed health and safety knowledge.

Provision of protective equipment also shows a negative relationship with the injuries recorded in the manufacturing sector of Bindura. The negative relationship correlate with the literature by Jack (2010) which states that protective equipment are the prerequisite for any industrial and manufacturing firms as per the industrial and labor laws in the country. Adherence to the standards enables the firm to record minimum number of accidents at the work place and the labor force can safely carry out their tasks without the fear of being injured with plant equipment.

## 4.8 Conclusion

The regression results of the estimated equation proved that protective equipment and average time has an inverse relationship with the occurrence of injuries whilst is Average Age (AA), Material Handling System (MHS), Working hours per day (WKH), Safety Training Workshops (ST) and Presence Hazards (PH exhibited a positive relationship with the dependent variable injuries. All the variables are statistically significant in explaining the variations in health and safety of workers in preventing industrial ergonomics. The following chapter will be responsible for recommendations, highlighting areas of further studies and summary.

# CHAPTER V

**SUMMARY, CONCLUSSION AND RECOMMENDATIONS**

## 5.0 Introduction

The research seeks to analyse effects of industrial ergonomics on the occurrence of incidents and accidents in the manufacturing sector in Bindura. This chapter is composed of the summary findings form the study, the policy implications and also the recommendations suggestions to several stakeholders in the manufacturing sector. Future researchers are also provided with suggestions in this chapter.

## 5.1 Summary

The research results from chapter four indicated that the model of the study is an analyst of the results. This indicates that Average Age (AA), Material Handling System (MHS), working hours per day (WKH), Safety Training Workshops (ST) and Presence Hazards (PH) influenced the occurrence of injuries in the Bindura manufacturing sector. The results from data analysis exhibited that safety training workshops was the main activity by most of the firms in the industry in an effort to improve safety awareness amongst workers to reduce the accidents recorded within the financial year for each firm to meet the NSSA requirements. The idea go the same way with the literature Jamal (2017), He advocating for the health and safety awareness for the manufacturing firms in order to reduce their costs in form of compensation to the injured workforce mentioning the higher levels of worker motivation when they know that the company is working tirelessly to achieve a zero accident environment which may also lead to establishment of strong ties with the stakeholders of the business. However, only 84 % of the variation in firm`s recorded injuries is being explained by the stated explanatory variables.

The study used 30 months sample size of time series data for Average Age (AA), Material Handling System (MHS), working hours per day (WKH), Safety Training Workshops (ST) and Presence Hazards (PH) in the manufacturing sector of Bindura from January 2019 to June 2021. The data used was retrieved from Annual Reports of the companies and supplements from interviews and questionnaires. Data analysis was completed using E-views 7.1 Statistical Package (2019). Trying to figure out the effects of health and safety procedures to the occurrence of injuries, the study made use of the Ordinary Least Squares (OLS) technique to estimate industry`s equation using injury as the dependent variable. The parameters created by the OLS method suit the best linear and unbiased estimator (BLUE) conditions. Under the study, case study approach design were used for the prediction of the essential and external strength to the study. The narrow database, short time period and nominated variables remained certain of the main limitations of this research. The study was directed to the manufacturing sector in Bindura. However, the future researchers should have to work on more variables that cater for industrial ergonomics in the manufacturing sector.

## 5.2 Conclusions

The study concludes that industrial training and workshops is important in curbing all the challenges caused by different ergonomics in the manufacturing sector. The positive relationship of the variable was realized since most of the companies in the sector resort to some health and safety courses for personal and collective protection in the workshop. The firms are also doing on the job trainings to familiarize the old aged workers with the modern machinery to reduce the rate of injuries during operation.

The inverse relationship between the explanatory variable Average working time and Protective equipment with the dependent variable injury in the research implies that the manufacturing firms must provide the much need proactive equipment and reduce the average working time for each worker in order to cater for fatigue and boredom of workers. The provision of protective equipment also help the industry to match the international standards for them to be internationally recognized and avoid being blacklisted by the global stakeholders because of not adhering to the international standards hence the firm might be less competitive from the international scene.

The negative relationship depicted by average working time with the dependent variable shows that manufacturing firms must gazette the average time that is ideal and standard to the workforce to avoid unnecessary overtime that are not subject to payments. The inconsistence in working hours can demotivate workers hence low productivity and they can also use raw materials in such a way that costs the firm.

