

**THE ERGONOMICS ISSUES OF OPERATIONAL
LEVEL EMPLOYEES IN ZOOS- A CASE OF
NATIONAL ZOO IN SRI LANKA**

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Master of Science in Occupational Safety and Health Management

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Thesis/Dissertation submitted in partial fulfilment of the requirements for the Master
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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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ABSTRACT

A zoo or zoological garden is a park where captive animals often from all over the world, live and are exhibited to visitors. Occupational ill-health problems in zoos can be caused by any or a combination of exposure to harmful substances, inhalation of harmful particles, poor working practices such as excessive or inappropriate manual handling, environmental factors, such as noise, poor light or cramped working conditions and diseases transmitted by animals.

Ergonomics can be described as a system of interaction between components in the workplace, which include the worker, the work environment (both physical and organizational), the task and the workspace. In manual handling, if done incorrectly or inappropriately it can result in one of several disorders of the muscles, joints and bones. The main cause is neglect of ergonomics principles which leads to bring inefficiency and discomfort to the workers. There is often an acute lack of awareness of ergonomics issues, education and training programmes and certification within developing countries. Ergonomics is the new phenomenon to Sri Lanka and studying and analyzing ergonomics related problems is still draw low acceptance and limited application in the zoos in Sri Lanka.

The literature survey was done to identify the concept of ergonomics and the elements of ergonomics. It also describes the ergonomic risk factors which are relevant to zoo workers.

The case study approach was figured out as the best research approach for this research while observations, preliminary survey questionnaires and semi structured interviews were selected as the best methods to collect data. Also, the research has executed through both quantitative and qualitative research analysis techniques. Statistical analysis including descriptive statistics, likert-scale and RII (Relative Importance Index) as well as content analysis were used for data analysis of this research.

As per the results of the pilot survey analysis, the indirect ergonomic risk factors are the age limit, work experience and number of working hours. Based on these findings, expose to dust, expose to odour, poor conditioned tools, poor condition of

machines, poor work design, poor communication, lack of work training and lack of involvement in decision making are the major ergonomic risk factors in the zoo. In addition to that, the survey was found that the discomforts among operational level employees due to poor ergonomics in the zoo are low back pain, discomforts in thigh/ knee and discomforts in hand/wrist. The illnesses found are tiredness, eye weakness, extensive sweating, muscular pain and numbness. Based on the results of observations, preliminary questionnaire survey and interview it can be concluded that the current practice of ergonomics in the zoo exist at a low level.

Key words: Ergonomics, Zoos, Risk factors, Sri Lanka

DEDICATION

To My Beloved Parents.....

ACKNOWLEDGEMENT

This research study would not have been possible without the assistance and dedication of numerous individuals and organizations. Therefore, I take this opportunity to convey my gratefulness to each and every one of them.

It is my foremost duty to pay my gratitude to Prof. (Mr.) Lalith De Silva, my dissertation supervisor for his keen interest, continuous encouragement, invaluable guidance and precious support in making this research study a reality.

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I wish to express my greatest appreciation to all the professionals in the Zoo field and all the operational level employees in the Zoo who contributed to this study by actively participating in the data collection process despite their busy work schedules. Unless for their valuable ideas, assistance and commitment, this study would not have been possible.

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LIST OF ABBREVIATIONS

HFESA- Human Factors and Ergonomics Society of Australia

IEA- International Ergonomic Association

ILO- International Labour Organization

ISO- International Organization for Standardization

MSDs - Musculoskeletal Disorders

OHS- Occupational Health and Safety

OSHA- Occupational Safety and Health Administration

PPE- Personal Protective Equipment

RII- Relative Importance Index

CHAPTER 01

1.0 INTRODUCTION

1.1 Background

The most important factor in any business is the people. The human resource differs from other resources as it has complex behaviors. According to the Confederation of Women Entrepreneurs (2014), health and safety of the employees are important aspects in an organization's smooth and effective functioning. Furthermore, it has been mentioned that good health and safety environment ensures an accident-free industrial set up and maintenance of occupational safety and health is very closely related to productivity and good employer-employee relationship.

According to Shikdar & Sawaged (2003), improving worker productivity and occupational health and safety (OHS) are major concerns of industry, especially in developing countries due to its high dependency on human labour. Moreover, the same authors stated that some of the common features for poor productivity of these industries are improper workplace design, ill-structured jobs, mismatch between worker abilities and job demands, adverse environment, poor human-machine system design and inappropriate management programs and these factors lead to workplace hazards, poor worker health, mechanical equipment injuries, disabilities and in turn this reduces worker productivity, product/work quality and increases cost. World Health Organization (WHO) (1999) pointed out that the health status of the workforce in every country has an immediate and direct impact on national and world economies. Total economic losses due to occupational illnesses and injuries are enormous. According to International Labour Organization (ILO) (2003), based on a selected compensation system, it has estimated that 4% of Gross Domestic Product is lost due to accidents and work-related diseases.

According to Citing Wikipedia (November, 2010), OHS may involve interactions among many subject areas including occupational medicine, occupational hygiene, public health, safety engineering, industrial engineering, chemistry, health physics,

ergonomics and occupational health psychology. Therefore, the ergonomics play a pivotal role within the OHS. The International Ergonomics Association (IEA) (2014) defines ergonomics as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system and the profession that applies theory, principles, data and methods to design the working environment in order to optimize human well-being and overall system performance. The primary objective of ergonomics is to ensure a good fit between the workers and their jobs, thereby maximizing worker comfort, safety, efficiency and productivity (Render & Heizer, 2001). Effective application of ergonomics in work system design can achieve a balance between worker characteristics and task demands (Shikdar & Sawaqed, 2003).

A zoo is defined as a permanent establishment where living, wild animals are kept for exhibition to the public for seven days a week or less with or without charge for admission. This will include; aquaria, sanctuaries, bird gardens (including birds of prey), safari parks and any collections of living species on display to the public (Health and Safety Executive- HSE, 2012). According to Citing Wikipedia (May, 2014), jobs such as zookeeper or zoo workers are labeled as dangerous job positions with limited regulations regarding the safety of zoo workers exist. In most of the zoos there are workers who perform the garden landscaping related tasks.

According to HSE (2012), occupational ill-health problems in zoos can be caused by any or a combination of the factors as exposure to harmful substances, inhalation of harmful particles, poor working practices such as excessive or inappropriate manual handling, environmental factors, such as noise, poor light or cramped working conditions, diseases transmitted by animals and work related stress. The manual handling is quite simply moving an object using one's body and includes supporting, lifting, lowering, pushing, pulling and throwing. If done incorrectly or inappropriately it can result in one of several disorders of the muscles, joints, bones and spine. Some of these conditions can be short term while some can result in long term ill health and especially if appropriate action is not taken, may even prevent someone from working thereafter (HSE, 2012). According to Jiang (2011), farm

workers and gardeners constantly use hoes to move soil, to cultivate and to create trenches for seeding. However, many hoes are not ergonomically designed and require wrist bending, body bending and awkward posture. These factors may cause unexpected injuries such as carpal tunnel syndrome, musculoskeletal disorder and lower back injuries.

According to HSE (2012), the management or control of health and safety at the zoo is an important factor in ensuring the health and safety of the employees and others who may be affected by the zoo's activities. Organizations are now expected to control health and safety as they would affect other core activities. Preventing harm to employees and preserving human resources is viewed as being cost effective and vital to reduce financial losses and liabilities. Further, it is said that the occupational ill health can lead to years of pain and suffering, resulting in sickness, prolonged absence from work and in some cases, early retirement. Yet occupational ill health is preventable and if zoo operators can survive with reduce ill health, they also reduce operating costs. Long-term sickness absence has a devastating effect on the productivity of business as well as the well-being and employment prospects of workers.

Occupational Safety and Health Administration (OSHA) (2004) does not designate a specific section of standards and regulations for zoo workers. However, the requirements for zoos fall under OSHA's general regulations for maintaining a safe and healthy work environment. According to Fontes (2008), it is also necessary to provide additional training to cover risks or hazards faced by animal handlers even if it is not mandated by regulation. Examples of training programs in this category include ergonomics and slips, trips or falls, effective use of the bio safety cabinet or chemical fume hood, safe handling of sharps and sterilization/disinfection.

Universally, ergonomics related issues are among the leading causes of low productivity in today's work environment. The situation is reportedly even worse in developing countries with appalling working conditions in many industries. In addition, there is often an acute lack of awareness of ergonomics issues, education

and training programmes and certification within developing countries (Sealetsa & Thatcher, 2011).

According to Jayaratne (2012), ergonomics have not yet well penetrated relevant fields in industrially developing countries, such as Sri Lanka. Most of the international research studies have done on ergonomic issues among veterinarians in zoos but not among zoo operational level workers. This research attempts to identify the ergonomic related issues and their risk factors of operational level employees in zoos.

1.2 Aim

The aim of this research is to evaluate the current practice of ergonomics with special reference National Zoo in Sri Lanka.

1.3 Objectives

To pursue the above aim, the objectives of the study are formed as follows.

1. Identification of the background of ergonomic concept and risk factors that cause ergonomics issues in a work environment.
2. Recognize the current ergonomic related issues and their risk factors in the National Zoo.
3. Evaluate the present condition of ergonomics in the National Zoo.
4. Suggest recommendations and methods of minimizing the ergonomic issues in Zoos.

1.4 Methodology

Literature Survey

A comprehensive literature survey was carried out by referring books, journals and other publications to get a basic knowledge and understand the theoretical views of ergonomic concept and elements of ergonomics, to identify the ergonomic risk factors and the ergonomics in zoos. Literature survey was mainly address the first objective of the study.

Research Design

The study was carried out by adapting the case study approach. In accordance, the unit of analysis was a National Zoo in Sri Lanka and the information was gathered using interviews, a pilot survey, observations and documents review. The pilot questionnaire survey was carried out to cover the second objective of the research and it was prepared by targeting operational level employees. The interview was carried out to cover the third objective of the research.

Research Analysis

The data from pilot survey was analyzed by using a likert scale in order to identify the satisfaction level of employees on risk factors and RII to rank the risk factors. Furthermore, a discussion was carried out to evaluate the findings of the interview.

1.5 Scope and Limitations

The research was limited only to the operational level employees of a National Zoo in western province, Sri Lanka. The focusing group was consisted with animal keepers, garden workers and workers in supportive section. In addition to that, the research was concentrated on only the problems of their physical work environment. The study and conclusions thereof based on primary data, which would basically be the responses of the respondents and thus might not represent the actual situation on the ground due to personal perspectives and beliefs. However, the questionnaires were strategically structured to help identify inconsistencies, traces of bias and lack of objectivity in responses.

1.6 Chapter Breakdown

Chapter 1: Introduction to the research

Chapter one is consisted of the background to the study, aim and objectives, research methodology, scope and limitations of the study and the chapter breakdown.

Chapter 2: literature Review

This chapter explains ergonomic concepts, ergonomic risk factors and ergonomic issues in zoos. Furthermore, it covers the national and international practices of ergonomics.

Chapter 3: Research Methodology

Chapter three explains the research methodology together with the data collection and analysis techniques adapted for this study.

Chapter 4: Research Findings

This chapter explains the findings of the research. It comprises with analysis and a discussion.

Chapter 5: Conclusions and Recommendations

Chapter five concludes the study with the conclusions, recommendations and further research areas.

1.7 Summary

This chapter summarized the subsequent chapters briefly by identifying the background to the research study strengthened by literature review. Further, aim and objectives for the research have been emphasized together with the research methodology in concise manner. This chapter also described the scope and limitations of this research study.

CHAPTER 02

2.0 LITERATURE SYNTHESIS

2.1 INTRODUCTION

Ergonomics is about designing for people, wherever they interact with products, systems or processes. The dictionary definition states that ergonomics is “The scientific study of equipment design, as in office furniture or transportation seating, for the purpose of improving efficiency, comfort or safety”.

