APPROVAL FORM

The undersigned certify that they have read and recommend to the Midlands State University to accept a dissertation entitled, "**Ergonomic hazards associated with steel manufacturing industry: A case study of Steelmakers Zimbabwe in Redcliff**," by Mamvura Tendai Gracious R123808J, submitted in partial fulfillment of the requirements for the Bachelor of Science Honours degree in Geography and Environmental Studies.

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Dedication

I dedicate this dissertation to my parents for without their support, love and prayers it would have been impossible to reach this far.

Acknowledgements

My deepest gratitude goes to my supervisor and chairperson, Doctor S. Jerie for his unfailing guidance and moral support when I was conducting this research. He always understood me throughout the whole process and his office was always open for assistance. Thank you so much doctor.

Secondly, special thanks to all the lecturers in the department for nurturing me for these past four years. I really acknowledge their effort and all my friends in the Geography department thank you. Special mention goes to the Steelmakers Zimbabwe team and National Social Security Authority staff, Mr. Gweme in particular, you also did a wonderful job during my dissertation, and you were always willing to assist. God bless you all!

Above all I really want to thank God my father for the wonderful gift of life, for being with me along the way, strengthening and guiding me. Without him it would have been impossible to reach this far. To Pastor Mhere, thank you for all the prayers and support.

Abstract

The research was carried out a Steelmakers Zimbabwe Private limited with the aim of understanding the ergonomic hazards that are associated with steel manufacturing. The objectives of the study comprehended identification of ergonomic hazards, analysis of their effects and an assessment of the effectiveness of measures that are in place to combat the impacts of the ergonomic hazards on employees. The research encompassed both qualitative and quantitative research paradigms and use of primary and secondary methods of collecting data pertaining to ergonomic hazards associated with steel manufacturing. Primary data was gathered through questionnaires, field observations and interviews while secondary data was obtained from the company health and safety records, clinic records, national health and safety policies and journals. The central findings realized from the research signified that the level of knowledge and appreciation of ergonomics amongst Steelmakers employees is still low due to inadequate training and lack of management commitment. The current economic situation in the country which is ailing at the moment also contributed to poor ergonomics and consequently a rise in work related musculoskeletal disorders and ergonomic injuries at Steelmakers. It was finally concluded that there is need to consider ergonomic interventions in the day to day operations of the company in order to reduce work related ergonomic hazards, risk factors and ergonomic injuries. Recommendations were also forwarded to the nation and company to carefully consider establishing an ergonomic association/movement and formulate and implement policies specifically on ergonomics.

Keywords: Ergonomics, Musculoskeletal disorders, ergonomic risk factors, ergonomic hazards, Steelmakers

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ACRONYMS

ESSA	Ergonomics Association of South Africa
IEA	International Ergonomics Association
ILO	International Labour Office
MMH	Manual Material Handling
NGOs	Non-Governmental Organisations
NSSA	National Social Security Authority
OHS	Occupational Health and Safety
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
PVT. LTD	Private limited
SHE	Safety Health and Environment
SHEQ	Safety Health Environment and Quality
SOPs	Safe Operating Procedures
SPSS	Statistical Package for Social Sciences
WMSD	Work related Musculoskeletal Disorders

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

The history of ergonomics dates back to the early twentieth century when people began to study the relationship between workers and their working environment. Etymologically, the term ergonomics originates from two Greek words, “ergon” meaning work and “nomos” meaning law hence it can be defined as the study of laws that govern work and its environment (Yisa 2005). Germany human factors and ergonomics in Zink and Fischer (2012) also defined ergonomics as a science that integrates social, economic and ecological objectives and is obligated to concepts which people can carry out their work in a comfortable and productive manner by assessing the effects of ergonomic hazards on the human body. The epistemological foundations of this discipline is what establishes the scientific framework of rules and norms that guide its scientific practice and now these have become problematic also since it has to deal with issues of complexity, emergence and sustainability (Dekker, Hancock and Wilkin 2013).

Singleton (nd) noted that most of the European pioneers in ergonomics were workers among the human sciences and it is for this reason that ergonomics is well balanced between physiology and psychology. A physiological point of view is important as it is a background to issues such as energy use, posture, and application of forces including lifting while a psychological orientation is required to study problems such as information and job satisfaction (Singleton *nd*). On the other hand, he further points out that American pioneers in this field were involved in either experimental psychology or engineering and it is for this reason that their typical occupational titles encompass human engineering or human factors reflecting a difference in emphasis from the European ergonomics but not in the core interests. Most of these industrially advanced countries incorporated their ergonomics in standards and set aside legislation and policies guiding ergonomics in different work places, for instance, on a regional level the European ergonomics standardization is within the Commission Europeenne-de Normalization (CEN) which established its Technical Committee 122 “Ergonomics” in 1987 (Nachreiner *nd*).

All this helped them to investigate and analyse ergonomic hazards and apply basic ergonomic principles to injuries and musculoskeletal disorders at work places.

Wignjosoebroto (2007) pointed out that in Indonesia ergonomists only have one thing in common. They believe that appropriate type of ergonomic approaches to interventions leads to increase in productivity, quality of working conditions, occupational health and safety, costs reduction, better environment and increase in profits. However, the progress is slow, accidents are still occurring and the situation is not changing. Wignjosoebroto (2007) attributes this to the fact that ergonomics movement was introduced by academicians from abroad who worked for some Indonesian universities. The standards, recommendations and procedures concerning occupational health and safety in developed countries would not be fully applied because of variations in climate, anthropometric measurements, and cultures, methods of work, technology and infrastructural facilities. In short, they still have a long way to fully incorporate the concept just like any other developing countries.

According to Scott and James (2009), ergonomics has a relatively short history on the African continent. Most countries in the region have not fully adopted the science compared to most developed countries. However, there is a growing awareness of the need for ergonomics and the international community and local enthusiasts have been actively involved in establishing the discipline in North, West, Central and Southern Africa. In South Africa, Ergonomics was first recognized in the early 1960s where investigations were carried out examining the effects of thermal stress on the miners. It took the country probably 20 years around the 1980s to establish a society and the Ergonomics Society of South Africa (ESSA) was finally accepted as the member of the International Ergonomics Association (IEA) in 1994 (Scott and James 2009). It can be noted that the field of ergonomics is an integral part of day to day life at work yet its application in Africa is still very low. There is need to investigate ergonomic occupational hazards and implement control measures in order to improve the health and safety of workers around Africa.

In Zimbabwe the field of ergonomics falls under Occupational Health and Safety. In 2001, the Zimbabwe Congress of Trade Union (ZCTU) health and safety department divided OHS hazards into six categories namely physical, chemical, mechanical, biological, psychological and

ergonomic (ZCTU 2001). Katsuro (2001) elude that all these six have a negative impact on employees. In his manual for occupational hygiene, Hirst (2010) pointed out some of the ergonomic hazards found at work places which are manual handling of loads, repetitive actions and use of display equipment such as computer screens. Kadiri and Niesing (2012) also noted some of the hazards as forceful movements, vibration, temperature extremes and awkward postures. He went on to explain the effects of these on workers in that they lead to cumulative trauma disorders (CTD) also known as work related musculoskeletal disorders (WMSD). Examples of msds include carpal tunnel syndrome, cellulitis, osteo-othritis and tendonitis. Hirst (2010) pointed out that many manual handling injuries tend to be cumulative in nature with far reaching repercussions for both employers and employees with therefore leaving the best strategy for preventing injuries being preventative rather than reactive.

Steel makers Zimbabwe generally involve heavy duty work and employees are exposed to ergonomic hazards such as repetitive and forceful movements; vibration, temperature extremes, manual handling and awkward postures. The industry requires higher production rates and as a result the duties involve frequent lifting, carrying, and pushing or pulling of loads with limited help from other employees or devices. The above factors when coupled with poor machine/equipment and workplace design create a physical stress on workers' bodies. Generally, ergonomic hazards are known to cause MSDs but in this case they mainly accounted for instant cuts, bruises, burns and sprains known as ergonomic injuries. Pheasant (2005) explains an ergonomic injury as the one that occurs as a direct or indirect consequence of the nature and demands of the person's working task and they may occur as discrete events which take place at a particular point in time due to a single episode of over-exertion. Jerie (2013) describes ergonomics studies as the study of complex relationship between people, physical and psychological aspects of the work environment and aims at optimizing the comfort, health, safety and efficiency of workers yet this is not the case in mining enterprises of Southern Africa. This is the same for Steelmakers Zimbabwe It is against this background that this study aims to investigate the ergonomic hazards associated with the steel manufacturing industry in Zimbabwe.

1.2 Statement of the problem

Steelmakers just like the bulk of manufacturing companies in Zimbabwe incorporates manual heavy duty work where awkward postures, bending and other ergonomic hazards are experienced. There have been recorded and unrecorded complaints of backaches, pain of the wrist, cuts, thermal injuries, sprains and strains at the company. Some employees already have permanent disabilities due to poor ergonomics. The year 2014 accounted for 361 accidents for both Unit 1 and 2, of these 38 had a lost time injury and were reported to the National Social Security Authority (NSSA). Of these accidents, 161 were due to unsuitable protective clothing which falls under wrong equipment and 111 were due to unsafe conditions which included poor work design and equipment hence many cuts, burns, bruises, sprains and strains were recorded. Other ergonomic injuries accumulate over time and it is because of this nature that some of the ergonomic injuries develop/go unnoticed and some employees lack adequate knowledge hence they opt to continue working without paying attention to these in order to earn a living. In addition to these, there is no clear policy addressing the issue of ergonomics alone within the company hence no attention to this area in particular. Moreover, a discussion with the NSSA OHS promotions officer highlighted that the plant was manufactured around 1927 long before the discipline had gained momentum, it is now dated and together with most equipment used at the company including PPE is imported from India hence in terms of human variability it can be said not to be ergonomically friendly. When taken seriously, an ergonomic program leads to increased productivity, job satisfaction, lowered workers' compensation claims and absenteeism. However, despite these gains many workers each year still suffer ergonomic injuries and cumulative trauma disorders. Given the current conflict between production and worker's safety in the area of study, this study endeavours to assess the impacts of ergonomic hazards and come up with recommendations on how basic ergonomic principles can be applied to control ergonomic hazards.

1.3 Objectives of the study

General Objective

To examine ergonomic hazards associated with the steel manufacturing industry.

Specific Objectives

- To identify ergonomic hazards in the industry
- To analyse the effects of the ergonomic hazards
- To assess the effectiveness of the measures in place to combat the impacts of ergonomic hazards
- To come up with recommendations on how ergonomic principles can be applied to prevent/minimize ergonomic hazards in steel manufacturing industries.

1.4 Justification of the study

A study in ergonomics in present day society is vital to the society. Over the past decades in most developing countries this discipline has been enshrined in occupational health and safety yet it is a very big, complex discipline which requires its own policies and legislation. Ergonomics affects employees on daily basis and the majority of them in developing countries are unaware of it. ILO fourth edition also pointed out that the basic aim of ergonomics is efficiency in purposeful activity in other words, efficiency in the sense that achieving the desired result without wasteful input, error and damage to the individual involved or others. Therefore the benefits of studying ergonomics include improved workers' health and safety and increased production and profits. Sound ergonomic principles in designing task and human-machine relationships reduces design induced human errors and also helps prevent significant occupational health and safety risks hence this study is justified as it investigates ergonomic hazards found in the manufacturing industry and it fills in the knowledge gap.