## 5.3 Policy Recommendations

Relying on the results and findings of this study, the manufacturing firms should relook at workers safety measures to reduce the risk of injuries and damages. In an attempt to reduce injuries using manual handling systems, firms should ensure policies that clearly states load permitted per individual, working hours, employee qualifications and handling used to be used tasks. However, policies should not be directed towards office workers as it was discovered to be insignificant.

From the conclusions above, average working time poses a negative value and it is of value to shift from long hours at work using manual means to mechanical handling system because they cause less injuries and take a short time to complete the task. This is because mechanical handling equipment usually does not involve lifting, pulling and pushing heavy loads, carrying out tasks in awkward postures, moves that cause fatigue. It encourages the use of forklifts, cranes, conveyors and dollies. As such the ergonomic problem can be solved by using mechanical handling systems to ferry heavy loads within the facility of the firm. In addition, research also showed that the occurrence of injuries and incidents was affected negatively by working hours. As such firms should reduce overworking employees through overtime. They should also introduce shifts for each employer with normal working hours. This should be done so as to maximize concentration of workers during working hours. High level of incidents and accidents that cause injuries in manufacturing firms are eliminated if workers are given sufficient time to work and rest.

In addition, the co-efficient for present hazards is strong. However, when using mechanical handling the equipment need to constant maintenance for instance machine belts system, such that it avoids jamming and cause injuries to the operators. Before operating the machinery guards should be place at all times as the machinery moves to avoid disruptions in movement which may cause damage and injury to personnel. Safety and risk officers should communicate hazards which are present in the work station and also emergency procedures. This can be conveyed during the safety talk meetings at the premises.

The findings shows a strong relationship between safety training workshop and occurrence of injuries. The firm should make sure that employees go through a compulsory health and safety training for them to adhere to the laid procedures of self-protection and the supervisors should ensure that workers take some breaks during work operations. This is so as to ensure that employees rest and gain knowledge and perform as per expectations. Supervisors should try and minimize overtime but should promote and enhance shift breaks as per company policy.

The results shows a weak positive relationship between injuries and employee average age. This implies that manufacturing firms should seek to employ people who have the required ages as per the international labor standards to avoid child labor and also avoid employing the aged personnel with a lot of health complications. In addition, firms should employ the young stars since they are energetic and are not subject to be tired and have fatigue during a short space of time and training should be provided to employees regularly.

## 5.4 Areas of Further Research

There is need for further studies to figure out how technological advancements can be used to eliminate industrial ergonomics associated with manual production processes. Technology is one of the factors that affects operations in the manufacturing sector but this study focused on the Bindura part of the manufacturing industry at the expense of the national industry. They should also be carried out in other sectors like mining and agriculture in Zimbabwe as to determine the effects of health and safety procedures to prevent occurrence of injuries to make sound corrective action. It is vital to carry out some studies which pursues to find the effect of industrial ergonomics on injuries at the work place so as to benefit from the knowledge. Studies can be conducted looking at other factors that affect injuries in the manufacturing sector among others in the region and beyond.

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# APPENDIX 1: QUESTIONNAIRE

# OUESTIONNAIRE: HEALTH AND SAFETY OCCUPATIONAL MANAGER

My name is Apynadge A Mabuka and I am a student at Bindura University and currently I am studying Bachelor honors degree in Purchasing and Supply and I am carrying out a research on determining the effects of material handling systems on employee safety in manufacturing industries in Bindura. You are kindly asked to answer the following questions in utmost good faith and diligence as your responses will be used for academic purposes. Please be assured that information obtained will be strictly confidential and will be used for this study only .I promise that the information will not be misused. Your great cooperation in participation on this

Questionnaire is appreciated.

Name of the Organization………………………………………..… Type of industry (Heavy or light) ………………………………...

Type of Material Handling system: ………………………………

1. Working Hours
   1. What are the average working hours per employee per day?
   2. Maximum hours per day?
   3. Minimum hours per day?
   4. What is the recommended working hours per day?
2. Workshop temperature

(a)What are the average temperatures in the shop floor?

* 1. Minimum temperature in the shop floor?
  2. Maximum temperature in the shop floor?
  3. What are the recommended temperatures in a shop floor?

1. Average Age

(a)What is the average age per worker in the shop floor?