Ergonomics has already been defined and its primary focus is on the design of work activity that suits the person in that it takes account of their capabilities and limitations from handling materials manually. A number of factors play a role in ergonomics, these include body posture and movement (sitting, standing, lifting, pulling and pushing) and environmental factors (noise, lighting, temperature, humidity) (Dul & Weerdmeester, 2008).

Under the umbrella of workplace hazards prevention, the prevention of ergonomics hazards is very significant. Effective application of ergonomics in work system design can achieve a balance between worker characteristics and task demands. This can enhance worker productivity and provide worker safety, physical and mental well-being, and job satisfaction.

Thus, this chapter reviews the literature on the concept of ergonomics and the elements of the ergonomics. It also describes the application of ergonomics in zoos in locally and internationally.

2.2 INTRODUCTION TO ERGONOMICS

2.2.1 History

According to Safety and Security Services – Algonquin College (2007), the word ‘ergonomics’ derives from Greek words ‘ergos’ (work) and ‘nomos’ (laws). Ergonomics developed into a recognized field during World War II, when for the

first time, technology and the human sciences were systematically applied in a coordinated manner. Physiologists, psychologists, anthropologists, medical doctors, work scientists and engineers together addressed the problems arising from the operation of complex military equipment. The results of this inter-disciplinary approach appeared so promising that the cooperation was pursued after the war, in industry. Interest in the approach grew rapidly, especially in Europe and the U.S leading to the foundation in England of the first ever national ergonomics society in 1949, which is when the term “ergonomics” was adopted. This was followed in 1961 by the creation of the International Ergonomics Association (IEA), which represents ergonomics societies that are active in more than 40 countries or regions, with a total membership of some 19,000 people (Dul & Weerdmeester, 2008).

2.2.2 Ergonomics Concept

Ergonomics can be described as a system of interaction between components in the workplace, which include the worker, the work environment (both physical and organizational), the task and the workspace (Render & Heizer, 2001). The same authors pointed out that, the primary objective of ergonomics is to ensure a good fit between the workers and their jobs, thereby maximizing worker comfort, safety, efficiency and productivity. According to Dul & Weerdmeester (2008), in several countries instead of the term ergonomics, the ‘human factors’ is also used. But some researchers have been pointed out some differences between ergonomics and human factors. According to Hagberg et al. (as cited in Jaffar et al., 2011), ergonomics focuses on how work affects workers while human factors emphasize designs that reduce the potential for human error. Furthermore, Dul & Weerdmeester (2008) mentioned that the formal definition of ergonomics, approved by the IEA, reads as follows:

“Ergonomics (or human factors) is the scientific discipline concerned with understanding of the interactions among humans and other elements of a system and the profession that applies theory, principles, data and methods to design, in order to optimize human well-being and overall system performance” (IEA, 2014).

A large number of factors play a role in ergonomics, these include body posture and movement (sitting, standing, lifting, pulling and pushing), environmental factors (noise, vibration, illumination, climate, chemical substances), information and operation (information gained visually or through other senses, controls, relation between displays and control), as well as work organization (appropriate tasks and interesting jobs). These factors determine to large extent safety, health, comfort and efficient performance at work and in everyday life (Dul & Weerdmeester, 2008).

Accordingly, there are several definitions that have been developed by researches and practitioners, based on such ergonomic factors and specify with the goals and objectives of ergonomics. Some of the common definitions are summarized in Table 2.1.

Table 2.1: Definition for the ergonomic concept

Source	Definition for ergonomics
Working environment	
Murrell (1965)	Ergonomics is the scientific study of the relationship between man and his working environment. In this sense, the term environment is taken to cover not only the ambient environment in which he may work but also his tools and materials, his methods of work and the organization of his work, either as an individual or within a working group. All these are related to the nature of the man himself; to his abilities, capacities and limitations.
Kroemer et al. (1994)	Ergonomics is the study of human characteristics for the appropriate design of the living and working environment.
Tayyari& Smith (1997)	Ergonomics is a branch of science that is concerned with the achievement of optimal relationships between workers and their work environment
Brooks (1998)	Ergonomics is a system of interacting components which includes the worker, the work environment both physical and organizational, the task and the workspace
Human behavior, abilities, limitations and other characteristics	
Sanders and McCormick	Ergonomics discovers and applies information about human behavior, abilities, limitations, and other characteristics to the

(1993)	design of tools, machines, systems, task, jobs, and environments for productive, safe, comfortable, and effective human use.
Williams. M	Ergonomics and human factors use knowledge of human abilities and limitations to design systems, organizations, jobs, machines, tools, and consumer products for safe, efficient, and comfortable human use.
Fernandez (1995)	The design of the workplace, equipment, machine, tool, product, environment and system, taking into consideration the human's physical, physiological, biomechanical and psychological capabilities and optimizing the effectiveness and productivity of work systems while assuring the safety, health and wellbeing of the workers. In general, the aim in ergonomics is to fit the task to the individual, not the individual to the task
Nature of human- artifact interaction	
Karwowski (2006)	Ergonomics is a unique and independent discipline that focuses on the nature of human-artifact interactions, viewed from the unified perspective of the science, engineering, design, technology and management of human-compatible systems, including a variety of natural and artificial products, processes, and living environments.
Dempsey et al. (2000)	Ergonomics is the design and engineering of human-machine systems for the purpose of enhancing human performance.
Promoting compatibility between human and systems	
Lee (2005)	Ergonomics is concerned with promoting compatibility between humans and systems. Ergonomics is pursued to enhance the effectiveness and efficiency with which work and other activities are carried out and to enhance certain desirable human values. These goals require increasing convenience of use, reduction of errors and increasing productivity.

In the design of work and everyday-life situations, the focus of ergonomics is the human. Unsafe, unhealthy, uncomfortable or insufficient situations at work or in

everyday life are avoided by taking account of the physical and psychological capabilities and limitations of human.

2.2.3 Aims and Objectives of ergonomics

According to Koker & Schutte (1999), the ultimate goal of ergonomics is to improve and maintain the well-being of the individual worker. At the same time the well-being of the organization will also be improved and maintained. The application of ergonomics has certain advantages for the individual worker such as an improvement in the health, safety, comfort, satisfaction and convenience. For the organization, on the other hand, there will be an improvement in the performance, productivity, effectiveness, efficiency and quality of the product or service.

Ergonomics deals with the interaction between human and machine in the work environment as in the Figure 2.1. The main objective of ergonomics is to achieve an optimal relationship between people and their work environment (Ariyadurai & Herath, 2003).

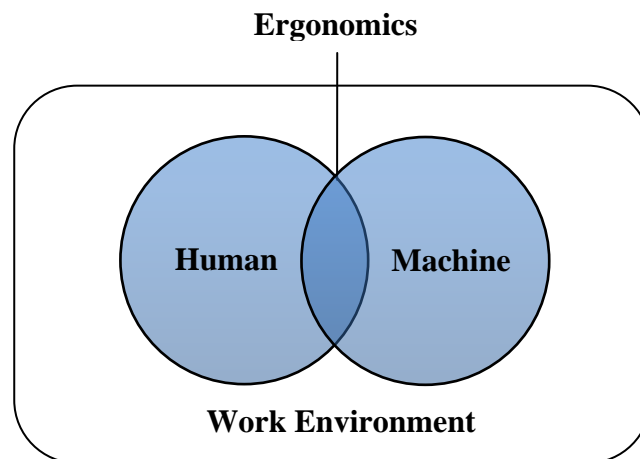


Figure 2.1: Ergonomics deals with the interaction between human and machine in the work environment

Source: (Ariyadurai & Herath, 2003)

2.2.4 Benefits of ergonomics

The literature indicates that an ergonomic process, which has correctly developed and implemented may bring tangible gains and rewards to individuals as well as to the organization. Therefore, the benefits that can be gained are as follows,

- **Improve productivity**

Ergonomics considers bio- mechanics and anthropometry of workers to improve the environment, enhance worker's morale and therefore, ergonomics can help to improve productivity. By applying ergonomics, it assists to ensure the working situation to be in harmony with the activities. Thus, the output can be enhanced without causing injury to the workers (Ariyadurai & Herath, 2003). According to OSHA (2000), providing a workplace free of ergonomic hazards can increase productivity by making jobs easier and more comfortable for workers.

- **Improve quality**

Poor ergonomics leads to frustrated and fatigued workers that do not do their best work. When the job task is too physically taxing on the worker, they may not perform their job like they were trained (Middlesworth, 2013). Therefore, Ariyadurai & Herath (2003) pointed out that ergonomics helps to develop a good working environment, to design a work place and tools, use design simulations. By that could improve the quality of a product.

- **Create a better safety culture**

Middlesworth (2013) reported that ergonomics shows the company's commitment to safety and health as a core value. Healthy employees are the most valuable asset, creating and fostering the safety & health culture at a company will lead to better human performance for the organization. Furthermore, Ariyadurai & Herath (2003) stated that a hazard may result from in-attention, incorrect expectation, tiredness, boredom, stress or information overload, at the time of installation of equipment and manufacturing faults or poor design, facility training or inadequate work procedures. In addition to that he mentioned, ergonomics analyses work procedures and equipment design prior to the event. This will help to improve the safety at work place for operators.

- **Help to keep the good health of workers**

According to Ariyadurai & Herath (2003), in ergonomics consider worker's leisure, sports domestic work etc. It develops the work place engineering by considering

anthropometry, bio mechanics and physiology of human being. Therefore, it helps to keep the good health of workers. Providing a workplace free of ergonomic hazards can lower injury rates as ergonomics risk incidences go down, lower costs as workers' compensation and other payments for illness and replacement workers go down (OSHA, 2000).

- **Improve the reliability of work place**

Ergonomic assists to put attention on machine maintenance, quality assurance of production, reduce waste without error/ damage at work place. Therefore, it improves the reliability of work place (Ariyadurai & Herath, 2003).

- **Increase job satisfaction**

According to Ariyadurai & Herath (2003), in ergonomics, organizations develop the environment to the standard levels and design the work system to comfort the operator. Those will give less fatigue, comfortable feelings and more satisfaction at the job. Simultaneously, OSHA (2000) stated that providing a workplace free of ergonomic hazards reduce absences because workers will be less likely to take time off to recover from muscle soreness, fatigue, and ergonomics related problems.

- **Personal development**

The main objective of ergonomics is to improve the productivity with a good quality production. It will increase the revenue flow to the company and finally it is shared to the operators. Additions to that, company will gratitude the workers and workers can be promoted to higher level stages in the organization structure (Ariyadurai & Herath, 2003).

2.2.5 Multi-disciplinary nature of ergonomics

Ergonomics is a multi-disciplinary science which draws heavily from many disciplines or fields of study (Zein, 2005). That means, to build a complete ergonomic study, people use the knowledge of different professional subjects. In addition to that, Sabnis et al. (2014) explained that the multi-disciplinary nature of ergonomics can play a unique role in the protection of people's health and in the

prevention of work related health hazards. Figure 2.2 illustrates the major disciplines contributing to the field ergonomics.