A number of benefits are to be derived from this study. The results can be used to educate the workers of Steelmakers Zimbabwe Pvt. Ltd and other manufacturing industries in Zimbabwe such as Bata shoe company, Zimasco, Zimplow, Sable chemicals and Zimchem only mentioning but a few to fully understand the importance of having an Ergonomic programme being

implemented at a work station. Mining entities especially artisanal and small scale mining areas can also benefit from this and implement an ergonomics programme. It reduces the impact of ergonomic hazards increasing their safety, assets protection and job satisfaction. As noted earlier on the case of Indonesia, even in Zimbabwe the science is still new and many industries are still trying to adopt it. It is however challenging due to cultural, stereotypes and anthropometric variations among others, hence this study by filling in the knowledge gap in Zimbabwe also awakens the concerned employees and employers.

Future researchers and learning institutions as well as the Occupational Health and Safety (OHS) department of the country under (NSSA) are also subject to benefit from this study. Currently the National Social Security Authority is working on the amalgamation of the Factories and Works Act 14:08 0f 1976, Pneumoconiosis Act of 1996 and Statutory Instrument 68 of 1990 to come up with one piece of legislation. This study is an important input to the authority during this process. The information extracted is vital for policy framework for Zimbabwean industries and institutions. Academicians interested in the field of ergonomics can also find this study beneficial as it can also be one of the starting points for future research in the country. The study brings together in a short form some recommendations on addressing Ergonomic hazards and problems being faced by other organisations to fully in-cooperate the Ergonomic Principles in their operations. This provides some useful frameworks to some Non-Governmental Organizations (NGOs) and other Institutions who wish to have convenient projects in addressing OHS problems in the manufacturing industries of Zimbabwe. This study is essential to justify the projects/programmes already put in place in various organisations and paves the way for future initiatives which help fit the job to the worker.

1.5 Study area

Steelmakers Zimbabwe is based in Midlands in the town of Redcliff which falls under kwekwe district 29^0 47^1 South and 19^0 2^1 East. The town is approximately 223km South West of Harare the capital city. It occupies two sites; the head office being in the Heavy Industrial site near Rutendo community and the other one is an extension, Unit 2 located one kilometer from the Harare-Bulawayo highway along Redcliff road. The town is located in an extremely iron-rich area and it has an altitude of 1220m above sea level. Redcliff is in region 3 with warm conditions. The terrain is hilly with a ridge separating Rutendo and Torwood. Vegetation is dominantly bushes and trees. There is a small tributary of Kwekwe River cutting across Rutendo.

According to the 2012 census, the town of Redcliff has got a total population of 35 925 divided into 17 175 males and 18 754 females. Steelmaker is situated just a kilometer from the Rutendo community. The town has relied on steel production as a source of revenue, ZISCO steel being the biggest company in the area employing the majority of residents of Redcliff and However due to economic hardships the companies have not been performing well. Other companies within the area include Zimchem refineries and Golden Crust bakery. Figure 1.1 below shiws the map of Steelmakers Zimbabwe.

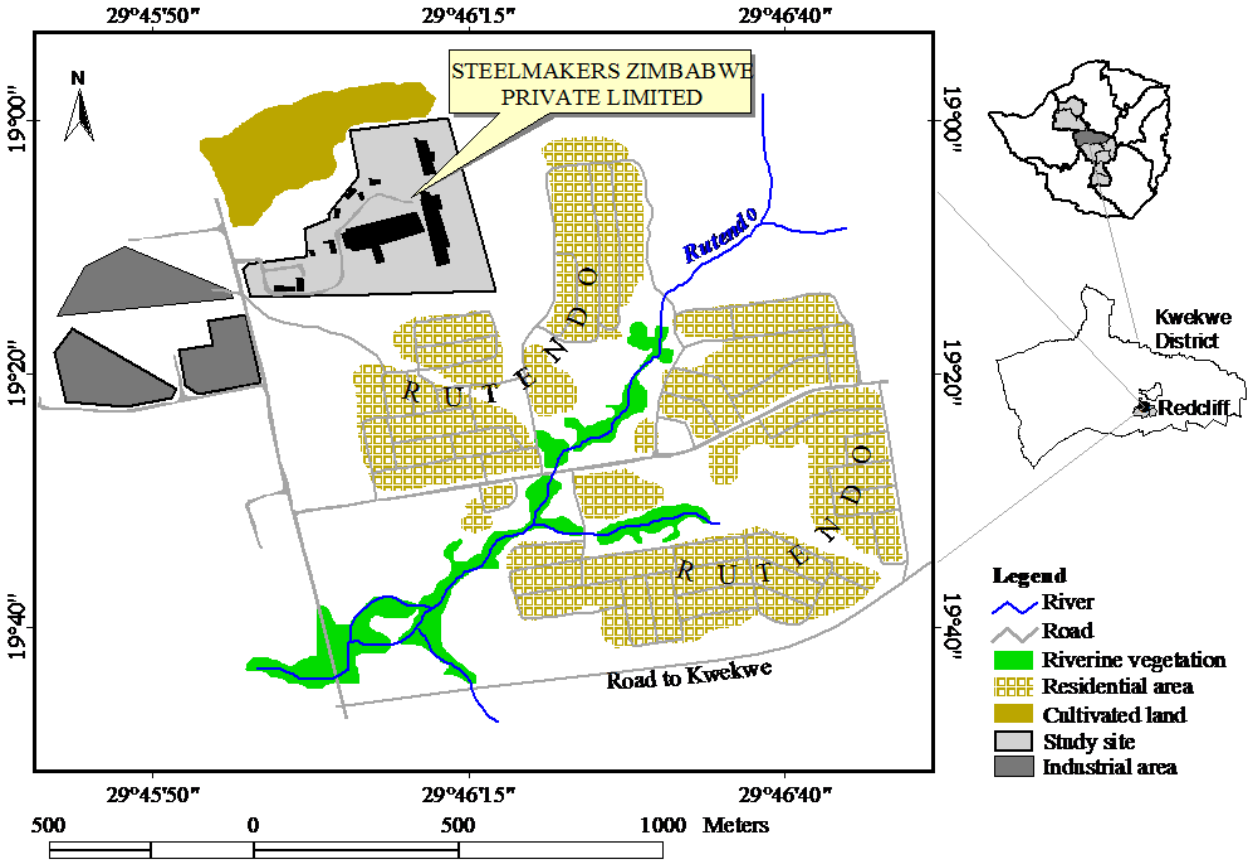

Figure 1.1 Map of Steelmakers Zimbabwe

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter brings to light the several studies on ergonomics that have been undertaken worldwide by different scholars which have been reviewed by the researcher. This literature review aims to explore the distinct aspects of ergonomic hazards surrounding industrial workplaces and also enables the researcher to gain an understanding of the issue under study through analysing previously done studies.

2.1. Ergonomics and ergonomic hazards

As noted in the previous chapter, the origin of ergonomics dates back to the early twentieth century. Many definitions from different scholars' reviewed by this researcher have two common themes in relation to ergonomics, that is, workplace design and work methods that fit the worker capabilities and limitations. For instance, Scott (2009) defines ergonomics as the scientific study of people at work considering human capabilities and limitations and the design of work so that it fits the worker's needs. Manuele (2013) on the other hand also defined ergonomics as the art and science of designing the work to fit the worker in order to achieve optimum productivity and cost efficiency and acceptable risk levels. Ergonomics can also be referred to a multidisciplinary science that seeks to conform the workplace and all of its physiological aspects to the worker (Vaidogas 2010). Scott (2009) further indicates that ergonomics in most cases is related solely to physical aspects at the workplaces and the prevention of work related musculoskeletal disorders and that this view has created confusion about what ergonomics is and its application. This may be due to the fact that ergonomics encompasses a lot of things and almost all the other hazards are in some way connected to ergonomics at workplaces.

There is no clear cut definition of ergonomic hazards though findings during this literature review showed that ergonomic hazards are any workplace conditions or factors that have the potential to cause an injury or illness of the musculoskeletal system (Kadiri and Niesing 2012). Vaidogas (2010) is of the view that ergonomic hazards are any uncomfortable and dangerous workplace conditions which may be created by job design or unfriendly technologies affecting

productivity, quality, and worker's safety and health. In all instances these are the factors related to the work design and work methods which are concerned with the work environment, work equipment and the worker himself. Hilgert (2013) adds that ergonomic hazards are sited amongst the global problems of the working environment by International Labour Organisation (ILO). He further goes on to say:

> "Definitions of workplace hazards, however, are socially contested; meaning workers and employers often disagree about the definition of workplace hazards. The phrase "imminent and serious danger" is one such legal standard that is used to determine when a worker can refuse unsafe work. One can argue over the specific hazard threshold that will be covered by the right to refuse. At a more fundamental level, however, is the question of who should have the right to define hazardous work in the first place. The typical decision makers are the legislators, regulators, and ultimately judges. An alternative view is that the workers themselves should be the ones to decide. Many people have a visceral negative reaction to the idea that a single worker should be empowered to define the very nature of a workplace hazard to which they are exposed."
>
> (Hilgert 2013)

The quote above shows the complexity of defining workplace hazards and the most complex of all, the ones who should define workplace hazards, this means what the worker could refer to as ergonomic hazards the employer may think otherwise. In this context one can note that even if ergonomic hazards are a worldwide occupational problem defining them at each workplace is determined by the level of employer-employee appreciation of ergonomics. Vaidogas (2010) observed that, "identification of ergonomic hazards is based on ergonomic risk factors which are conditions of the work process, workstations, or work method which contribute to the likelihood of developing MSDs." Kadiri and Niesing (2012) noted the following ergonomic hazards namely; "repetitive and forceful actions; vibration, temperature extremes and awkward postures that arise from improper work methods and improperly designed workstations, tools, and equipment," these are the world wide recognized ergonomic related hazards that this study will also focus on. In this study, the researcher mainly focused on ergonomic hazards around the manufacturing industry.

2.2. Ergonomics risk factors

Collins et al (2011) highlights that ergonomic risk factors are the work conditions and methods that have the potential to harm the musculoskeletal system. OSHA (2015) outlines some of the ergonomic risk factors that have this potential to harm the musculoskeletal system leading to the development of cumulative trauma disorders or ergonomic injuries. They highlighted the following ergonomic risk factors:

- "Exerting excessive force for instance when lifting objects, pushing or pulling heavy loads, manually pouring materials or maintaining/controlling of equipment and tools.
- Performing the same or similar tasks repetitively.
- Working in awkward postures or being in the same posture for a long period of time-these positions place stress on the body such as prolonged or repetitive reaching above shoulder height, kneeling, squatting or leaning over a counter.
- Localized pressure into the body part through pressing the body or some parts such as the hand against sharp edges.
- Combined exposure to several risk factors also leads to the development/ incidences of ergonomic injuries"

(OSHA 2015)

Ergonomic risk factors can be confirmed by carefully studying the injury and illness statistics (Bhattachanya and McGlothlin 2012). This will help in identifying ergonomic hazards that are present in the workplace together with accident/incident investigations. Vaidogas (2010) also supports the view that identification of ergonomic hazards is based on ergonomic risk factors which encompass conditions of the work process, workstations, or work method which contribute to the likelihood of developing MSDs.

Bhattachanya and McGlothlin (2012) suggested three forms of ergonomic risk factors namely job, psychosocial and personal related risk factors. Job related risk factors refer to conditions or characteristics of the external environment that may affect the probability that an overexertion injury may occur. These are weight of the load being moved, location of the load relative to the worker when it is being moved, size and shape of the load and frequency of handling. On the

other hand personal risk factors include age, level of physical conditioning, strength and medical history. Psychosocial or organisational risk factors include stress, job satisfaction, monotonous work, social support at work and high perceived work demands. The authors however noted that the mechanism of how these factors might increase the risk of MSDs is not fully understood but it is believed these factors lead to both physiological and biomechanical responses that increase the risk of MSDs.