1. Maximum age per worker in the shop floor day?
2. Minimum age per worker in the shop floor?
3. What is the recommended age?
4. Safety Training workshops
   1. How many safety training workshops do your employees receive in each year?
   2. How many do you recommend?
5. How many accidents were reported at this company in the last 12 months?
6. Do your workers put on protective clothing always? YESNO
7. Do your workers ever complain about inadequate space? YESNO
8. Do your workers ever complain about inadequate light? YESNO

**APPENDIX II: DESCRIPTIVE STATISTICS**

ACC

AA

AT

W

H

K

ST

PH

PC

M

HS

Date: 10/25/14

Time: 04:43

Sample: 1 37

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mean  Median  Maximum Minimum  Std. Dev.  Skewness  Kurtosis  Jarque-Bera Probability  Sum  Sum Sq. Dev.  Observations | 6.729730  7.000000  13.00000  1.000000  2.912126 -0.084075  2.619311  0.267014 0.875021  249.0000  305.2973  37 | 28.00000  27.00000  37.00000  20.00000  4.490731  0.371279  2.309394  1.585341 0.452634  1036.000  726.0000  37 | 32.91892  32.00000  46.00000  28.00000  4.218862  1.067653  3.805810  8.030328 0.018040  1218.000  640.7568  37 | 9.189189  10.00 000  12.00000  6.000000  1.729448  0.096013  2.299269  0.813842 0.665697  340.0000  107.6757  37 | 7.297297  7.000000  24.00000  2.000000  3.950140  1.990673  9.681563  93.26219 0.000000  270.0000  561.7297  37 | 0.567568  1.000000  1.000000  0.000000  0.502247 -0.272772  1.074405  6.175201 0.045611  21.00000  9.081081  37 | 0.675676  1.000000  1.000000  0.000000  0.474579 -0.750555  1.563333  6.655906 0.035866  25.00000  8.108108  37 | 0.270270  0.000000  1.000000  0.000000  0.450225  1.034587  2.070370  7.932943 0.018940  10.00000  7.297297  37 |

**APPENDIX III**

# Summary of econometrics results

# Table 4.3: Econometric results

Dependent Variable: ACC

Method: Least Squares

Date: 10/24/14 Time: 17:46

Sample: 1 37

Included observations: 37

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Coefficient | Std. Error t-Statistic |  | Prob. |
| AT  C  MHS  PC  PH  ST  WHK  AA | 0.052750  -6.334045  2.060155  0.069193  0.649337  -0.197513  0.661778  0.204119 | 0.074888 0.704382  3.172973 -1.996249  0.870455 2.366755  0.937723 0.073789  0.821757 0.790182  0.083655 -2.361048  0.228202 2.899970  0.091142 2.239559 |  | 0.4868  0.0554  0.0248  0.9417  0.4358  0.0252  0.0070  0.0330 |
| R-squared  Adjusted R-squared  S.E. of regression  Sum squared resid  Log likelihood  F-statistic  Prob(F-statistic) | 0.722763  0.655844  1.708393  84.63957  -67.80918  10.80055  0.000001 | Mean dependent var  S.D. dependent var  Akaike info criterion Schwarz criterion  Hannan-Quinn criter.  Durbin-Watson stat |  | 6.729730  2.912126  4.097793  4.446100  4.220588  1.367099 |

**APPENDIX IV**: correlation matrix

CORRELATION

ACC AA AT WHK ST PC PH MHS

.000000 0.700945 0.099910 0.650225 -0.451626 -0.105385 -0.063135 0.396243

0.700945 1.000000 -0.007331 0.622332 -0.331974 -0.039101 0.049263 0.151127

.099910 -0.007331 1.000000 0.196323 0.074827 0.388840 0.271401 -0.207506 0.650225 0.622332 0.196323 1.000000 -0.036925 0.144523 0.096803 0.075206 -0.451626 -0.331974 0.074827 -0.036925 1.000000 0.260308 0.276620 -0.327578 -0.105385 -0.039101 0.388840 0.144523 0.260308 1.000000 0.677186 -0.618401

-0.063135 0.049263 0.271401 0.096803 0.276620 0.677186 1.000000 -0.574374 0.396243 0.151127 -0.207506 0.075206 -0.327578 -0.618401 -0.574374 1.000000