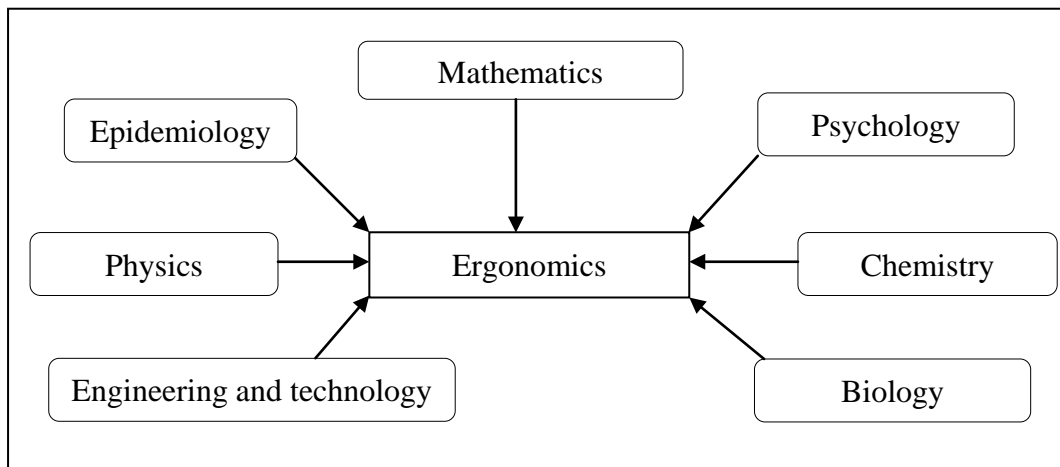


Figure 2.2: Major disciplines contributing to ergonomics

Source: (Zein, 2005)

2.2.6 Work related risks due to lack of ergonomics

Applied ergonomics literature recognizes a small set of common physical risk factors across many occupations and work settings (Cohen et al., 1997). According to Jaffar et al. (2011), factors that contribute to work related risk of musculoskeletal injury are called risk factors. Further, the same author mentioned that, the major work related risk factors are repetitive work, exerting a force, awkward and static postures, contact stress or pressure.

According to Golob & Sykes (2002), ergonomic risk factors can be divided into two categories, primary risk factors and secondary risk factors, as explained in the following paragraphs.

The primary risk factors are,

- **Force:**

The force that a worker exerts on an object is a primary risk factor. Muscles and tendons can be overloaded when a strong force is applied against the object. A risk can also occur when a weaker force is applied repeatedly or continuously over a long period of time. Exerting high or low muscle force can interfere with circulation, lead to muscle fatigue and tissue damage. These conditions can result from gripping,

pinching, holding lifting, lowering pushing, pulling, carrying and stopping a moving object or resisting the kickback from tools. Factors that affect the amount of force applied include, size of the load weight of the load position of the load how often the load is handled how long of time the load is handled (Golob & Sykes, 2002).

The tasks perceived by veterinarians as being most likely to cause MSD included lifting, surgery and animal handling. Lifting has been shown to be associated with musculoskeletal pain or injury in veterinarians (Hafer et al., 1996).

- **Work Posture:**

Posture refers to the position the worker assumes to do a task. The goal is to maintain a neutral body posture throughout the job task. Neutral posture reduces the strain on working muscles and joints and keeps blood circulating, which enhances the body's ability to remove toxins. Any posture that requires the body to move out of the neutral posture range is considered to be awkward posture. Awkward postures force the muscles to work harder and stress the ligaments, such as when any part of the body bends or twists away from a comfortable position. A posture held for a long time is called a static posture (Golob & Sykes, 2002).

According to D'Souza et al. (2009), small animal veterinarians frequently adopt awkward postures or angles of lift animals from our floor level.

- **Repetition:**

Repetition is the rate of recurrence with which a task or set of motions is performed. Using the same body part repeatedly to perform a task puts a worker at increased risk of musculoskeletal disorders (MSDs), as it does not allow for the rest or recovery of the affected muscles (Golob & Sykes, 2002).

According to Hafer et al. (1996), in a study of occupational hazards reported by American swine veterinarians showed that 51% of participants had pain due to repetitive actions.

- **Contact Stress:**

Contact stress occurs when a hard or sharp object comes in contact with a small area of the body. The tissues and nerves beneath the skin can be injured from the pressure (Golob & Sykes, 2002).

- **Duration:**

The amount of risk depends on the duration the worker is exposed to the risk factor. Duration should be considered along with the four primary risk factors, rather than separate from them (Golob & Sykes, 2002).

The secondary risk factors can cause primary risk factors or make them worse. They include,

- **Environmental factors:**

- **Temperature**

Extreme temperatures, particularly when coupled with high humidity, can affect performance. Low temperatures in limbs can result in constriction of the blood vessels causing a loss of tactile sensitivity and decreased grasp and dexterity (Peters & Patterson, 2002).

- **Vibration**

Vibration affects tendons, muscles, joints and nerves. Vibration to a specific body part can decrease sensitivity and result in unnecessary increases in muscle contraction, which may lead to injury or fatigue of that part. Localized vibration from machines and hand tools can damage the nerves and blood vessels of the hands and arms. Whole-body vibration, experienced by people who operate heavy equipment such as truck and bus drivers, increases the risk of lower back pain and damage to the spinal discs. The body's response depends on the duration, frequency and extent of the vibration (Golob & Sykes, 2002).

According to HSE (2012), in zoos where workers use powered hand-held tools regularly or for long periods of time or perform other work which exposes them to

vibration through their hands, they are at risk of developing permanently disabling diseases of the hands and arms (hand-arm vibration syndrome).

Illumination

Appropriate lighting and elimination of glare in the work area allows for adequate depth perception and contrast by the worker(s) when handling material such as when lifting and carrying objects. Improper lighting can be a contributing factor to a MSD (Golob & Sykes, 2002).

Noise

According to Kingsley (2012), noise level is one of the ergonomic elements that impacts on employee communication and cognitive activities.

Noise in zoos can become a problem for a number of reasons including traffic movement, the operation of mechanical plant, use of work equipment, the animals at the zoo, large numbers of visitors and music provided in hospitality areas.(HSE, 2012).

- **Work rate:**

Individual workers vary in the rates at which they perform the same task. Some individuals need longer periods to recover from physical work to prevent injury. The more critical or physically demanding the task, the more desirable it is to let the worker set the pace, where possible. Just as important, where possible, is to avoid sudden increase in workload. Planning the work rate will also involve consideration of work recovery cycles/task variability and staffing schedules (Golob & Sykes, 2002).

2.2.7 Standards and guidelines related to ergonomics

There are variety of reputed standards and guidelines related to ergonomics.

- **OSHA Ergonomic Program Standard**

The Occupational Safety and Health Administration (OSHA) is proposing an ergonomics program standard to address the significant risk of work-related MSDs

confronting employees in various jobs in general industry workplaces (OSHA, 1999). According to Philip & Seibert (2001), the standard does not apply to employers whose primary operations are covered by OSHA's construction, maritime or agricultural standards, or employers who operate a railroad. General industry employers covered by the standard would be required to establish an ergonomics program containing some or all of the elements typical of successful ergonomics programs such as management leadership and employee participation, job hazard analysis and control, hazard information and reporting, training, MSD management, and program evaluation, depending on the types of jobs in their workplace and whether a MSD covered by the standard has occurred (OSHA, 1999).

- **ISO/TC 159/SC1-General ergonomics principles**

According to International Organization for Standardization (ISO), TC 159/SC1 is charged with producing general standards that apply across various subject areas within ergonomics. Its scope is “standardization of general ergonomics principles for the design and evaluation of products, systems, services, and environments.” Germany (DIN) holds the secretariat for SC1, and Georg Kramer of Germany is its current chair. TC 159/SC1 has the following active working groups:

- Working group 1 – Principles of ergonomics and ergonomics design
- Working group 2 – Ergonomic principles related to mental work (ISO 10075)

The general ergonomic principles of this standard are shown in Table 2.2.

Table 2.2: General ergonomic principles-ISO TC 159/SC 1

Ergonomic principle	Description
ISO 6385:2004	Ergonomic principles in the design of work systems
ISO/DIS 6385	Ergonomic principles in the design of work systems
ISO 10075:1991	Ergonomic principles related to mental work-load - General terms and definitions
ISO/NP 10075-1	Ergonomic principles related to mental work-load - Part 1: General concepts, terms and definitions

ISO 10075-2:1996	Ergonomic principles related to mental workload -Part 2: Design principles
ISO 10075-3:2004	Ergonomic principles related to mental workload - Part 3: Principles and requirements concerning methods for measuring and assessing mental workload
ISO 26800:2011	Ergonomics - General approach, principles and concepts

Source: (ISO)

- **ISO TC 159/SC5- Ergonomics of the physical environment**

The ISO has stated that, the scope of this standard is to develop international standards in the area of ergonomics of the physical environment, including: thermal environments, vision and lighting, danger signals and communication in noisy environments, people with special requirements, surface temperatures, integrated environments and perception of air quality. Working groups formed for:

- Thermal environments
- Integrated environments
- Physical environments for people with special requirements
- Perceived air quality

- **NIOSH Ergonomic Guidelines for Manual Material Handling**

According to NIOSH (2007), this guideline is written for managers and supervisors in industries that involve the manual handling of containers. It offers suggestions to improve the handling of rectangular, square, and cylindrical containers, sacks, and bags. It also contains information on risk factors, types of ergonomic improvements, and effective training and sets out a four-step proactive action plan. The plan helps to identify problems, set priorities, make changes, and follow up.

Sections 1 and 2 of “Improvement Options” provide ways to improve lifting, lowering, filling, emptying, or carrying tasks by changing work practices and/or the use of equipment. Guidelines for safer work practices are also included. Section 3 of “Improvement Options” provides ideas for using equipment instead of manually handling individual containers. Guidelines for safer equipment use are also included.

This document discusses approaches including:

- Eliminating lifting from the floor and using simple transport devices like carts or dollies.
- Using lift-assist devices like scissors lift tables or load levelers.
- Using more sophisticated equipment like powered stackers, hoists, cranes or vacuum assist devices.
- Guiding user choice of equipment by analyzing and redesigning work stations and workflow.

2.3 ELEMENTS OF ERGONOMICS PRACTICE

2.3.1 Domains of ergonomics

Ergonomists often work in particular economic sectors or application domains. These application domains are not mutually exclusive and they evolve constantly. New ones are created, old ones take on new perspectives. Within the discipline, domains of specialization represent deeper competencies in specific human attributes or characteristics of human interaction (IEA, 2014). Hence, according to the nature of the ergonomics, it can be categorized as shown in the Figure 2.3.

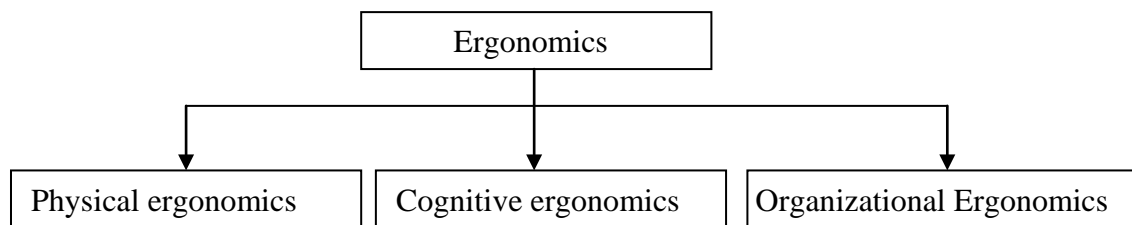


Figure 2.3: Ergonomics categorization

Source: (IEA, 2014)

- **Physical ergonomics**

Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. The relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health (Human Factors and Ergonomics Society of Australia -HFESA, 2014).

- **Cognitive ergonomics**

According to IEA (2014), cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. The relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design.

- **Organizational ergonomics**

HFESA (2014) pointed out that the organizational ergonomics is concerned with the optimization of socio technical systems, including their organizational structures, policies, and processes. The relevant topics include communication, crew resource management, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, organizational culture, virtual organizations, telework, and quality management (IEA, 2014).

2.4 ERGONOMICS FOR ZOOS

2.4.1 Overview of zoos

A zoo or zoological garden is a park where captive animals often from all over the world, live and are exhibited to visitors. The word zoo comes from the Greek word zoion, which means “animal” (“Zoo”, 2014). According to Citing Wikipedia (November, 2014), the number of major animal collections open to the public around the world now exceeds 1,000, around 80% of them in cities. Zoo animals live in enclosures that often attempt to replicate their natural habitats or behavioral patterns, for the benefit of both the animals and visitors. Further it mentioned that, the safari park, aquaria, roadside zoos, petting zoos and animal theme parks are considered as types of zoos.