2.3. Industrial ergonomics

Kadiri and Niesing (2012) observed that when ergonomics is applied at an industrial work area for instance workshops, laboratories, manufacturing and processing areas it is referred to as industrial ergonomics. Almost all workstations are included in industrial ergonomics except for computer workstations. In the industry different jobs are performed on different workstations. Organisational related practices can be a source of ergonomic hazards considering how the organisations operates, the level of its appreciation of ergonomics and the work environment design. It is the duty all employers to protect the workers and provide a safe working environment for all of them. Protecting basic refusal rights where workers face the most dangerous working conditions has had wide public support generally (Hilgert 2013). Workers should have a right to refuse to work where their safety is compromised.

2.3.1. Sources of ergonomic hazards

Mile and Perrewe (2011) proposes that the central hypothesis of the person-environment (PE) fit theory is that a misfit between the person and the environment leads to psychological, physiological and behavior strains. In this regards the “misfit” becomes the source of ergonomic hazards. For as long as injury statistics have been compiled manual material handling incidents have been prominent both in frequency of occurrence and severity of injury. Manual material handling involves work that is done manually be it lifting, pushing or pulling. These can be sources of ergonomic hazards due to the force exerted during manual material handling tasks; this force can lead to ergonomic injuries/MSDs.

Lack of job control has been demonstrated to be one of the primary causes of psychological and physiological dysfunction (Hilgert 2013). Many employees throughout the world are faced with ergonomic injuries as a result of failure to control their jobs. This so because the equipment,

machinery and the work station is normally designed without putting ergonomic considerations first and the employees are bound to adapt to the already set station though it might pose harm to the musculoskeletal system.

2.4. The effects of poor ergonomics on workers

Giving too little attention to ergonomics around the workplaces produces both financial and health-related problems. Vaidogas (2010) further indicated that the matter gets even more complicated as the health problems tend to multiply the company's financial problems. This is due to the increased burdens of workers compensation and paying salaries to injured employees who will be off duty because of these occupational injuries and illnesses. Some of the common indicators of the presence of ergonomic problems are employee complaints of musculoskeletal disorders, rising trends in accidents and injuries, absenteeism, low and poor quality production. Vaidogas (2010) mentioned that MSDSs account for more than 30% of all occupational injuries in the United States while in the European Union they account for over 50%. Work-related musculoskeletal disorders are the worst effects of poor ergonomics as noted in the literature reviewed by this researcher. These can almost affect the whole body but literature showed that they mostly affect the neck, shoulders, back and upper limbs (Collins *et al* 2011 and Kadiri and Niesing 2012) the table 2.1 shows some of the common work-related MSDs of the upper limbs.

Table 2.1 Common WMSDs that affect the upper limbs

DISORDER	SYMPTOMS	CAUSES
Carpal tunnel Syndrome	Numbness of middle fingers, especially at night	Repetitive wrist flexion
Myofascial pain of the neck	Heaviness and aching in the shoulders, upper back and neck	Overhead work and work with extended arms Computer posture Stress reaction
Shoulder bursitis	Shoulder pain and Stiffness	Repetitive shoulder Movements
Rotator cuff tendinosis	Shoulder pain and stiffness	Repetitive shoulder movements with twisting and overhead activities
Lateral epicondylitis	Lateral elbow pain, especially with extended wrist	Lateral elbow pain, especially with extended wrist
Trigger finger	Locking of fingers in flexion	Repetitive hand grip

Source: Collins *et al* (2011)

Bhattachanya and McGlothlin (2012) also indicated that despite the spread of mechanization in industry,MSDs attributed to manual material handling (MMH) are still a major cause of lost work time. These MSDs include a variety of injuries or disorders of the wrists, arm, shoulder, neck and back as well as upper and lower extremities. There are a variety of MMH activities that increase a worker's risk of developing a work related MSD, including jobs that involve a significant amount of manual lifting, pushing, pulling or carrying.

Pew and Mavor (2007) observed that discomfort serves as an early warning sign for injury. In addition, discomfort can itself be costly as it affects the quality or at times the quantity of work performed. Workers therefore should report any discomfort as early as possible to minimize its effects on their health and production as it is one of the effects of poor ergonomics. Failure to account for the user's physical limitations and capabilities when designing systems can result in decreased performance and productivity, discomfort, cumulative trauma or injury and even death.

2.5. Management/control of ergonomic hazards

Vaidogas (2010) observed that the risk factors in the workplace must be identified first in order to reduce musculoskeletal disorders and other ergonomic hazards effectively and then practical measures taken to reduce the risks. These can be achieved through partaking risk assessments, health surveillance, training, ergonomic work systems which involve studying the effect of the whole work station, equipment, work methods, and work organisation to identify problems and solutions also preventing fatigue. Management or control of ergonomic hazards and injuries involve administrative, engineering and behavioral modification solutions. Administrative solutions suggests minimising the number of daily working hours, modification of work, job rotation and introducing additional breaks into repetitive work. Engineering interventions on the other hand encompass technical ergonomic measures which can reduce the workload and hence the occurrence of musculoskeletal disorders. Jerie (2012) also supports the view that ergonomic hazards can be eliminated through engineering, administrative measures and personal protective equipment. Personal protective equipment provision should encompass issuing workers with the proper equipment for handling tasks and they should be adequately trained on its proper use. Technical interventions may integrate redesigning of the physical environment and introduction of lifting and transfer aids. Behavioral modification focuses on the training of employees on safe working methods that reduces the incidence of MSDs. Such training may involve proper lifting techniques in manual handling, for instance instead of lifting loads with backs employees should lift with their legs. Employees can also be advised to seek each other's help when handling heavy loads. A multidisciplinary approach in controlling the occurrences of ergonomic injuries is required including organisational, technical and personal measures (Vaidogas 2010; Kadiri and Niesing 2012). Workers should also be actively involved in the

processes of change this is known as the participatory approach; it is believed to have a positive effect on the success of an ergonomics intervention program (Scott 2009).

All workers' rights must be protected by the employers, government and workers themselves and ensure that work takes place in a safe and healthy working environment. Alli (2008) proposed some fundamental principles of occupational health and safety which could help to control ergonomic hazards in the workplaces namely:

- "Occupational safety and health policies must be established. Such policies must be implemented at both the national and enterprise levels. They must be effectively communicated to all parties concerned.
- A national programme on occupational safety and healthy must be formulated. Once formulated it must be implemented, monitored, evaluated and periodically reviewed. Social partners encompassing employers, workers and other stakeholders must be consulted and this should be done during formulation, implementation and review of all policies, systems and programmes.
- Continuous improvement of occupational safety and health must be promoted. This is necessary to ensure that national laws, regulations and technical standards to prevent occupational injuries, diseases and deaths are adapted periodically to social, technical and scientific progress and other changes in the world of work.
- Occupational health services covering all workers should be established. Ideally all workers in all categories of economic activity should have access to such services, which aim to protect and promote workers' health and improve working conditions
- Education and training are vital components of safe healthy working environments. Workers and employers must be made aware of the importance of establishing safe working procedures and of how to do so. Trainers must be trained in areas of special relevance to particular industries, so that they can address the specific occupational safety and health concerns.
- When none of the above approaches is feasible, or when the degree of safety achieved by them is considered inadequate, the only solution is to provide exposed persons with suitable personal protective equipment (PPE). This is the final line of defense and should

be used only as a last resort, since it entails reliance on active cooperation and compliance by the workers. Moreover, such equipment may be heavy, cumbersome and uncomfortable and may restrict movement; employers should consult workers or their representatives on suitable PPE having regard to the type of work and the type and level of risks. Furthermore, when hazards cannot be otherwise prevented or controlled, employers should provide and maintain such equipment and clothing as are reasonably necessary without cost to the workers. Protective equipment and clothing should comply with the standards set by the competent authority and take ergonomic principles into account. Workers have the obligation to make proper use of and take good care of the personal protective equipment and clothing provided for their use." (Alli 2008)

The above mentioned principles when coupled with engineering controls can effectively manage ergonomic hazards and reduce the occurrence or ergonomic injuries and illnesses. Figure 2.1 shows the ergonomics and stress model.

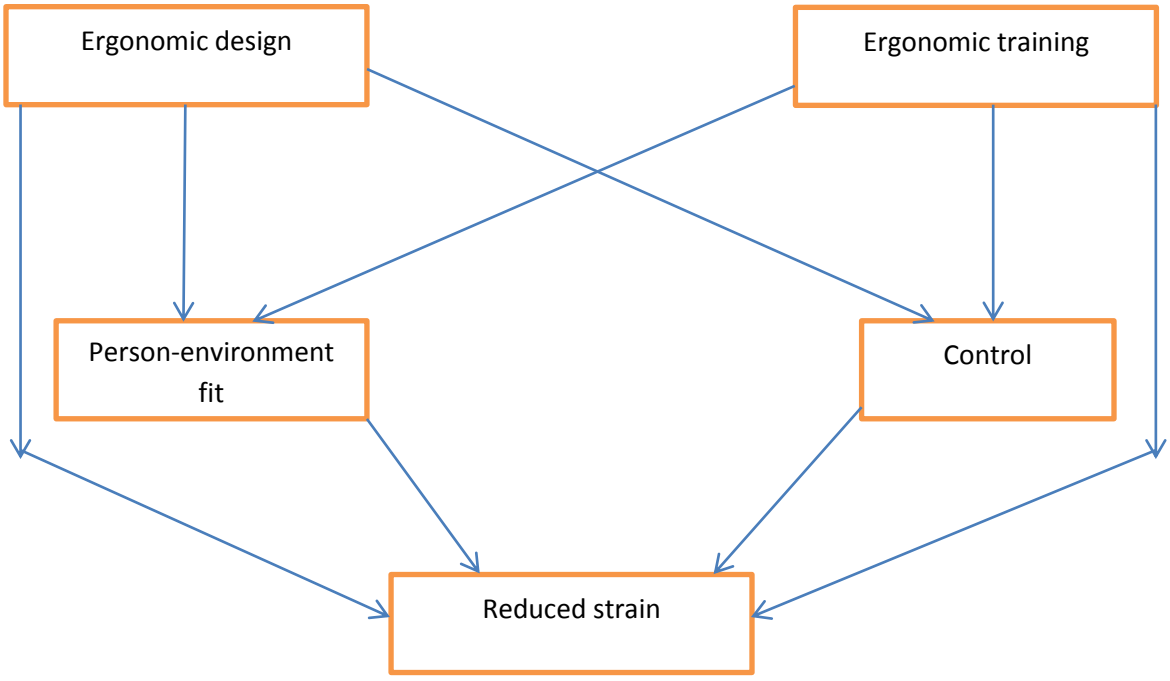

Figure 2.1 Ergonomics stress model

Source: Mile and Perrewe (2011) Ergonomics and stress model

The illustration above shows ergonomic design and training as measures to manage hazards. A proper design ensures the person-environment fit while training strengthens control thereby reducing physical and psychological strain on the bodies. Mile and Perrewe (2011) noted that lack of job control is the primary cause of psychological and physiological dysfunction hence it is very important to ensure adequate training and redesigning such that employees gain job control.

Bhattachanya and McGlothlin (2012) also proposed a systematic way of identifying ergonomic hazards which can be effective in eliminating the incidence and costs of musculoskeletal disorders and injuries. This involves identification, that is, ergonomic job analysis. This is the methodology used by engineers and safety professionals to describe work activities for the purpose of comparing existing task demands to human capabilities. The process of identifying hazards arising from poor work design involves reviewing of records to identify jobs associated with high rate of accidents and injuries; and becoming familiar with the processes and job activities that are performed in each work area.