According to “Zoo” (2014), a primary function of modern zoos is to educate the public. Zoos try to teach visitors the ecological and behavioral details of particular animals, both native and exotic. Further it says zoos are also concerned with the general issues of conservation, preservation, and habitat protection and with preventing species from becoming threatened, endangered, or extinct.

The relevant statistics on zoos in worldwide are shown in Table 2.3.

Table 2.3: Statistics on zoos in worldwide

Zoo Statistics	Figures
Total number of accredited zoos	142
Total number of animals in accredited institutions (Zoos, Aquariums & etc.)	751,931
Total number of species in all zoos	6,000
Total number of endangered species in zoo captivity	1,000
Total amount of money contributed by zoos and aquariums annually	\$16 billion
Total number of jobs provided by zoos	142,000
Total number of people that visit a zoo each year	175 million

Source: (Zoo facts, National Zoo, 2012)

2.4.1.1 National Zoo in Sri Lanka

According to Citing Wikipedia (November, 2014), National Zoological Gardens of Sri Lanka is a zoological garden founded in 1936. This Zoological Garden is one of the oldest zoological gardens in Asia. Its sprawling areas are host to a variety of animals and birds. The zoo exhibits animals but also places an emphasis on animal conservation and welfare, and education.

It also mentioned that the vision for the zoo include, "To create one of the world's outstanding zoological institutions, that is a centre of the excellence for conservation, research and education" and mission is "Resourceful conservation of animals by means of a learning, achieved through the exhibition of species which were adopted with loving care". The annual revenue is approximately LKR 40 million.

The capacity of labor is also important in achieving targets in the organization. According to the Annual report of Department of National Zoological Gardens (2011), there are 380 employees working in the zoo and majority of them are from labor grade. Among these 380 employees, 27 are staff grade, 10 are supervisors, 15 are security officers and all others are minor employees. Animal keepers and mahouts, aquarium attendants, gardeners, garden laborers, drivers and other skill laborers such as fitters and carpenters are fallen into minor category.

2.4.2 Ergonomics in Zoos

According to Health and Safety Executive- HSE (2012), occupational ill-health problems in zoos can be caused by any or a combination of the following:

- exposure to harmful substances
- inhalation of harmful particles
- poor working practices such as excessive or inappropriate manual handling
- environmental factors, such as noise, poor light or cramped working conditions and
- diseases transmitted by animals.

The MSDs, diseases and discomfort are a major cause of pain, injury, illness, reduced productivity and absenteeism from work (Hagberg et al., 1995). Both physical and psychological factors are generally considered to be risk factors for MSDs. Physical factors include exposure to physical load, awkward postures, prolonged static postures, vibration, repetitive tasks and secondary tasks (Bernard, 1997). Psychological risk factors for MSD include stress, low job satisfaction, hours worked, low job control, time and work demands and poor organizational culture in the workplace (Waersted & Westgaard, 1991).

Manual handling is quite simply moving an object (load) using one's body and includes supporting, lifting, lowering, pushing, pulling and throwing. If done incorrectly or inappropriately it can result in one of several disorders of the muscles, joints and bones (HSE, 2012). Further it has mentioned that some of these conditions can be short term while others can result in long-term ill health and especially if appropriate action is not taken, may even prevent someone from working again. In general, there are workers in the zoos who doing manual handling related tasks such as, lifting of large garbage bins.

According to HSE (2012), many items of equipment or plant have the potential to transmit vibration to the operator either by poor design, poor maintenance or incorrect use. Likely sources are chainsaws used in forestry or fencing work, hammer drills, trimmers and brush cutters and regular use of tractors or small transport vehicles, particularly off road. Workers who operate or drive off-road machinery

may be exposed to high levels of whole-body vibration and suffer from low back pain. In zoos, can see the workers who operate tractors regularly to transport animal foods and waste items.

Noise in zoos can become a problem for a number of reasons including traffic movement, the operation of mechanical plant, use of work equipment, the animals at the zoo, large numbers of visitors and music provided in hospitality areas. Wherever possible, however, steps should be taken to reduce noise levels and noise exposure. While PPE such as ear defenders may be appropriate in some circumstances, in others, such as working in animal enclosures with animals present, they may introduce other, more serious risks (HSE, 2012).

In addition to that, musculoskeletal discomfort is one facet in the occupational health of veterinarians for which there is a paucity of information concerning prevalence, risk factors and effects. Internationally, a high proportion of work related injuries are attributed to MSDs and these result in absenteeism from the work place, reduce productivity and personal costs (Buckle, 2005 & MacDonald, 2004). According to the study of Scuffham et al. (2009), 18% of veterinarians reported absence from work due to MSDs. Fritschi et al. (2006) showed that 50% of veterinary respondents had chronic MSD problems. As a support for the above statement, in a recent study of Australian veterinarians Smith et al. (2009) found that high self-reported MSDs affecting the lower back, neck and shoulders.

Previous studies have focused on physical risk factors such as animal handling and lifting (Scuffham et al., 2009). It is only very recently that psychological risk factors associated with MSD such as stress (Loomans et al., 2008).

According to Scuffham et al. (2009), implications for veterinary profession with the high prevalence of MSDs include pain, discomfort, injury, lost time, loss of productivity, loss of earnings and intangible effects on lifestyle which may result in retention problems for this profession. The same author further said that the most commonly cited solutions to reduce MSDs of veterinarians are use of correct manual handling techniques, ensuring that work is carried out a suitable height and regular rotation of tasks and jobs.

2.4.3 Common ergonomics practices in Sri Lanka

According to Abeyssekera (2012), prior to the 1980s, ergonomics was hardly known in Sri Lanka. The rapid development process seen in Sri Lanka in early 1980s has been hampered by the political and ethnic unrest. It is widely known that the science of ergonomics (human factors sciences) contributes immensely to the technology development and can boost the industrialization process in industrially developing countries. The same author mentioned that two Swedish experts visited Sri Lanka in 1996 to spread the awareness to ergonomics. Those experts carried out ergonomic surveys which revealed that significant mismatches existed between the workers and their work tools as well as work systems. These deficiencies affected adversely the productivity and worker comfort. Deficiencies in occupational health and safety and enormous waste in production are other significant negative factors observed by the experts.

In addition to that, there are some ergonomic promotion practices implemented in Sri Lankan context. According to Jayaratne (2012), Sri Lanka is seen as a model developing country. In a context of rapid technology transfer, promotion of ergonomics both at macro and micro levels will undoubtedly contribute to economic and human development of a nation. Furthermore, the same author stated that, the Sri Lanka Medical Association (SLMA) being the apex medical organization in the country will be a partner in promoting ergonomics. As a support of above statement, Aloysius (2012) described that, to resolve the high-tech related health problems, an evolving specialty known as ergonomics has now entered the healthcare field. In Sri Lanka an expert committee on ergonomics was formed under the SLMA to introduce ergonomics to the local medical community, general public and healthcare settings. There have been several fragmented approaches focused on ergonomics such as OHS, ergonomics for children, healthy schoolbag campaign and healthcare facility ergonomics.

The prime objective of SLMA expert committee on ergonomics is to promote ergonomics to medical community, general public and in healthcare settings (SLMA, 2013).

Activities of SLMA Expert Committee on Ergonomics

- To function as the umbrella body in promoting ergonomics
- To map and collate evidence in ergonomics and health consequences
- To synthesize and disseminate new knowledge on ergonomics
- To advocate healthcare and other stakeholders in relevant sectors on issues related to ergonomics
- To interface with national and provincial health professionals and other stakeholders (eg. other government bodies, INGOs) as appropriate to generate funds and to facilitate the implementation and adoption of ergonomic initiatives
- To initiate and sustain activities both at national and sub-national level to expand ergonomics in health and relevant fields

2.5 SUMMARY

This chapter reviewed the literature related to ergonomics and expected to provide a detailed understanding of the ergonomic concept, ergonomic risk factors and ergonomic related standards and regulations. Specific importance was given to the ergonomic risk factor as it is considered to be the base for this research. The chapter further identified the importance of ergonomics and elements of ergonomic practice and finally discussed the current application of ergonomics in zoos.

CHAPTER 03

3.0 RESERCH METHODOLOGY

3.1 INTRODUCTION

This chapter aims to set out the methodological framework which was used to accomplish the aims and objectives of this research study, ‘Evaluate the current practice of ergonomics in a National Zoo in Sri Lanka’. It describes in detail the research methodology used in completing this research including the research philosophy, research approach and research techniques used for data collection as well as data analysis. The research process in whole is also has been illustrated at the end of the chapter.

3.2 RESEARCH METHODOLOGY/DESIGN

Research methodology refers to the principles and procedures of logical thinking processes which apply to a scientific investigation (Fellows and Liu, 2003). According to ‘Nested’ methodology illustrated in Figure 3.1, research methodology or design consists of the following main components.

- (i) Identifying **Research Philosophy** on which the research is premised
- (ii) Selection of an appropriate **Research Approach** for theory testing and/or building
- (iii) Selection of **Research Techniques** for data collection and data analysis

(Senarathna, 2005)

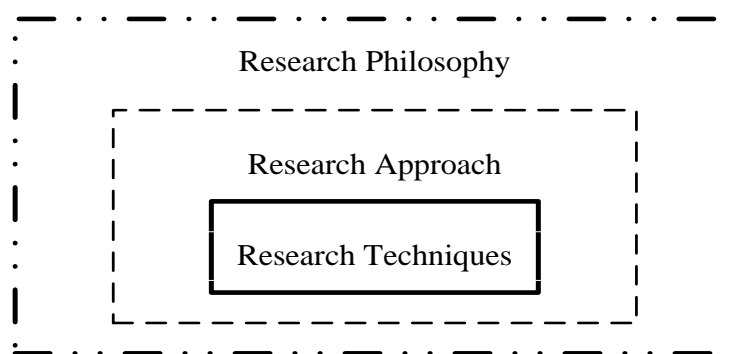


Figure 3.1: ‘Nested’ Research Methodology

(Source: Kagioglou et al., 2000 cited Senarathna, 2005)

The final outcome of a research depends heavily on its research design. Therefore, it is of paramount importance to develop the most appropriate research design for particular research study. Thus, the sub sections below describe in detail the research methodology of this research study.

3.2.1 RESEARCH PHILOSOPHY

Research philosophy is the basic belief system or worldview that guides the investigator (Guba and Lincoln, 2000 cited Senarathna, 2005). Research philosophy is shaped by assumptions of ontological, epistemological and axiological foundations. Ontology describes what knowledge is and assumptions about reality while epistemology describes how we know it and assumptions about how knowledge should be acquired and accepted. Axiology explains what researcher values go into it and assumptions about value system (Senarathna, 2005).

According to the aims and objectives of this research as described in chapter 01, this research holds ontological philosophy which tries to evaluate the current practice of ergonomics in a National Zoo in Sri Lanka and suggest recommendations and benefits of minimizing the ergonomic issues in zoos.

3.2.2 RESEARCH APPROACH

Research approach may be defined as the plan for moving from the research question to the conclusion (Tan, 2002). In addition to that, Easterby-Smith et al. (2002) stated the research approaches helps in organizing the research activities, including the collection of data, in ways that are more likely to achieve research aims.

Research approaches are classified mainly into two categories as quantitative and qualitative. Quantitative approach tends to relate to positivism and seek to gather factual data. It studies relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously (Fellows and Lui, 2003). Survey researches and experimental researches are basically coming under quantitative approaches. By using a qualitative approach, the researcher will study the whole population as individuals or groups and will identify beliefs, understandings, opinions and views of people and analyze them to

find solutions (Fellows and Lui, 2003). Case study research, ethnography, action research and grounded theory approach can be considered as qualitative research approaches.

This study was carried out by adapting the case study approach. The research has executed through both quantitative and qualitative research analysis techniques. The second objective of this research was recognition of current ergonomic related issues and their risk factors in the zoo. Therefore, a pilot questionnaire survey was carried out to accomplish this objective. Further, the research problem of this study was developed as; “How is the current practice of ergonomics in a National Zoo in Sri Lanka?”. Yin (1994) suggested that the case study research approach for the researches which have research problems like “how” and “why” types. In addition to that, to evaluate the present condition of ergonomics in the zoo an interview was carried out to this research. Therefore, case study approaches was identified as the most suitable research approaches in order to achieve the aims and objectives of this study.

3.2.3 RESEARCH TECHNIQUES

An appropriate research technique should be identified to operate the research once the selecting of research approach is completed. The research technique could be discussed under two types as data collection technique and data analysis technique. Commonly used data collection techniques are interviews, questionnaires, document surveys, observation and participation (Tan, 2002). Observations, pilot survey and semi structured interviews have been used as the main data collection tools in this research.

The data analysis technique acts as the media to interpret the collected data and provide the conclusion. Statistical analysis, content analysis, pattern-matching and cognitive mapping are commonly used techniques in data analysis. The statistical analysis, within – case analysis and cognitive mapping were used as the data analysis techniques in this research.

3.3 RESEARCH PROCESS

The overall research process, to achieve the objectives identified in chapter one can be illustrated as follows (See Figure 3.2).

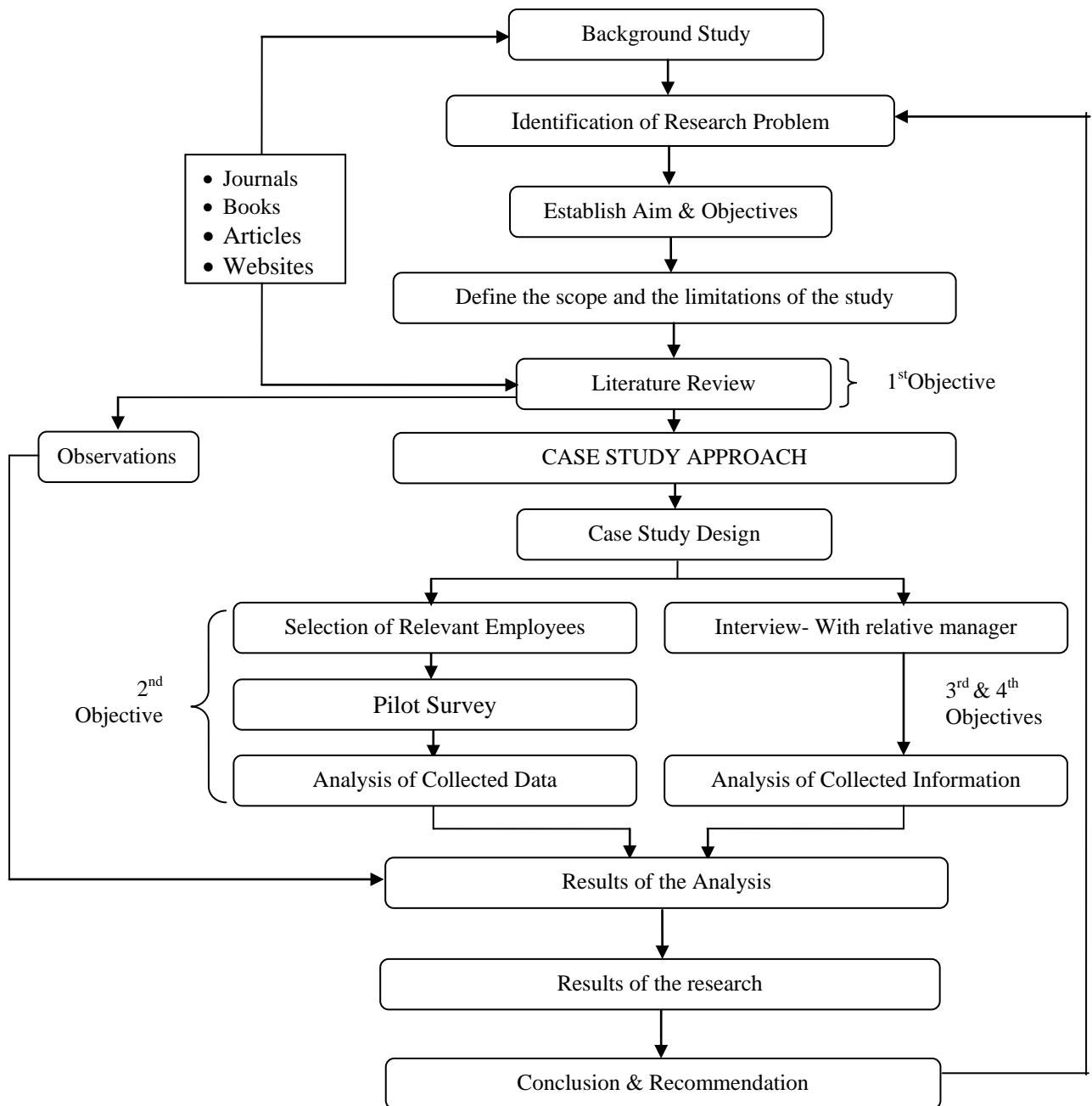


Figure 3.2: Research Process

3.3.1 BACKGROUND STUDY

The researcher carried out a background study on a broader perspective to familiarize with the subject areas of ergonomics and application of ergonomics in zoos. In this background study, the researcher went through books, journal articles and unpublished dissertations. The recourses that went through were mainly focused on ergonomic issues among operational level employees in the industrial context. The focus gave on ergonomic issues in zoo workers were very fewer in referred resources. Thus, a literature synthesis was undertaken to identify research issues in depth with relevance to ergonomics in zoos.

3.3.2 LITERATURE SYNTHESIS

The literature synthesis was carried out mainly by referring books, journal articles and unpublished dissertations. The broad topics addressed during the literature synthesis were; introduction to ergonomics, elements of ergonomics practice and ergonomics for zoos. The literature synthesis was further extended to research methodology area specially relating to both quantitative and qualitative researches in order to gain broader knowledge to design the research.

3.3.3 CASE STUDY DESIGN

Ragin and Beker (1992 cited in Patton and Appelbaum, 2003) stated that case studies are based on analytic generalization rather than statistical generalization. The case study designing procedure which is emphasized next, including the identification of unit of analysis, defining the number of cases and selection of cases.

3.3.3.1 Identification of unit of analysis

Identification of ‘unit of analysis’ or the ‘case’ is of foremost importance to any research design and it is linked with the way the research problem is created (Yin, 1994). This study aims to evaluate the current practice of ergonomics in a National Zoo in Sri Lanka. Therefore, the unit of analysis or the case in this research is a National Zoo which is the one and only government owned zoological institute in Sri Lanka. To select the suitable unit of sampling, the following analysis was adopted for this research study (See Figure 3.3).

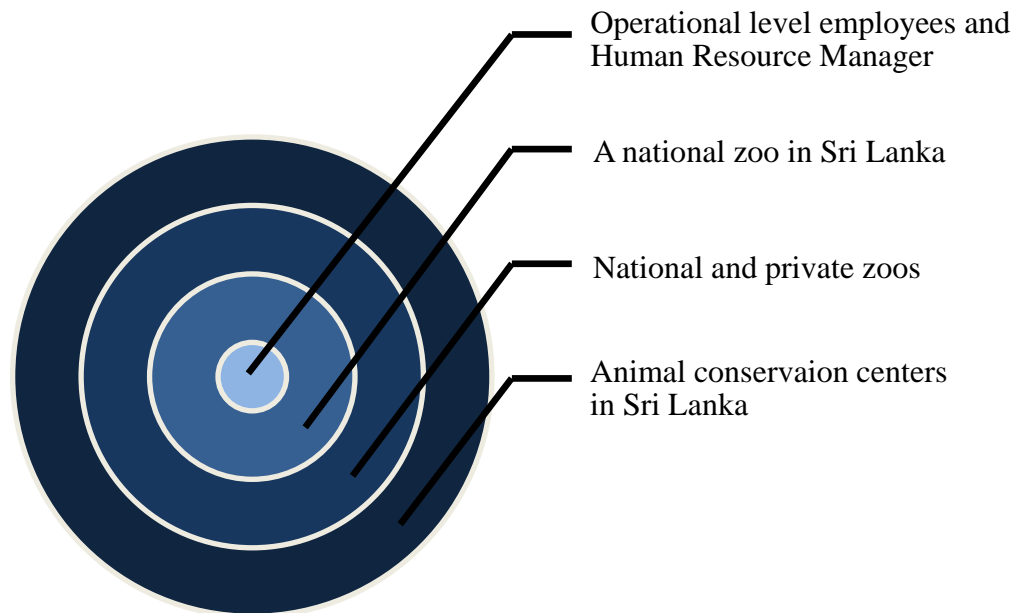


Figure 3.3: Unit of analysis

3.3.3.2 Defining number of cases

After identifying the unit of analysis or the case, the defining of number of cases is important. According to Yin (1994), the number of cases in case study could vary from one to eight as per the nature of the research. Perry (1998) stated that, when the study area is too broad in a qualitative research, it is advisable to use only one or two and utmost four.

By considering above and since there is only one National Zoo in Sri Lanka, the researcher decided to limit the number of cases which was investigated in this case study to one. The selection criterion of this case is graphically illustrated in next section (See Figure 3.4).

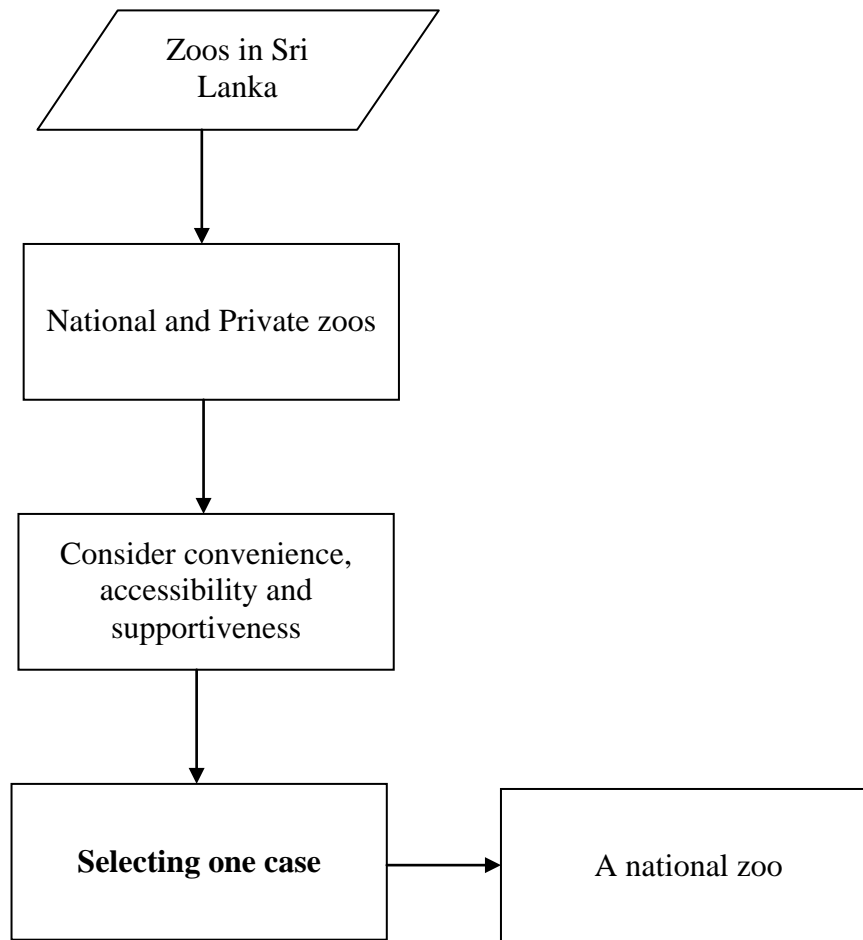


Figure 3.4: Criteria for selecting the cases

3.3.4 DATA COLLECTION

3.3.4.1 Data collection process

The data collection was conducted through observations, preliminary questionnaire survey and semi structured interviews. The operational level employees and Human Resource Manager of the selected zoo were focused.