Zare et al (2015) observed that, "reports in the literature have stated that without considering the ergonomic approach, quality management disciplines will not achieve their goals." Despite of its benefits, managers see ergonomics as a strictly health and safety tool that is useful for injury/illness prevention instead of recognising its capacity to improve productivity, quality and to reduce costs. This view should change and at the same time paying attention to continual needs of each stakeholder as this will ensure success of intervention measures. Pew and Mavor (2007) are of the view that it is clearly ideal to design an ergonomically correct system in the early stages of system design and ideally that a formal institutionalised process for incorporating ergonomics into system design preexists. They further indicated that in ergonomics, the main thrust behind the methods is one of prevention and designing the system to minimize risk factors and that without such a proactive and organised approach, the human cost can range from mild discomfort to cumulative trauma or injury and possibly even death. It is of uttermost importance to consider the workers' physical limitations and capabilities when designing systems.

Scott (2009) further indicated that factors affecting ergonomics intervention are management support and commitment; ergonomics awareness and know-how; employee participation in

democratic climate, motivation, organisation and culture; legislation, inspection and cost effectiveness of intervention programs. When these factors are addressed carefully, managing ergonomic hazards at workplaces becomes easier.

2.6. Knowledge gap

Previous studies on ergonomics have greatly contributed to the pool of knowledge available. Many studies have been carried out in the United States and the European Union identifying ergonomic hazards, risk factors, the burden of musculoskeletal disorders and how ergonomic principles can be applied to attain better results. In South Africa, much work on ergonomics covers the mining industry and health facilities. This researcher therefore noticed a gap in the information and knowledge available on ergonomics in Zimbabwe specifically the steel manufacturing industry. Different industries and workplaces present different hazards therefore different prescriptions should be given accordingly but first there is need to know what is happening on the ground so that recommendations can be drawn from that. Henceforth, this study aims to bridge the knowledge gap between other developed countries and the Zimbabwean Steel manufacturing industry.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter outlines the research methodology that has been employed by the writer in coming up with this research project. As defined by Rajasekars *et al* (2013) research methodology is a systematic way to solve a problem which essentially outlines the procedures by which researchers go about their work of describing, explaining and predicting phenomena gaining knowledge. It aims to give the work plan of research encompassing the research design adopted, type of research, research approaches and philosophy. This chapter also justifies the research tools used, data collection, and analysis and presentation techniques in addressing all the objectives of the study.

3.2. Research design

Kothari (2004) defines a research design as the conceptual structure within which research is conducted which constitutes the blueprint for the collection, measurement and analysis of data. Langen (2009) is in support of this view that a research design is a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings. It answers the initial questions raised by the research objectives. It keeps the research intact and also keeps the researcher focused. Kothari (2004) noted that the function of a research design is to provide for the collection of relevant evidence with minimal expenditure of effort, time and money. The researcher adopted the descriptive case study design in order to obtain an in depth understanding of what is going on, how it is going on and why it is like that in the area of study. Therefore the type of research she employed is the analytical research type as she goes on in explaining why phenomena under study are like how they are.

The main objective of this study was to examine the ergonomic hazards associated with steel manufacturing at Steelmakers Zimbabwe hence the research design and type helps in investigating real life situations with people's views and experiences being explicitly extracted then qualitatively and quantitatively analyzed and presented. According to Kothari (2004),

qualitative research is especially important in the behavioral sciences where the aim is to discover the underlying motives of human behavior while quantitative is mainly based on the measurement of quantities. In this respect the study explores both quantitative and qualitative research approaches known as triangulation. The triangulation of these two approaches is highly useful for the research process and for the epistemological development of the research problem in that they have different angles therefore the results complement each other and yield a comprehensive picture of the determinants under study. The phenomenological philosophy is also employed as it is qualitative and humanistic in nature. This philosophy is built upon open ended questions on questionnaires and during interviews and observations.

3.3. Population and sample

3.3.1. Target population

Kothari (2004) noted that all items in any field of inquiry constitute a population. Therefore the target population comprises of employers and employees at Steelmakers Zimbabwe. The organization currently has an establishment of around 200 employees. The inclusion of both employers and employees is to be done since ergonomics involve the workstation/equipment/machinery design and human errors which has to do with employers acquiring them while these are designed for workers who are mostly exposed to the physical and mental strain these pose.

3.3.2. Determination of sample size and sampling procedure

Knight (2002) highlighted that sampling is about selecting who or what is to be studied and that a good sample is one that represents the whole population. The total number of items to be selected from the population constitutes a sample. Meanwhile Jerry and Marcin (2007) postulated that a sample is a small part of anything which is intended to stand for or represent the whole population. Given the number of workers under the target population which was around 180 at the time of the study, one third of the population was sampled that is 60. The sampling purposively involves the various business units of the company. These include Production, Clinic and Human Resources. There are different types of sampling designs as noted by Kothari (2004), these are based on representation and element selection. The representation basis can be further divided into two that is probability and non-probability sampling while the element selection

technique relies on restricted and unrestricted sampling. This study adopts the probability restricted sampling design.

As noted above the study population was divided into several subdivisions though they can be divided into two main groups that are production and administration. Stratified sampling was to be adopted thus dividing the whole population into relatively homogeneous sub entities referred to as a strata then random sampling can be carried out in each strata. The random samples in each stratum are chosen in a way that there is proportional representation of the whole population or stratum. The advantage of this sampling design was that all the employees had an equal chance of being selected in each strata. For the interviews, convenience sampling was the best fit because the interviewees were purposefully chosen by the researcher those who were known and easily accessible to the researcher. These methods are inexpensive and also time efficient that's why they were chosen.

3.4. Methods of data collection

In this study, both primary and secondary methods of data collection were employed. Primary data has been defined by Kothari (2004) as that which is collected afresh for the first time hence it happens to be original in character while secondary data is that which have already been collected by someone else and had passed through the statistical process. Primary data methods adopted include questionnaire surveys, interviews and observations. Secondary data was used to compliment the data obtained from primary data. Literary data from journals, reports and books was used in this study.

3.4.1. Questionnaire surveys

A questionnaire survey can be defined as a fixed set of questions which can be used to obtain data on the study population and the answers obtained are used in formulating hypotheses and addressing the questions raised by the objectives. Jerry and Marcin (2007) elicit that questionnaires answer the what, where, when, how and why questions in fact finding. The questionnaire used during the study was a combination of both closed and open-ended questions used to entreat information from the employees at Steelmakers Zimbabwe. It captured demographic data, time on the job, type of tasks carried out, ergonomic hazards associated with the jobs, their suspected effects, the effectiveness of measures that are in place to control these

hazards if any and the questionnaire also gave the respondents a chance to add their views and recommendations towards the subject under study. The main objective under this method was to be able to quantify and qualify data obtained and be able to analyse it both quantitatively and qualitatively. This method was both cost-effective and non-time consuming and the questionnaires were self-administered. Refer to Appendix 3.1 for the questionnaire used in this study.

3.4.2. Interviews

Interviews and questionnaires bear many similarities in that they involve questionnaires that are administered in person. However, an interview conversation is much more flexible and has personal questions. Structured interviews were adopted as a guide to obtain information pertaining to organisation of ergonomics in the company. This method was selected as it allows the researcher to investigate and prompt things one cannot observe such as thoughts, values, prejudices, views, feelings and perceptions (Jerry and Marcin 2007). This method allows the interviewer to alter questions depending on how the interviewee is answering. Appendices 3.2 show the structured interview guides that were used during the study.

Table 3.1 Interviewees and rationale for choosing them

Interviewee	**Rational for choosing them**
Chief safety officer (Appendix 3.2.1-Health works)	➢ Is responsible for company SHE policy, manuals and procedures implementation. ➢ Is responsible for training employees on safe operating procedures. ➢ Carries out daily plant inspections, monitors working behaviors and proposes recommendations hence is in the best position to assess the ergonomic hazards encountered by employees and keeps records of all the injured employees.
Human resources personnel (Appendix 3.2.3)	➢ Responsible for enrolling employees, keeps all employee records and is also responsible for training.
Nurse in charge (Appendix 3.2.1-	➢ Attends to all occupational injuries and keeps all clinical records of the employees.

Health workers)	
NSSA inspector/Egonomist (Appendix 3.2.2)	➢ Have information on the occupational, health and safety legislation in relation to ergonomics. ➢ Carries out OHS inspections in organisations including Steelmakers.

Key informants were purposefully selected since this method tends to be time consuming.

3.4.3. Field observations

Harrell and Bradley (2009) suggested that direct observation is a data collection method in which the researcher does not participate in the interactions. Jerry and Marcin (2007) on the other hand argue that observation method can also involve several stages of participation of the observer. These however reach a conclusion that observations allow the study of people's behavior. In addition to this one can also observe for instance in this study the type of equipment/tools being used, the workstation itself and can draw meaningful conclusions on whether or not the workstation environment is ergonomically conducive for employees. Employees were observed as they were carrying out their duties on how they interact with each other and their working environment; how they operate their machinery, handle their tools and also the frequency of breaks they take during the course of their work. Appendix 3.3 shows the observation checklist used during the study.

3.4.4. Secondary data sources

Secondary data sources are datasets that are already available, in this instance sources such as journals, books, clinical records, accident investigation and report forms, safe operating procedures and manuals.

3.4.4.1. Steelmakers Zimbabwe SHE and Clinical records

The department keeps records of all accident statistics, investigations and reported injuries. The department also has safe operating procedures (SOPs), a manual and a she policy in use. In addition to these there are copies of all the legislation governing occupational health and safety. Information of any use in relation to ergonomic hazards associated with the production of steel at the company was also drawn from these secondary sources. Accident statistics for the past five years were accessed for the analysis of trends, major causes of accidents and nature of injuries.

SOPs, manuals and SHE policy were analysed by the student and helped come to a conclusion whether the policies address the issue of ergonomics, to what extent and what needs to be done to improve the already set structures. On the other hand, the clinic keeps mainly two types of registers that is one for injuries on duty and the other for sick cases. There was need to identify to what extent does the clinic recognize ergonomic injuries and if there are any measures in place towards minimizing the exposure of employees to ergonomic hazards.

3.5. Data analysis and presentation

Data analysis and presentation can be referred to as organisation of data, providing structure and eliciting meaning. Data from the questionnaires was mainly analysed through SPSS and Microsoft excel while interviews and field observations' results were used for the qualitative discussion. The information was then presented through tables, bar graphs, pie charts and test of significance were also carried out (Chi-Square tests).

3.6. Ethical considerations

Jerry and Marcin (2007) defined ethics as postulates regarding what people ought to do, or their moral principles of conduct. The whole research project takes ethical considerations from formulation of research project up to presentation and reporting.

- The design and planning of the research was structured in such a way that it does not deprive some participants of their privacy. The researcher ensured that they were not susceptible to any risks as a result of this research project.
- The research methods and procedures employed encompassed obtaining consent from participants; there was no deception and manipulation in gaining access.
- In analyzing the data, fabrication, ignoring and filtering of results that do not fit the researcher's expected end was considered unethical therefore it was avoided at all costs.
- Conclusions only consistent with the results were drawn.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter presents the research findings. It encompasses the discussion of the results gathered and comparisons to previous research work done in the field of ergonomics and occupational health and safety. These results and discussion are guided by the research objectives raised in chapter one.

4.1. Organisational SHE structure at Steelmakers

Steelmakers Zimbabwe Private limited is made up of five main plants namely the Smelting, Foundry, Rolling mills, Crusher and Oxygas plant. All these departments or plants have got one central Safety Health Environment and Quality manager who reports directly to the Group General Manager and one Chief safety officer who works with other safety officers, SHE representatives and attachees.