- **Observations**

The observations are involved either direct observations or participant observations. The direct observations have been used in this study. Hence, the direct observations were involved by making several field visits in the zoo.

- **Preliminary questionnaire survey**

Unstructured questionnaire was presented to collecting the data from particular operational level employees. The questionnaire survey was conducted within

randomly selected 45 operational level employees who are working under animal, garden and supportive sections.

- **Semi structured interviews**

The semi structured interviews are most important form of interviewing in case study research and it is productive tool on a clear structure which carefully developed and practiced (Yin, 2003).

Interview structure

The interview structure has been developed by using one interview guideline and this guideline was formed to capture data on the present condition of ergonomics in the zoo. The interview guideline was with reference to the literature synthesis and objectives of the study.

Interview process

The interview was conducted with the Human Resource Manager who is responsible for health and safety of occupants in the zoo. To maintain the confidentiality, the name of the organization and the interviewee has not been revealed in this report or any other document relating to this study.

3.3.5 DATA ANALYSIS

3.3.5.1 Statistical Analysis (Descriptive Analysis)

The general information of the employees were analyzed in percentage wise and the results have been demonstrated through graphical charts. In addition to that to identify the ergonomic risk factors in the working environment based on the satisfaction level, five-point likert-scale was used in the questionnaire as following Table 3.1,

Table 3.1: Likert-scale for identify ergonomic risk factors base on satisfaction level

Level of satisfaction	Scale number
Highly dissatisfied	1
Dissatisfied	2
Somewhat satisfied	3
Satisfied	4
Highly satisfied	5

Thereafter, the identified risk factors were ranked using RII. Following equation can be utilized to calculate the RII.

$$RII = \frac{\sum (W n)}{A \times N}$$

W - Constant expressing the weighting given to each response

A- The highest weighting

n- The frequency of response

N- Total number in the response

Above equation based on the likert scale and it is represented as following Table 3.2,

Table 3.2: Likert scale for rank the risk factors

Ranking of risk factors	
0%-10%	1
10%-20%	2
20%-30%	3
30%-40%	4
40%-50%	5
50%-60%	6
60%-70%	7
70%-80%	8
80%-90%	9
90%-100%	10

3.3.5.2 Cognitive Mapping

Data displaying capabilities of content analysis is always a problematic issue, even though it enables better interpretation of qualitative data. Miles and Huberman (1994 cited in Senarathne, 2005, p.81) state this issue as,

“it is hard on analysts because, it is dispersed over many pages and not easy to see as whole. It is sequential rather than simultaneous, making it difficult to look at two or three variables at once. It is usually poorly ordered and it can get very bulky.”

Therefore, to overcome these shortcomings, it is obvious that a content analysis alone is not enough and effective. Hence, the need of proper data displaying techniques is emphasized. Senarathne (2005) stressed that the ‘cognitive maps’ is one of the possible data displaying techniques which contain matrices and networks; provide a holistic view by allowing the reader to move back and forth between an understanding of the whole. Hence, for the results of observations cognitive mapping was selected as the data displaying technique to present expedient understanding to the reader in a holistic manner.

3.3.5.3 Conclusion Drawing

Conclusion drawing is the final stage of data analysis. Patton and Appelbaum (2003) state that, “the ultimate goal of the case study is to uncover patterns, determine meanings, construct conclusions and build theory.” Thus, constructing conclusions is one of the ultimate goals in the study. The findings from the empirical study; their interrelationship with existing literature; and the propositions from this study to both the theory and to the practice was emphasized under conclusions. Further, new research directions that appeared from this research were also illustrated in the conclusions.

3.3.5.4 Write-up

Even though the writing up gives as the final stage of the dissertation, this has been gradually done throughout the research process in sequential manner. The outline of the report includes presenting the research problem, describing the methods used to conduct the research, explaining the data gathering and analysis techniques used and concluding with the answers to the questions. Throughout the write-up process, visual aids such as tables, figures and charts were presented for the ease of the user.

3.4 RESEARCH VALIDITY

Any method of study is imperfect without considering the basic issues relating to appraisal of the validity of any research outcomes. Yin (1994) explained that, to confirm the validity of a research study and to pass certain design tests with regards to diverse levels of research validity, as explained below.

- **Construct Validity-** Establishing correct operational measures for the concepts being studied
- **Internal Validity-** Establishing casual relationships, whereby certain conditions are shown to lead the other conditions, as distinguishes from spurious relationships
- **External Validity-** Establishing a domain to which study's findings can be generalized
- **Reliability-** Demonstrating that the operations of a study such as data collection procedures can be repeated with the same results

The measures of Yin (1994) which were taken to ensure the validity of this case study research are identified in the Table 3.3.

Table 3.3: Measures taken to ensure the validity of the research

Test	Measures taken in this research
Validation with the interview process	<ul style="list-style-type: none"> • Transparent interview process: Tape-recording or note-taking during interview and developing interview transcript to ensure accurate data capture. Maintain confidentiality. • Consistent interviewee sample: Human Resource Manager who is responsible for occupational health and safety at the zoo.

3.5 SUMMARY

This chapter briefly discussed the research methodology including the research approach, data collection and analysis techniques which were used to achieve the research objectives. The case study approach was figured out as the best research approach for the research while observations, preliminary questionnaire survey and interviews were selected as the best methods to collect data. Also, the research has executed through both quantitative and qualitative research analysis techniques. Statistical analysis including descriptive statistics and likert-scale for satisfaction level and RII as well as content analysis were used for data analysis. The chapter graphically illustrated the overall research process followed in carrying out this research study.

CHAPTER 04

4.0 RESEARCH FINDINGS AND DATA ANALYSIS

4.1 INTRODUCTION

Chapter three discusses the research methodology used for this research study. The aim of this Chapter is to clarify the research findings in a detailed manner through empirical study conducted. To fulfill the objectives of the research, the study has acknowledged what was emphasized in literature and these have been broadly explored through data collected from observations, preliminary questionnaire survey and interviews. This chapter is organized according to the following topics.

- I. A direct observation has been carried out by making several field visits in the zoo to identify the causes for the ergonomic related issues and health issues due to poor ergonomics. (See section 4.2).
- II. A pilot survey has been carried out, with the ultimate objective of identifying the current ergonomic related issues and their risk factors in the zoo. (See section 4.3).
- III. Within case analysis of the selected case has been done and the findings of the case were obtained through the interview conducted with the Human Resource Manager of the zoo. (See section 4.4). In addition to that, the findings of the preliminary questionnaire survey were also used for the within case analysis.

4.2 OBSERVATIONS

4.2.1 Causes for the ergonomic related issues in the zoo

A direct observation was carried out by making several field visits in the zoo identify the causes for the ergonomic related issues. The causes for the ergonomic related issues are illustrated in Figure 4.1.

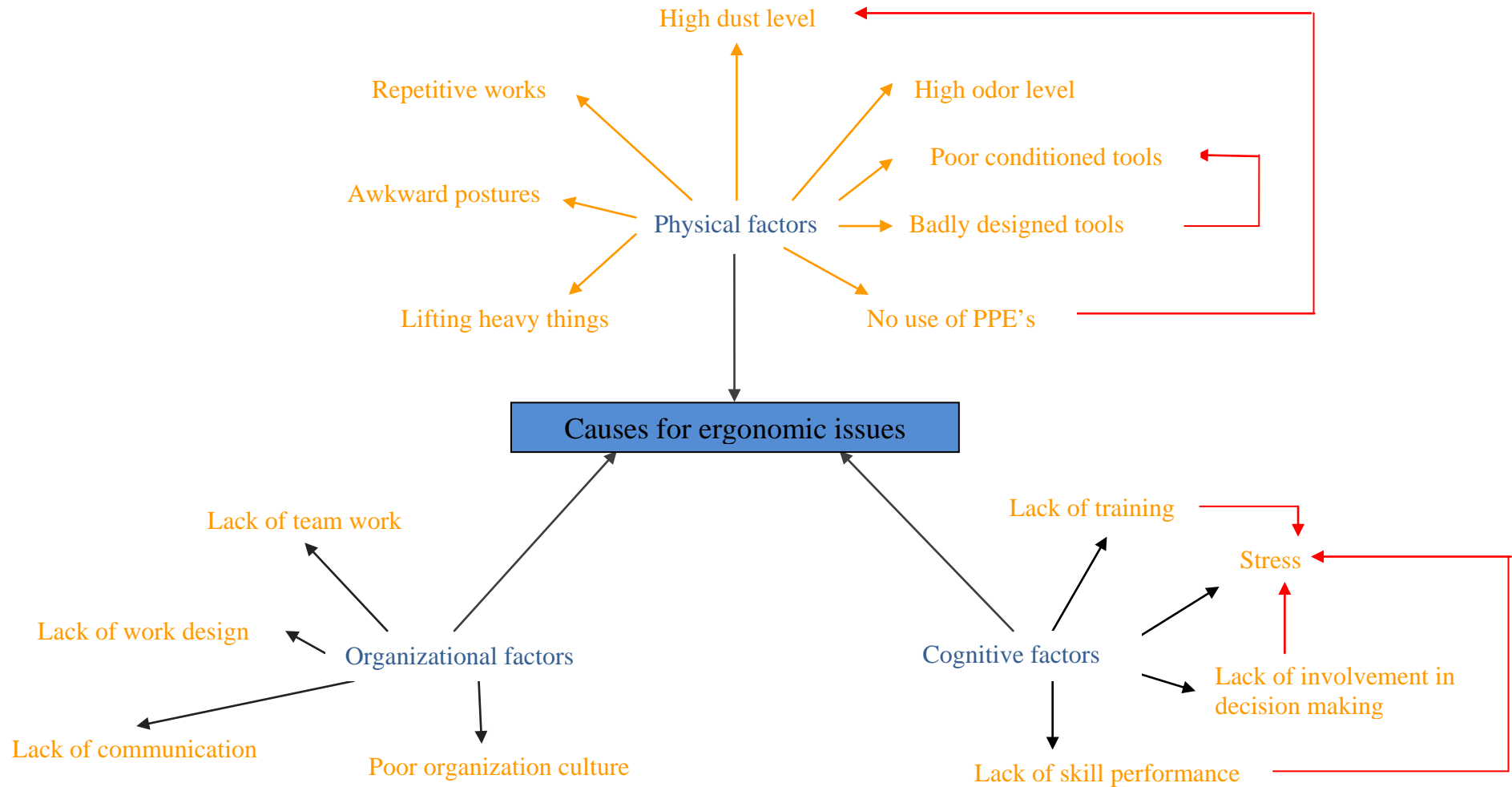


Figure 4.1 : Cognitive map - causes for the ergonomic related issues in the Zoo

According to the observations done at the zoo, could identify key risk factors which cause ergonomic issues as physical, organizational and cognitive factors.

Physical factors

The workers in garden section are lifting heavy garbage bins and put them into the tractor. Also could observe that the workers are not following the correct postures when lifting heavy things. This may cause pains in the body. Eg: Low back, Hand, Knee and etc. In addition, it was observed that, in every section (Garden, Animal and Supportive) the workers were doing repetitive works and they were followed awkward postures when doing the tasks.

The workers in supportive section such as Carpenters, Painters and Masons are exposing to dust when doing the tasks and the garden workers are also exposing to dust specially when sweeping the roads and cutting grasses. No one was wearing masks for reduce expose to dust in every section. Exposure to odor also is another ergonomic risk factor which was found in the zoo. Specially, the workers in animal section work in an odor environment.

The most of the tools use in every section were not in good condition. Also the tools have not maintained properly and most are old ones. Some tools have not designed ergonomically too.

Organizational factors

The other key ergonomic risk factor was organizational factors. Under this factor could identify several sub factors. One is lack of teamwork. During the field visits could observe that the team work among workers is poor. Also the way of work has been designed seems not good. The working procedures existed in the zoo was traditional and has not done any changes. And also there was no proper occupational health and safety manual prepared for the workers.

The communication among the managerial level and low level employees is not strong. And in some situations could see the communication among supervisors also less.

The organization culture exist in the zoo was not much in satisfaction level. Most of the low level workers in the zoo had not a clear idea about their job tasks and as mentioned above, most of the working procedures are traditional. Also, most of the

workers were engaged with work without paying attention on their health and safety. Eg: No use of PPE's. The leadership of middle and top level staff also not much effective.

Cognitive factors

The other key ergonomic risk factor was Cognitive factors. Under this could identify some sub factors as lack of training, lack of involvement in decision making, lack of skill performance, lack of involvement in decision making, lack of skill performance and worker stress. The job related trainings provided for the workers is less. Most of the workers had not aware about the occupational health and safety. The workers had not received any training on ergonomics too. Such as, handle tools correctly and lifting of heavy material (Eg: Garbage bins) correctly. In addition, job rotation was not there.

During the field visits could identify that the getting the involvement of low level employees on decision making is less. The workers just do the orders coming from the top level and have not chances to generate their ideas on decision making process and the management commitment to workers also less. Lack of skill performance is another risk factor which was identified. Most of the workers are doing the same task throughout their job period. The changes for the tasks and job rotation have not done. Therefore, the performance skills of the workers are less. Also as mentioned above the training sessions provided for the workers are less.

The aforesaid ergonomic risk factors are leading to cause stress for the workers. Stress may cause health issues for the workers and that may lead to reduce their efficiency.

4.2.2 Occupational health issues due to poor ergonomics in the zoo

According to the accident records in the zoo from 2012 – 2015, could find out some recorded occupational health issues due to poor ergonomics. Table 4.1 shows the summary of the occupational health issues.

Table 4.1: Occupational health issues due to poor ergonomics

Health issue	Frequency
Eye injuries	05
Pains in knee	02
Pains in fingers	01
Low back pain	16
Pains in ankle	01
Pains in leg	09
Pains in neck	03
Pains in hand	03
Pains in shoulder	01

In most of the records it has been mentioned that, lifting of heavy garbage bins, carrying of wheel barrows and cleaning of animal enclosures are the main causes for the health issues.

Summary of the observations findings:

Through the observations could identify the causes for the ergonomic related issues in the zoo as physical, organizational and cognitive ergonomic risk factors. The physical factors are lifting heavy things, awkward postures, repetitive works, expose to dust, expose to odour, poor conditioned tools, badly designed tools and no use of PPE's. The organizational factors are lack of team work, lack of work design, lack of communication and poor organizational culture. As cognitive factors could identify lack of training, stress, lack of involvement in decision making and lack of skill performance. According to the accident records of the zoo, there was a high frequency in low back pains, pains in legs and etc. Lifting of heavy garbage bins, carrying of wheel barrows and cleaning of animal enclosures are the main causes for the health issues.

4.3 PILOT SURVEY

The preliminary questionnaire survey was conducted within randomly selected 45 operational level employees who are working under animal, garden and supportive sections in the zoo. Questionnaire was developed based on the findings of previous research studies and by using the data demonstrated in the literature review. The questionnaire survey was conducted to cover the second objective of his research.

The questionnaire has been broken to three main headings as employee's general information, ergonomic risk factors (Here, the satisfaction level of worker relevant to the work place condition was evaluated. Thereafter, the identified risk factors were ranked) and the ergonomics issues (Discomforts/Illnesses). Also a simple language was used to develop the questionnaire.

As emphasized in the research methodology, five-point likert-scale has been used for the questionnaire to analyze the employee satisfaction level. Each choice are anchored with a descriptor, ranged from 1-5 expressing, highly dissatisfied, dissatisfied, somewhat satisfied, satisfied and highly satisfied regarding the workplace condition in practicing respectively. The analysis has been synchronized in a sequential order corresponding to the facts identified from the literature review and observations. Thereafter, RII analysis was done in order to rank the identified risk factors by referring Table 3.2.

4.3.1 Indirect ergonomic risk factors

According to the nature of the organization and its employees, it has different characteristics. The employees who participated to the survey were different in age, experience and number of working hours. These facts are affecting indirectly to make the employees in comfort or discomfort. And also it can be identify as the initiation of ergonomics.

Age Limit

Table 4.2 and figure 4.2 present the participants' age limit.

Table 4.2:Participants' age limit

Age Limit	Number of respondents	Percentage (%)
Below 25 years	0	0
25-35 years	6	13
35-45 years	13	29
45-55 years	23	51
Above 55 years	3	7

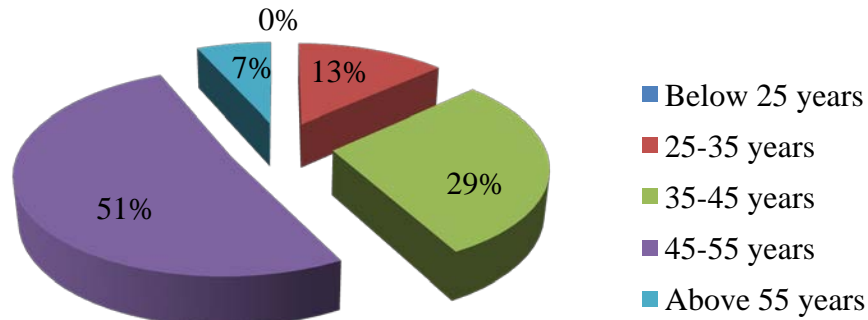


Figure 4.2: Participants' age limit

As per the Figure 4.2, out of all respondents 58% workers were more than 45 years old while the rest of 42% were young. The age may indirectly affect to the worker to increase the possibility of cause ergonomic issues. In addition to that, if the majority of respondents are old workers, it may affect to decrease the efficiency due to high absenteeism.

Time in position

Figure 4.3 presents the participants' work experience.

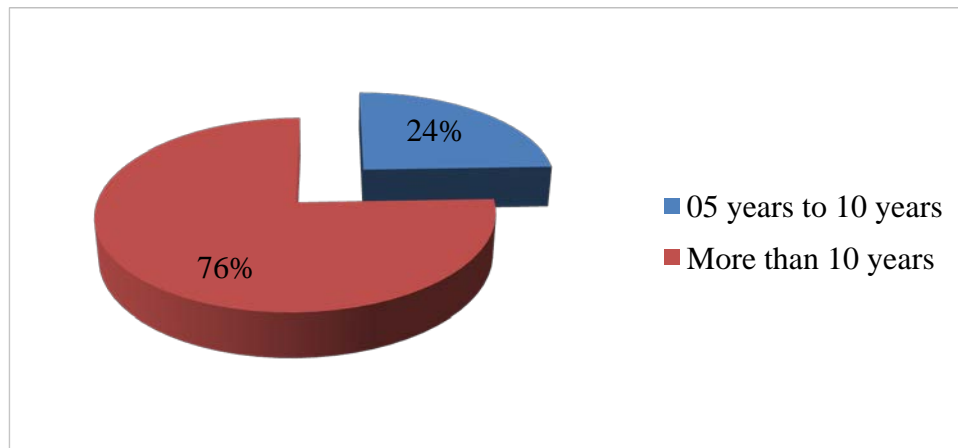


Figure 4.3: Work experience of the participants

The time in position or work experience is another factor that affects to continue the employee and work environment relationship. It can be affects in two ways. If the worker has more experience with the task, he may have certain skills and may have certain knowledge about the ergonomics. Therefore, since the worker is aware of the

ergonomics, there is a possibility to reduce the discomforts along with the experience. However, in the other hand at the same time because of the experience can occur long term discomforts and illnesses too. According to the figure 4.3, majority of the respondents have more than ten year experience, accounting for 76% of the total respondents. And the survey results showed that there was no respondents which have working experience below 5 years. The work experience may indirectly affect to the worker to increase the possibility of cause ergonomic issues.

Number of working hours

Figure 4.4 presents the number of working hours of the participants.

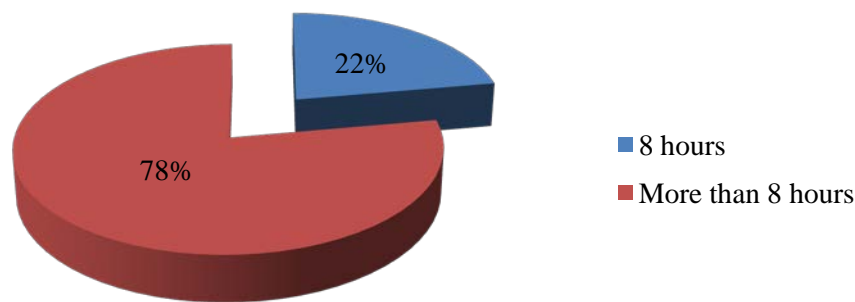


Figure 4.4: Working hours of the participants

With regards to the ergonomics, the number of working hours is a significant factor. Repetition of work, working in a static posture and working in an awkward posture for long hours may increase the discomforts. As per the survey, out of the forty five participants 78% of them are engaged in more than eight hours while 22% are in normal working hours of eight hours.

4.3.2 Ergonomic risk factors

The ergonomic risk factors differ from each other by environment, features of the organization and its workers.

To make the survey comfortable, the information was divided into three major parts as physical factors, organizational factors and cognitive factors. Majority of the

ergonomic risk factors that recognized in the literature review were in the zoo. As well as, during the field visits could observe some physical ergonomic risk factors that exist in the zoo.

4.3.2.1 Identification of ergonomic risk factors based on respondents satisfaction level

Figure: 4.5 gives an overview of the respondents’ level of satisfaction with the physical ergonomic factors at the National Zoo. (The detail calculations are shown in Appendix C)

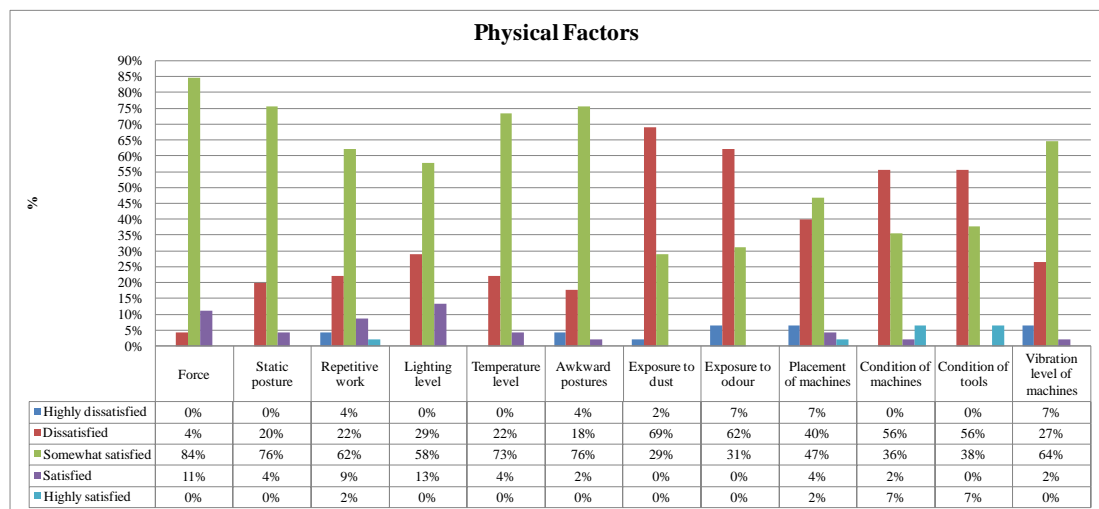


Figure 4.5: Physical ergonomic risk factors

All the respondents have been rated their satisfaction level for all the twelve factors of force, static posture, repetitive work, lighting level, temperature level, awkward postures, exposure to dust, exposure to odour, placement of machines, condition of machines, condition of tools and vibration level of machines.