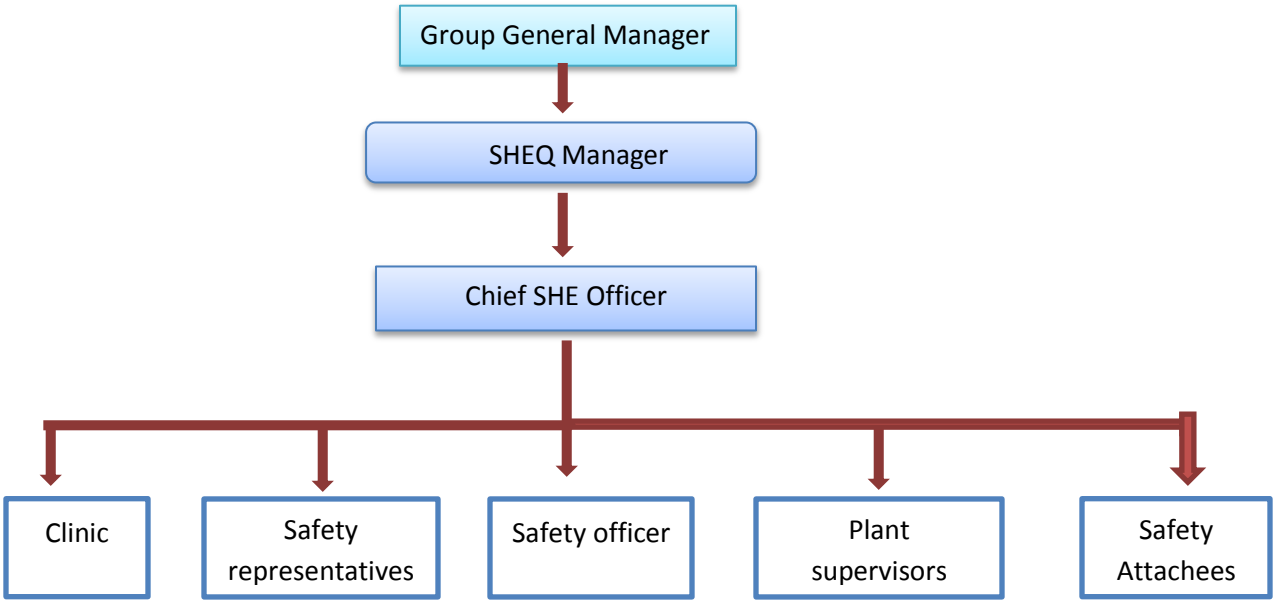

Figure 4.1: Organisational SHE structure at Steelmakers Zimbabwe (Pvt) Ltd.

The SHEQ manager controls all safety, health, environment and quality issues at steelmakers. The manager works with the safety department and quality department. In the safety department, she advices the company management on legal and statutory instruments related to SHE issues

and enforcement of Occupational Health and Safety (OHS) legislation. Some of the manager's duties include carrying out major accident investigations, planning committee meetings and workshops. The chief safety officer induct and train new employees, visitors and contractors on Safety Health and Environmental (SHE) issues, enforces safety legislation and policies, ensure that all employees adhere to safe work procedures through daily plant tours, carries out all accident investigations, monitor enforcement of recommendations, process and send claims to NSSA and carry out SHE trainings with employees. Safety officers and attachees carry almost the same duties, doing accident investigations, safety audits, and hazard identifications and monitoring safe work behavior. Plant supervisors on the other hand works hand in hand with employees ensuring that safety talks are held daily, monitoring employee behavior and identifying risks and hazards as they arise. Safety representatives include supervisors, employees and contractors. These seat in the SHE executive meetings supposedly done every month, they raise SHE concerns of employees and help the SHE department with recommendations and monitoring. The clinic mainly helps injured employees with immediate medical attention, carries out awareness campaigns and doing medical examinations.

4.2 Types of ergonomic hazards

The first objective was to identify ergonomic hazards while the second was to analyse the effects of ergonomic hazards at Steelmakers Zimbabwe (Pvt) Ltd. To achieve these objectives, questions were asked on occupational safety and health hazards around the workplace, causes of accidents, personal protective equipment and observations. Analysis of relationships were undertaken in order to analyse the cause and effect relationships of ergonomic hazards. Figure 4.2 and table 4.1 shows the hazard types yielded from the questionnaire responses.

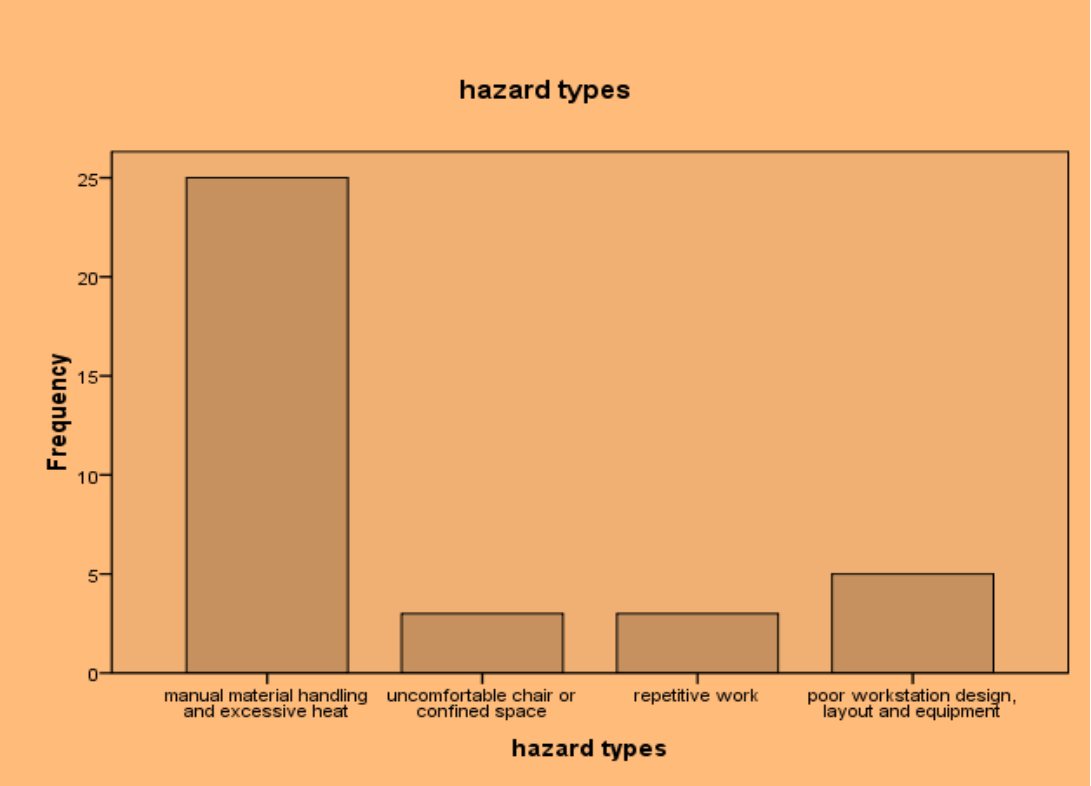

Figure 4.2 The types of ergonomic hazards at Steelmakers

Source: Field survey (2015)

Table 4.1 Types of Ergonomic Hazards

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	manual material handling and excessive heat	25	69.4	69.4	69.4
	uncomfortable chair or confined space	3	8.3	8.3	77.8
	repetitive work	3	8.3	8.3	86.1
	poor workstation design, layout and equipment	5	13.9	13.9	100.0
	Total	36	100.0	100.0	

As noted in table 4.1 manual material handling accounts for 69.4% of the hazards, uncomfortable chairs/confined workspace; repetitive work, and poor workstation design, layout and equipment accounts for 8.3%, 8.3% and 13.9% respectively. This is so because most of the work done at Steelmakers Zimbabwe involves manual handling such work as packing material, tonging during rolling and pushing and pulling of scrap material. The Chief Safety Officer indicated that,

> "absence of forklifts and other lifting aids increase the risk of injuries from manual material handling, and the shortage of transport and other resources result in employees doing the work manually that should be done with the aid of trucks such work as moving scrap material from one point to the other, they end up pulling or pushing carts around which requires excessive force."

ILO (2005) also noted that manual handling of large, bulk objects is common in iron and steel industries despite the high degree of mechanization and aid devices. Plate 4.1 shows some of the tasks performed at Steelmakers that require manual material handling

Plate 4.1 Tongs men performing their work.

Source: Field observations (2015)

The Tongs men works in groups of ten, two per rolling stand. Their work involves inserting hot steel bars from one pass to the other. Their work involves repetition, pulling and pushing steel

bars using the tongs. This work is performed four hours to five hours per day having one hour breaks in between. Jerie (2012) noted that most manual material handling tasks constitute risk or injury and the factors under consideration being the task, load, work environment and individual capacity. In terms of individual capacity, the tongs men are limited because their work is paced by the mill and they have to adapt to that speed which most of them highlighted that it is difficult to keep up with the pace.

Confined spaces or uncomfortable chairs accounted only for 8.3% because only a few people work in confined spaces and those with uncomfortable chairs were mainly crane operators and machine operators. Plate 4.2 was captured during field observations and it shows a sitting workstation whereby this employee spends the whole day operating the cold shear machine while on an uncomfortable steel chair.

Plate 4.2: Employee operating machinery whilst on an uncomfortable chair

Source: Field observations (2015)

This increases the risk of lower back pains and at times their feet will be suspended while they operate. Scott *et al* (2010) noted the following for seating work stations:

> "No one posture is suitable all of the time or for all people. Regular changes in sitting postures are necessary to reduce the effects of straining the same muscle groups and fatigue. Tasks should be organised so that people can take breaks periodically. If people

are seated for most of the working day they need well-designed seating including adjustments and padding. No chair will seat people comfortably for more than about an hour at a time. Even the best designs become uncomfortable over time. Work seating should be adjustable at least in seat height and backrest angle. Adequate lumbar support at the base of the spine is important for comfort and back care."

Although confined workplaces and uncomfortable chairs accounted for only 8.3%, employees at these workstations are at the risk of developing MSDs taking into consideration what Scott *et al* (2010) said.

4.3 Nature of injuries

A number of injuries rising from poor ergonomics were gathered through the survey. Figure 4.3 shows the various injuries which were identified by respondents.

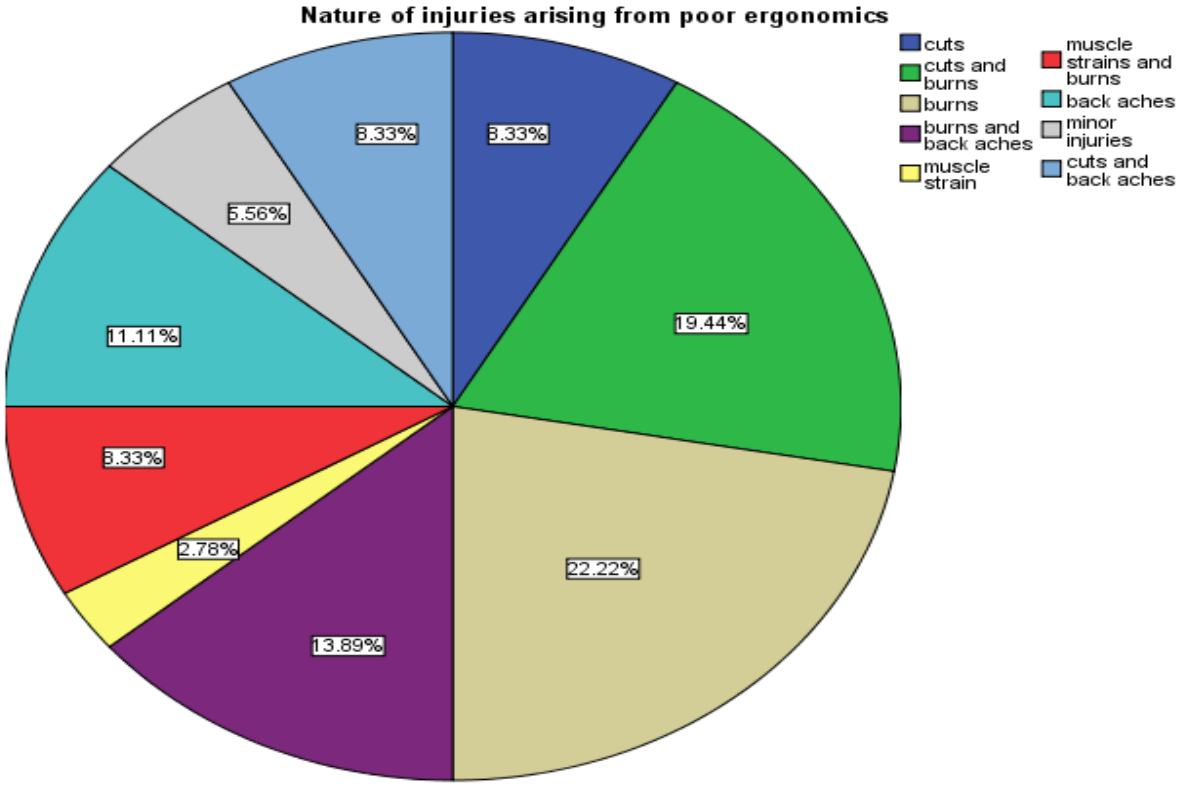

Figure 4.3 Nature of Injuries arising from poor Ergonomics

Source: Field survey (2015)

Twenty-two percent of the respondents indicated that they experience burns due to poor ergonomics while 19.44% indicated they experience both cuts and burns. Others indicated they experience cuts alone (8.3%); cuts and back aches (8.3%), others just minor injuries (5.6%), burns and back aches (13.89%) and so on. Poor ergonomics at Steelmakers mainly accounts for instant injuries.

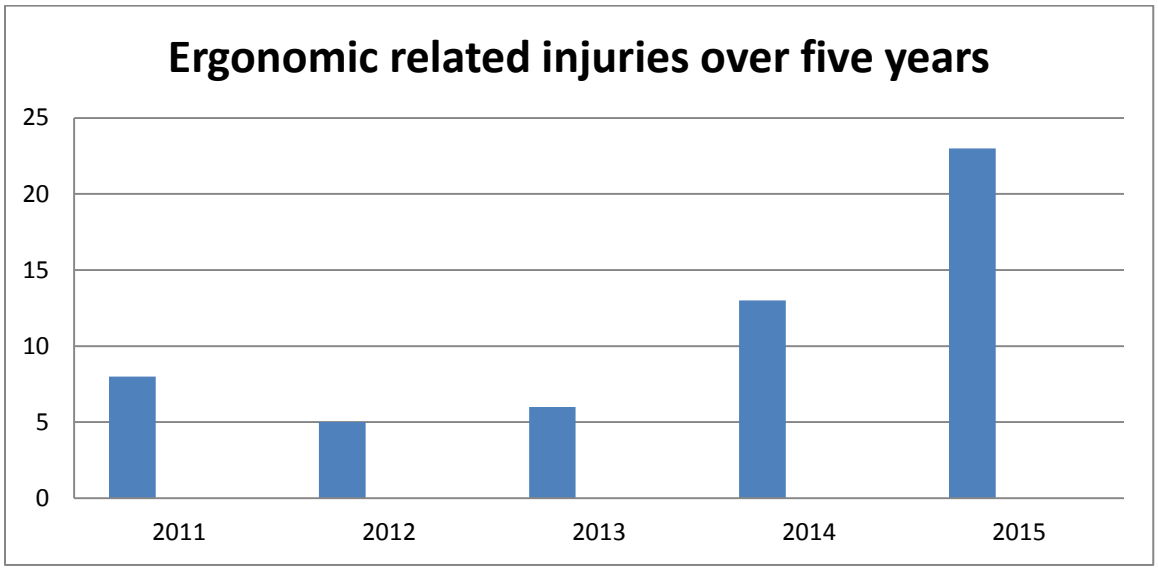

Figure 4.4 Injuries related to ergonomics over five years

Source: SHE records at Steelmakers (2011-2015)

Figure 4.4 shows a trend in the ergonomic related injuries at Steelmakers. According to the accident register these injuries were due to improper PPE, poor workstation layout, forceful movements and heavy lifting of loads. The injuries also varied from back aches, cuts, muscle strains and burns.

Table 4.2: Chi-Square Tests for the types of hazards and nature of injuries

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.421[a]	24	.117
Likelihood Ratio	30.000	24	.185
N of Valid Cases	36		

The Chi-Square value for table 4.6 is 0.12 and it is greater than 0.05 therefore there is no association between the types of hazards and the nature of injuries reported. An interview with the clinic's sister in charge indicated that some of the main ergonomic injuries such as back aches, pains of the shoulders and wrists sometimes go unnoticed due to lack of knowledge of ergonomics.

4.4 Knowledge of ergonomics amongst employees

Sixty-six percent of the respondents indicated that they are not familiar with the term ergonomics while 39% indicated that they are familiar with the term. Those who are familiar with the term indicated the following as consequences of poor ergonomics: "workplace injuries, backaches, weak joins and straining muscle, absenteeism and low production." A Chi-Square test was undertaken to determine whether there is any association between the respondents' level of education and the knowledge of ergonomics.

Table 4.3: Chi-Square Test for level of education and knowledge of ergonomics

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.134[a]	3	.545
Likelihood Ratio	3.176	3	.365
N of Valid Cases	36		

As noted above the Pearson Chi-Square value is above 0.05 therefore we reject H_1 and accept H_0 meaning that there is no association between the level of education and knowledge of ergonomics. Ergonomics is relatively a new field in Zimbabwe and it has not been fully incorporated in other studies except for those students doing medicine or occupational health and safety. It might have been the case that those who had knowledge of ergonomics would have been trained at work. Scott *et al* (2010) is also of the view that most developing countries have very limited knowledge concerning ergonomics and that they have very few qualified ergonomists. This is true for Zimbabwe, the country's organisation that deals with OHS issues NSSA only have one ergonomist at the moment, whereas it is even advisable to have an ergonomists in industrial firms to boost productivity and safety.

4.5 Workload of employees

The researcher also got responses on workload. The responses varied from average to too much workload; however 55.6% of the respondents noted that the workload was too much. The table below shows the responses for workload.

Table 4.4 Workload of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Average**	**6**	**16.7**	**16.7**	**16.7**
	High	10	27.8	27.8	44.4
	too much workload	20	55.6	55.6	100.0
	Total	36	100.0	100.0	

When asked of the effect the workload had on them, the respondents gave different responses. Eleven respondents indicated that they would end up not having any rest while fifteen indicated too much workload leads to fatigue and mental stress. Another respondent who is a machine operator indicated that too much workload leads to stress and development of back pains. One other also responded to the question on the effect of the workload that "it may cause ergonomic problems like pulling of muscles and pain of the back." This might be as a result of the work posture and repetition of work all day long. The responses signaled that workload can also be a cause of ergonomic hazards as it increases the number of working hours minimising breaks. Five of the responses from packers highlighted that their work conditions pose the risk of injury to their musculoskeletal system and further indicated the body parts mostly affected are the back and the hands.

Packers normally work in groups of fours. During the field observations and interviews, the employees who work at the packing section indicated that they sometimes work for more than nine hours up to twelve at times depending on the available material. They only rest when there is a breakdown or when material is unavailable for packing. Most of them indicated that they

have too much workload and their work involves repetitive motions, continuous bending and manual handling of material, for instance the stopper used is heavy. As a result most of them highlighted that they end up experiencing back and shoulder pains. They also indicated they do not normally report these pains except for instant injuries and excessive muscle strains.

A Pearson's Chi-Square test was taken to determine if there is any association between number of working hours and workload of the worker.

Table 4.5 Chi-Square Tests for the number of working hours and overall workload of respondents

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.191[a]	6	.058
Likelihood Ratio	12.637	6	.049
N of Valid Cases	36		

The Chi-Square value for table 4.3 is 0.058 which is slightly above the critical value, there we accept H_1 and reject H_0 meaning that there is a slight association between the number of working hours and overall workload of respondents. As noted from the questionnaire responses, as the workload increases, the number of working hours also increases limiting the amount of rest time for employees. Therefore too much workload increases the risk of the burden for musculoskeletal disorders.

4.5.1. Leave conditions of respondents

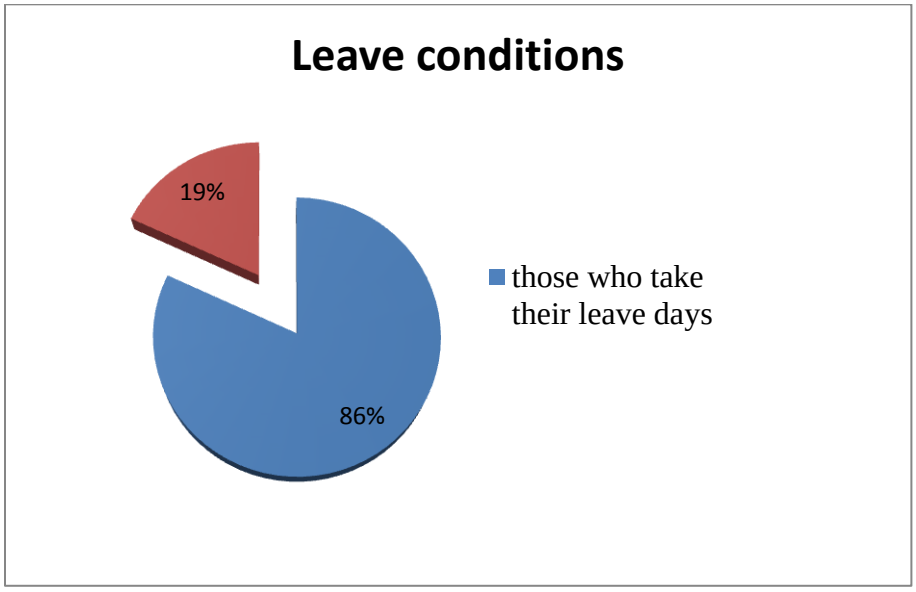

Figure 4.5 Leave conditions

Source: Field survey (2015)

As noted in the pie- chart above, 86% of the employees indicated that they do not take their leave days while only 19% indicated that they take all their leave days. While employees indicated that the importance for taking vacation leave is mainly for resting many of them are not going because of the following reasons obtained from questionnaire responses:

- Some indicated they only take a few days off in case of emergencies
- Some sell their leave days due to demanding production rate
- Some indicated that they cannot go for leave since they are only contract workers.
- Others mentioned shortage of manpower

The Labour Act (14:08, 2005) states that employees are entitled to an annual leave of thirty calendar days at the end of each year with an employer. This gives them time for renewal; however, most employees at Steelmakers do not take time for leave putting them at the risk of developing cumulative trauma disorders taking into account the identified ergonomic hazards.

4.6 Ergonomic control measures

The third objective was to assess the effectiveness of measures in place to combat the impacts of ergonomic hazards. An interview with the Human resources manager who also used to be the SHE manager till December 2015 noted the following ergonomic control measures,

> "Awareness campaigns and in-house training, mechanical audits and other safety audits national policies and legislation, accident investigations and remedial actions."

The Chief Safety and health officer noted the following current control measures;

> "We have Safe Operating Procedures (SOPs) and there are SOPs for every department and machinery that requires extra safety precautions. These procedures mainly state hazards and risks found in a department and how employees are supposed to carry out their duties in that department, we also train employees every quarter but sometimes when need arises for instance, a department with many injuries for that month. We train employees on lifting techniques e.g. use of legs and not the back. Moreover, there are fans and one hour breaks for the tongs men who work in an extremely hot environment and at some point they were given refreshments to cover for the water lost through diaphoresis (sweating). The safety department also carries out monthly safety audits in which we assess housekeeping, state of machinery, and electrical appliances."

These were the words of the Chief Safety Officer when asked on the ergonomic control measures they have. She however noted that the machinery is now old which limits the success for the safety audits they carry. She also noted that NSSA carry out inspections and pass recommendations which sometimes are not fully implemented because of the current economic environment. In as much as training is concerned she noted that NSSA also carries out trainings but they are limited by resources as the trainings are not done freely.

Employees' responses from the questionnaire survey were also used to assess the effectiveness of measures in place to control ergonomic hazards. Table 4.6 shows responses from employees after they were asked whether the measures in place by management lack clear strategies for action.

Table 4.6 Responses for control measures' strategies for action

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree strongly	14	38.9	38.9	38.9
	Agree	11	30.6	30.6	69.4
	Moderate	10	27.8	27.8	97.2
	Strongly disagree	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

The responses show that fourteen of the thirty-six respondents strongly agreed that control measures by management lacked clear strategies for action while eleven just agreed, ten moderately agreed while just one strongly disagreed. A Pearson's Chi-Square test was also carried out to determine whether there is any association between the clarity of control strategies by management and effectiveness of control measures.

Table 4.7 Chi-Square test for the measures' lack of clarity on strategies for action and effectiveness of these measures.

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.099[a]	12	.049
Likelihood Ratio	22.107	12	.036
N of Valid Cases	36		

As noted above, the Chi-Square value for the test is 0.049 and it is slightly less than 0.05 therefore we accept H_1 and reject H_0 meaning there is any association between the measures lacking clear strategies for action and the effectiveness of control measures. This means that if control measures lack clear strategies for action they consequently become ineffective in

controlling the hazards. There is also a possibility that employees were not adequately trained in relation to ergonomics. Table 4.8 below indicates responses from questionnaires where employees were asked whether training in relation to ergonomics was inadequate. Their responses were given as ordinal/ranked data.

Table 4.8 Employee training on ergonomics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree strongly	12	33.3	33.3	33.3
	Agree	17	47.2	47.2	80.6
	Moderate	1	2.8	2.8	83.3
	Disagree	2	5.6	5.6	88.9
	Strongly disagree	4	11.1	11.1	100.0
	Total	36	100.0	100.0	

Of the respondents, 12 strongly agreed that training in relation to ergonomics at work was inadequate, 17 just agreed, 1 was moderate, 2 disagreed while 4 strongly disagreed. A larger percentage (80.6%) did not receive adequate training on ergonomics that perhaps explains why the control measures were ineffective and lacked clarity because they did not understand them.

Below is a list of factors that were raised from questionnaires that hinder the effectiveness of occupational health and safety regulations:

- Lack of/inadequate/inconsistent training and provision of safety clothing
- Individual safety culture aspects
- Current economic situation which is ailing at the moment
- Long working hours
- Lack of implementation from the management and proper follow ups by the safety department and NSSA inspectors
- Lack of respect for workers' rights

- Consideration of production over safety issues
- Noncompliance of safety regulations by the company
- Employees lack of interest in training
- Use of old model technology which is largely manually operated.

These were the top factors hindering the effectiveness of OHS mentioned by employees during the questionnaire survey.

The Chief SHE officer also noted some factors hindering the effectiveness of OHS. She noted that changing the whole plant would be one of the most viable ergonomic control measures; however she noted that it is too expensive and considering the current economic environment it is almost impossible. She went on to note cultural differences in the sense that it is an Indian organisation based in Zimbabwe henceforth the way Indians perceive safety issues might differ from the way Zimbabweans perceive them. An interview with the NSSA OHS inspector raised the following as some of the factors hindering the effectiveness of OSH regulation on ergonomics,

> "There is a conflict of interest between employers and inspectors whereby employers are mostly concerned with production while inspectors are concerned with safety of employees. The extent of reporting is poor- musculoskeletal disorders (MSDs) may be ignored as they are gradual. There is also a weakness on the law that does not fully recognize ergonomic injuries due to their gradual nature. There is lack of in-house expertise per company on ergonomics; at least a company should have an ergonomist. There is poor level of appreciation of ergonomics in companies and even at national level since this is relatively a new field in Zimbabwe and thus the extent of the damage of MSDs cannot be ascertained here. People may not report because they do not get anything or any specific help."

These are some of the major hindrances mentioned by the NSSA inspector on the effectiveness of ergonomic control measures in Zimbabwe. The International Labour Office (2013) also noted that the current global economic recession which leads to reduced production and downsizing of companies amongst others is also responsible for depreciating OHS standards in industries.

4.7 Personal Protective Equipment

Personal protective clothing is the last line control measure in the event engineering controls are not feasible. Responses from questionnaires revealed that only 17% of the respondents are provided with protective clothing while 83% indicated they are not provided.

Table 4.9: Chi-Square Test for the type of PPE provided and frequency for provision

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	74.951[a]	35	.000
Likelihood Ratio	66.799	35	.001
N of Valid Cases	36		

The Chi-Square value for table 4.10 is 0.00 and it is less than 0.05 therefore we accept H_1 and reject H_0 meaning that there is significant association between the type of personal protective equipment provided and the frequency for provision. Respondents from the questionnaire survey highlighted that gloves are the only PPE type they are provided with in most cases. There is no specific time interval for provision of different types of protective clothing. Figure 4.6 shows the type of personal protective equipment provided.

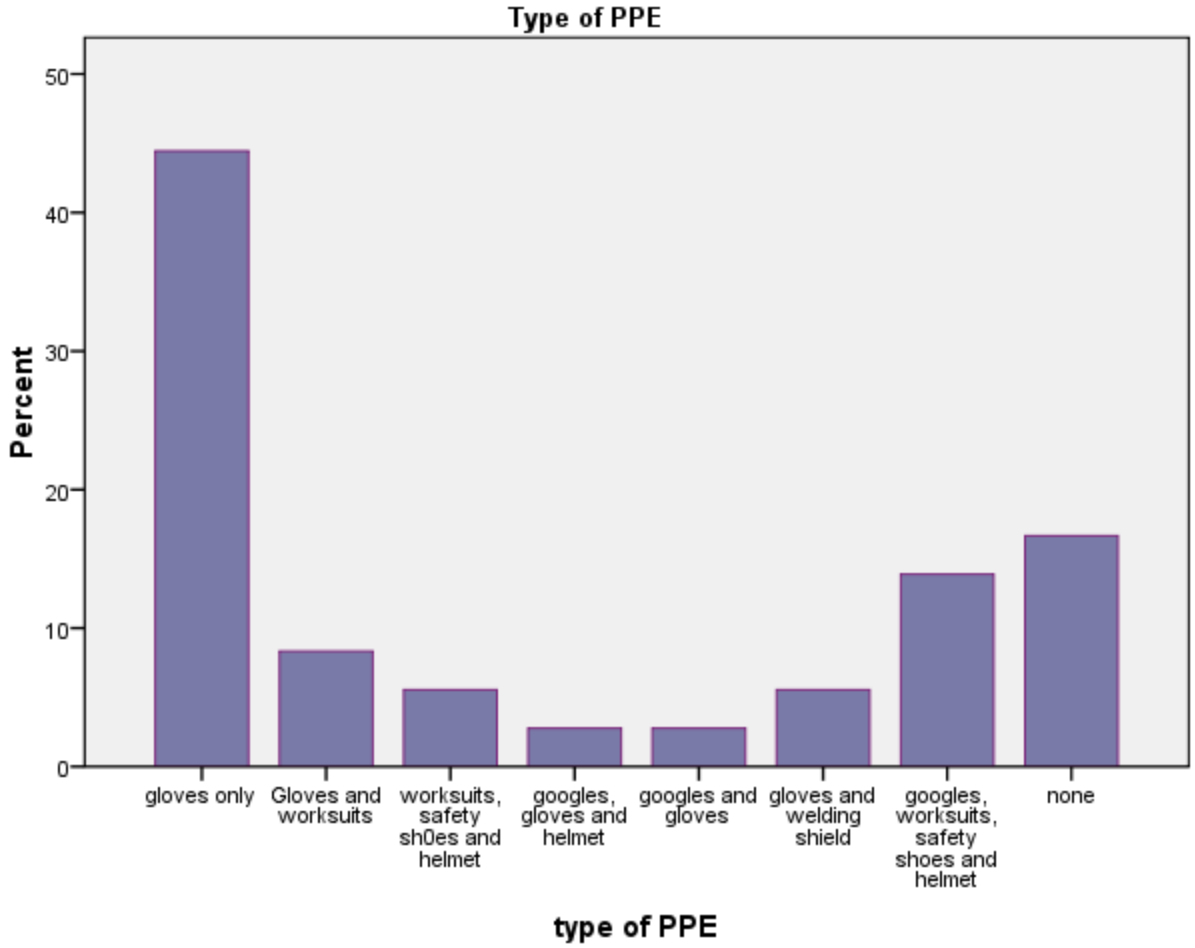

Figure 4.6 Source: Field survey (2016)

Other types of PPE such as work suits and safety shoes are provided to employees sometimes once a year or twice and other indicated they buy their own personal protective equipment. Most employees also noted that the gloves provided are not that comfortable to use during performing their tasks while some tongs men also noted that they are not provided with leggings frequently. Plate 4.3 shows how some tongs men had dealt with the problem of lack of leggings. They continue using the old torn legging tying them around but they are not comfortable.

Plate 4.3 Shows type and condition of leggings and safety shoes used by Tongs men

Source: Field observations (2015)

4.8 The Legal framework and workplace ergonomics

Steelmakers Zimbabwe as a manufacturing industry in Zimbabwe is required by law to follow certain Occupational Health and Safety Legislation throughout its entire operations. Throughout the interviews and field observations, it was noted that the company is aware of some of the legislation governing OHS for instance their commitment to the Factories and Works Act (14:08), Statutory Instrument 68 of 1990 and others. These other pieces of legislation only imply the issue of ergonomics. The company is required by law to establish a SHE policy which read;

> *"Steelmakers Zimbabwe (Pvt.) Ltd is a steel manufacturing company. As management we acknowledge that it is our solemn obligation to harmonize our operations with our surrounding environment as well as creating a safe working culture within our work environment. In order to continue to implement our drive towards this goal, our health and environmental strategy includes the following elements;*

- *Compliance with statutory instruments aimed at promoting health, safety and environmental management*
- *Ensure that all employees, contractors and business partners are inducted on occupational safety, health and environmental matters and understand their obligations with respect to this policy*
- *Conduct regular safety audits for compliance by trained inspectors*
- *Commitment to continual improvement and prevention of occupational accidents and illnesses*
- *Involve the workforce in the development and implementation of management systems and standards that minimize adverse safety, health and environmental impacts resulting from its operations, products and services."*

As noted above, the company policy does not clearly state the issue of ergonomics. In an interview it was brought to light that the policy was drafted as per NSSA requirements and that they are supposed to state five or six things as required by NSSA as a result ergonomics is enshrined in other issues on the policy.

On a national scale, the issue of ergonomics is stated in the Zimbabwe National Occupational Safety and Health Policy of 2014. According to the policy, ergonomics is "the adaptation or matching of work to the capabilities of employees in light of their physical and mental health" while a hazard is defined as a "source or situation with potential to cause harm in terms of human injury or ill health, damage to property, damage to the work environment or any combination of these." The policy appreciates that occupational injuries and accidents rise as a result of uncontrolled worker factors, environmental conditions and the state of the equipment and machinery in use hence the fifth Policy objective states that, "To provide for ergonomics, prevention of occupational accidents and for emergency preparedness"

Policy Principle number 12 states that,

> "all lost time injuries preventing or likely to prevent a worker from attending duty for 3 or more shifts, all fatalities immediate or delayed and all injuries to persons not employed in the workplace where the accident occurs such as customers, clients and members of

the public shall be reported to the nearest Inspector of workplaces as soon as possible and certainly within 24 hours of occurrence"

The above principle indicates that the Policy mostly recognizes instant injuries with instant impacts noticeable; however ergonomic injuries are in most cases cumulative in nature that they take time to manifest into a noticeable problem. This is a weakness in the reporting structure as required by law consequently cumulative trauma disorders will progress unreported. This is also the case for Steelmakers; the Chief Safety Officer even noted that it is difficult to classify MSDs as occupational injuries. The industrial nurse however also indicated that sometimes workers report back aches as sick cases that's when they notice that they are in fact occupational injuries.

On the Strategic Areas of Focus part 6.6 "Hazards identification and risk assessment" of the national policy, it is stated that the employers should effect OSH programmes. Programmes are to be implemented in this hierarchy:

- Elimination of hazard or risk,
- Control of the hazard or risk at source through engineering controls or organisational measures,
- Minimising the hazard or risk by designing safe work systems which include administrative control measures,
- Providing personal protective equipment and
- Maintaining a hazard and risk register with all identified and profiled hazards and risks to inform mitigatory programmes.

The last section of the Policy which is OSH in the economic sector part 7.4 speaks on the manufacturing industries. It clearly states that organisations involved in manufacturing should pay attention and monitor occupational safety and health issues which amongst them are the issues of ergonomics.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Ergonomics is a relatively new field in Zimbabwe indicated by the above results. The ergonomic hazards at Steelmakers constitute heavy loads, heat, uncomfortable work spaces and repetitive work. Employees are faced with risk factors such as manual material handling of the heavy loads, over exertion, awkward posture and repetitive motions also implying the risk of musculoskeletal disorders. Accident registers show injury statistics are on the rise from the period 2012 to 2015 signifying the growing concern for ergonomic interventions. It was established during the study that over 60% of the respondents are not aware of the issue of ergonomics and some even suffer ergonomic injuries unaware and they do not report.

The research also established other factors that put the employees at the risk of suffering musculoskeletal disorders such as leave conditions. It was noted that despite the importance of taking all annual leave days, employees sell their days due to economic hardships and shortage of labour. Lack of training on ergonomics also contributed to the employees' lack of ergonomics awareness and probably leaving them susceptible to hazards caused by poor ergonomics. Other respondents from other sections also noted that long working hours led to them getting fatigue and losing concentration on their work. The time factor was raised by employees who assume awkward work postures such as bending the lower back, neck and head. These are at a greater risk of suffering work related musculoskeletal disorders with time.

The research however established that the company had set control measures to control ergonomic hazards. Most of these are administrative such as breaks for the tongs men and some fans. It should be noted that these measures are ineffective as they mainly cater for the tongs men only. There is need to vary tasks across the whole plant and wherever possible introduce some engineering controls which are best fit for ergonomics. In a nutshell, more still needs to be done to fully incorporate the principles of ergonomics at Steelmakers in order to prevent work related musculoskeletal disorders and other injuries resulting from poor ergonomics

5.2 Recommendations

Taking into consideration the findings obtained from this research, the following suggestion were forwarded:

- Steelmakers Zimbabwe (Pvt) LTD needs to form an ergonomics facilitation team which may comprise of workers, supervisors, engineering team and SHE department to overseer ergonomics implementation throughout the whole plant. In addition to this, there is need for a written policy document specifically on ergonomics clearly outlining how they intend to eliminate ergonomic hazards and should show commitment to continual improvement.
- The company SHE department also needs to carry out regular workplace risk assessments on individual workers to identify their capabilities, shortfalls and tasks that put the risk of causing harm because different individuals have different anthropogenic variations hence one workplace may be safe to one but not safe to the other so there is need to continually assess these variations.
- The company should consider engineering controls, that is, automation where possible, offer comfortable ergonomic chairs to machine operators and crane drivers and improve the state of equipment such as tongs and stoppers at packing section in order to minimize or prevent the risk of developing work related MSDs or ergonomic injuries.
- Steelmakers should get certified with the safety management system OHSAS 18001 as it assist to improve compliance by providing a structure for establishing, monitoring and complying with all legal and regulatory requirements that relate to the operations of the company. Getting certified not only improves workers health and safety but ensures quality and increases production and savings.
- There is need for provision of adequate fans in the plant for cooling purposes as the plant is very hot due to hot steel bars and furnaces and the company should also embrace provision of refreshments to cover for the body fluids lost through perspiration.
- Employees need to adopt dynamic and varied work postures and movements, rotating jobs and taking adequate breaks so that they do not end up putting localized pressure on the same muscles which may lead to cumulative trauma disorders or MSDs but rather they get time to rest, renew their strength and use varied muscles.

- There is need for continuous training and education of employees and supervisors on the issue of ergonomics in order to increase knowledge and raise awareness thereby reducing the burden of suffering musculoskeletal disorders/ergonomic injuries.
- NSSA should adopt strict measures in terms of inspection and fines to companies in order to help them comply with regulations so that company top management prioritises safety issues, ergonomics in particular and adopt ergonomic principles to avoid fines and increase savings.
- The country should come up with a separate instrument or policy specifically on ergonomics as it is one of the pillars for sound occupational health, safety and production.
- Last but not least, there is need for a conducive environment in the country, socially, economically and politically as well for sound implementation of laws, policies and regulations.

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APPENDIX 3.1 QUESTIONNAIRE

MIDLANDS STATE UNIVERSITY

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

QUESTIONNAIRE SURVEY: ERGONOMIC HAZARDS ASSOCIATED WITH STEEL MANUFACTURING INDUSTRY, A CASE STUDY OF STEELMAKERS ZIMBABWE IN REDCLIFF.

This questionnaire has been designed to examine the ergonomic hazards that are associated with steel manufacturing at Steelmakers Pvt Ltd. Data obtained from this will be used for academic purposes and will not prejudice anyone involved in the survey.

DEPARTMENT…….....PLACE ……

FIELDWORKER……DATE …….

SCHEDULE NO…….

Section A: Personal data

1. Sex Female ☐ Male ☐

2. Age of respondent ……

3. Educational level …….

3. Occupation……

4. Time on present job ……

Section B: Causal factors

5. What are the occupational health and safety hazards that are around your workplace ……..……..
…….……

6. What are the main causes of accidents in your department …….
……

7. Nature of injuries arising from those accidents ……

8. (a) How often do people get injured: Daily ☐ Weekly ☐ Fortnightly ☐ Monthly ☐

(b) Why is this so …….

(c) Do workplace conditions pose the risk of injury to musculoskeletal system (muscels) ……., if so what parts of the body are mostly affected ……

9. Nature of work mainly responsible for accidents……

10. (a) Are you familiar with the term ergonomics ……....

(b) What are the consequences of poor ergonomics ……

……
……

11. How many hours do you work per day ……..

12. (a) How many leave days do you have annually? ……

(b) Do you take all your leave days annually? Yes…… No……, if no why……

……

(c) Why is it important for employees to take some time off from work? ……...

……

(d) How would you rate your overall workload? Very low ☐ Low ☐ Average ☐ High ☐ Too much workload ☐

(e) What effect does this workload have on employees? ……

……

13.a) Does your employer provide with full protective gear? Yes ☐ No ☐ if no why? ……..

……

b) What type of PPE are you provided with …….

……

c) How suitable is the PPE provided to the tasks performed……

……

d) How frequent are you provided with PPE ……

e) Are employees trained on its proper use ……..

Section C: Management and legislative issues

In this section indicate your response using the index: (1) Agree strongly

(2) Agree

(3) Moderate

(4) Disagree

(5) Strongly disagree

	1	2	3	4	5
14. The measures that have been put in place by management to control ergonomic hazards lack clear strategies of action.	☐	☐	☐	☐	☐
15. The measures in place are effective in controlling hazards.	☐	☐	☐	☐	☐
16. Knowledge on law governing occupational health and safety is low amongst employees.	☐	☐	☐	☐	☐
17. Training in relation to ergonomics at work is inadequate.	☐	☐	☐	☐	☐
18. Employees understand their rights, duties and responsibilities as per the provision of the law.	☐	☐	☐	☐	☐

19. What are the factors that are hindering the effectiveness of occupational safety and health regulations?

……
……

20. What measures have you adopted at individual level to control ergonomic hazards?

……
……

21. Can you recommend any two measures the company and fellow colleagues should adopt in order to minimize the impacts of ergonomic hazards?

……..……
…….

THANK YOU, SIYABONGA, TATENDA

APPENDIX 3.2.1: Interview guide for health workers

1. From your own point of view what are ergonomic hazards?
2. What are the causes of ergonomic hazards in the plant?
3. To what extent has ergonomic hazards accounted for injuries (cuts, bruises, sprains, strains and msds) within the last five years?
4. What effects do these have on employees?
5. What are the measures that are in place to combat the impacts of ergonomic hazards?
6. To what extent does the company SHE policy address the issues of ergonomics?
7. How effective are these measures?
8. How old is the plant?
9. (i) How often do you do trainings?

   (ii) Do you often train employees on the application of ergonomic principles?

   (iii) How effective are these trainings.
10. What are the contributions of NSSA in relation to ergonomic hazards?

What are your recommendations on this subject?

Appendix 3.2.2: Interview guide for the NSSA inspector/ergonomist

1. In your understanding, what are ergonomic hazards?
2. What are the causes/sources of these hazards in the manufacturing industries?
3. To what extent do they affect the employees in Zimbabwe?
4. Can you give an overview of work related musculoskeletal disorders in the manufacturing industries in the Zimbabwe?
5. Does the country have any legislation on ergonomics?
6. How effective is it in addressing ergonomic issues at different levels in the country?
7. What are some of the measures that have been put in place in order to combat the impacts of ergonomic hazards? Any educational campaigns etc.
8. Do you provide organisations like steelmakers with in-house trainings on ergonomics
9. How can basic ergonomic principles be applied at steelmakers to minimize the impacts of ergonomic hazards?

APPENDIX 3.2.3: Interview guide for the human resources personnel.

1. From your point of view what are ergonomic hazards?
2. To what extent do you know the effects these have on employees?
3. What is it that you consider when recruiting new employees into the plant? Are there any medical examinations required prior to commencement of work?
4. (i) How do you determine whether the candidate is fit for the working environment that is the degree to which the job's demands will be met?

   (ii) How do you ensure that the environment will meet the needs, abilities and skills of the candidate?

5. To what extent does the company enrolment policy address the issue of ergonomics?
6. Give any recommendations on how ergonomics can be incorporated in daily human resources business

Appendix 3.3: Observation checklist

Department/Section	Activity	Ergonomic hazards	Corrective action
Smelting			
Continuous casting area			
Pre-heating furnaces			
Rolling mills			
Machine shop			
Cooling bed			
Packing			

Additional information

……
……
……