The study revealed that most of the respondents are dissatisfied with the factors of exposure to dust, exposure to odour, placement of machines, condition of machines and condition of tools. Majority of them are somewhat satisfied with the factors of force, static posture, repetitive work, lighting level, temperature level, awkward postures and vibration of machines. Out of all respondents, a few of them are satisfied and highly satisfied with the above factors and the percentages of each factor are under 15%.

In addition to that, with the results of the observations too could identify that the workers in animal and garden section are exposure to dust and odour. As well as the condition of materials and tools are poor in supportive and garden section.

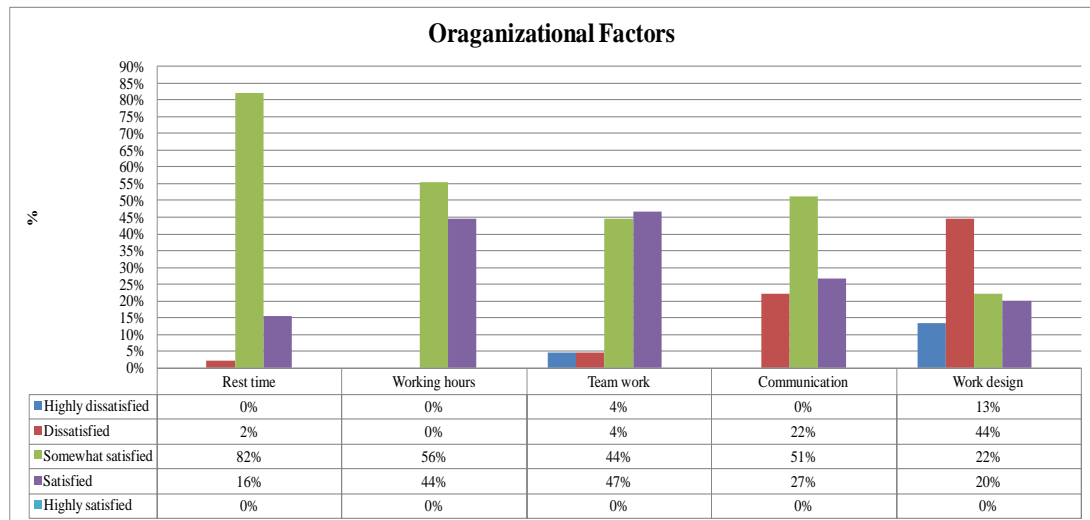


Figure 4.6: Organizational ergonomic risk factors

All the respondents have been rate their satisfaction level for all the five factors of rest time, working hours, team work, communication and work design. (The detail calculations are shown in Appendix C)

In terms of the organizational ergonomic risk factors, the study revealed as presented in figure 4.6 that, some respondents are satisfied with team work and most and majority of them are somewhat satisfied with rest time, working hours and communication. As well as, 44% of respondents are dissatisfied with their work design as they found it is not suited enough for their comfort.

In addition to that, during the field visits also could observe that the way of work has been designed was not in good. The working procedures existed in the zoo was traditional and not updated.

The communication among the high and low level employees seemed not strong. The organization culture in the zoo was not much in satisfaction level and could see that the workers were engaged with work without paying attention on their health and safety.

Figure: 4.7 gives an overview of the respondents' level of satisfaction with the cognitive ergonomic factors at the National Zoo. (The detail calculations are shown in Appendix C)

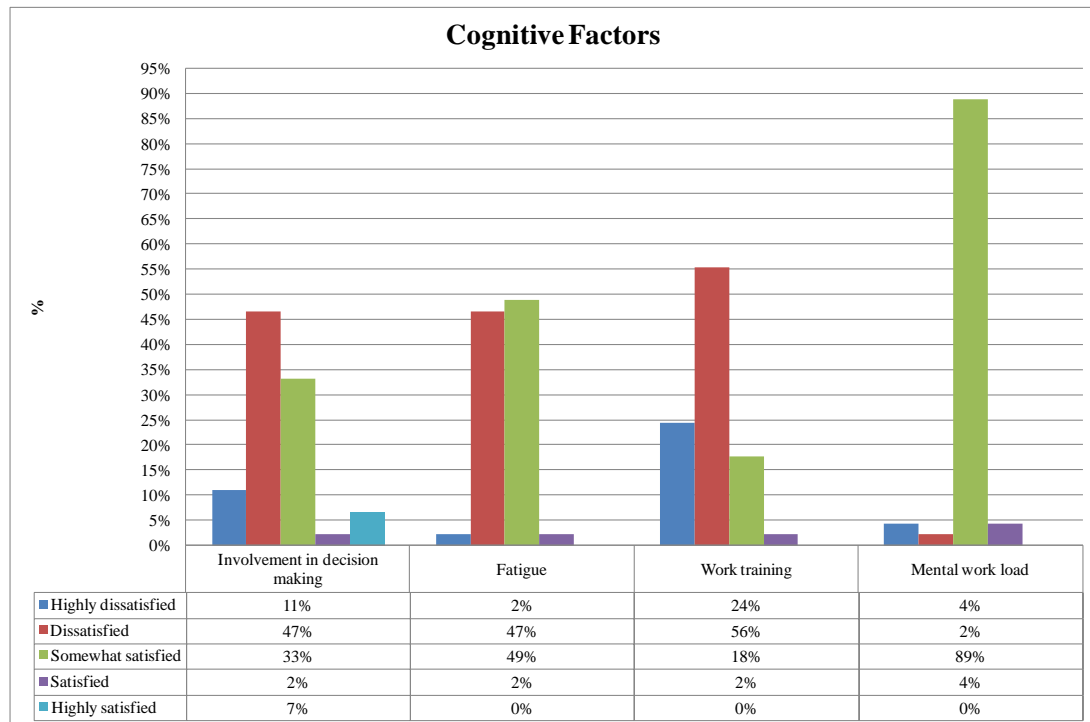


Figure 4.7: Cognitive ergonomic risk factors

The respondents have been rate their satisfaction level for the factors of involvement in decision making, fatigue, work training and mental work load as presented in figure 4.7.

As shown in this figure, most of the respondents are dissatisfied with the factors of involvement in decision making and work training. Most of the respondents are somewhat satisfied with the fatigue and metal work load. Also the results are showing that out of all respondents, 47% of them are dissatisfied with the fatigue. A few of them are satisfied and highly satisfied with the above factors and the percentages of each factor are under 10%.

The study observed that the job related trainings provided for the workers are less and most of the workers had not aware about the occupational health and safety and ergonomics too. In addition, during the field visits could identify that the getting the involvement of low level employees on decision making is less.

In summary, the above illustrated factors (see figure 4.5, 4.6 and 4.7) are the most common ergonomic risk factors in the National Zoo.

4.3.2.2 Ranking of ergonomic risk factors

The RII values have been calculated as shown in Table 4.3. The detail calculations are shown in Appendix D.

Table 4.3: Ranking of ergonomic risk factors

S/No	Risk Factor	RII	Rank
Physical factors			
1	Force	0.52	12
2	Static posture	0.56	9
3	Repetitive work	0.57	7
4	Lighting level	0.54	11
5	Temperature level	0.55	10
6	Awkward posture	0.57	7
7	Exposure to dust	0.74	1
8	Exposure to odour	0.73	2
9	Placement of machines	0.64	5
10	Condition of machines	0.65	4
11	Condition of tools	0.66	3
12	Vibration level of machines	0.58	6
Organizational factors			
1	Rest time	0.50	3
2	Working hours	0.41	5
3	Team work	0.45	4
4	Communication	0.54	2
5	Work design	0.67	1
Cognitive factors			
1	Involvement in decision making	0.69	2
2	Fatigue	0.64	3
3	Work training	0.77	1
4	Mental work load	0.52	4

Among the identified ergonomic risk factors, exposure to dust is clearly the highest in the ranking for physical factors as shown in Table 4.3. The risk factors of exposure to odour, poor condition of tools and poor condition of machines can be rank respectively according to the results. The table displays the factor of poor work design on top of the ranking for organizational factors. For cognitive factors, lack of work training is the highest in ranking. Lack of involvement in decision making also can be identified as a high risk factor exists in the zoo.

4.3.3 Ergonomic issues

As recognized above, there are number of factors affect for the ergonomics in the National Zoo. They are varying according to the employee, working environment and organization as well. Through the questionnaire survey, it was able to identify the number of discomforts and illnesses the employees are suffered from in the zoo. The ergonomic issues identified in chapter two were used to this questionnaire. Figure 4.8 presents the discomforts of respondents due to poor ergonomics.

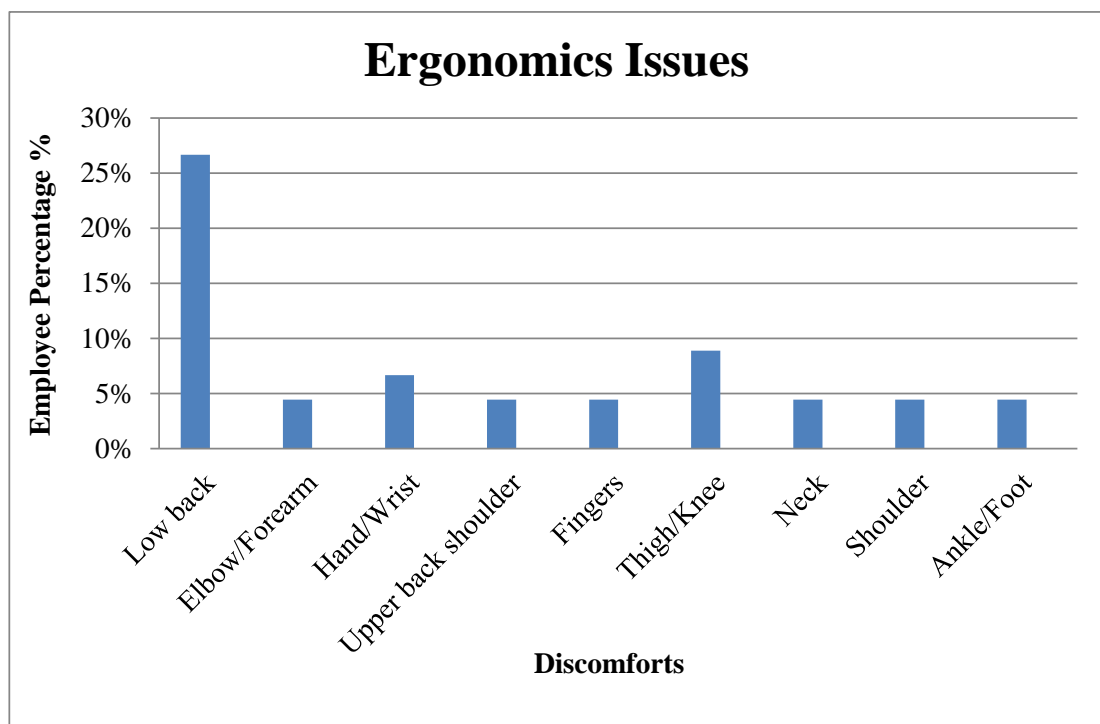


Figure 4.8: Discomforts due to poor ergonomics in the zoo

Here, out of 45 participants, 69% of them are suffered from various discomforts as shown in figure 4.8. The study has found that, 27% of respondents have low back pain. The repetitive work, static posture and awkward postures might be the causes

for such discomforts. Also, comparatively high percentages have discomforts in thigh/knee and hand/wrist. Therefore, it can be recognized that these are the very common ergonomics issues among the operational level employees in zoos.

Additionally, there is less percentage of respondents who have discomforts in elbow/forearm, upper back shoulder, fingers, neck, shoulder and ankle/foot.

In addition, the study was found that some respondents have illnesses due to poor ergonomics in the zoo. Figure 4.9 presents the illnesses of respondents due to poor ergonomics.

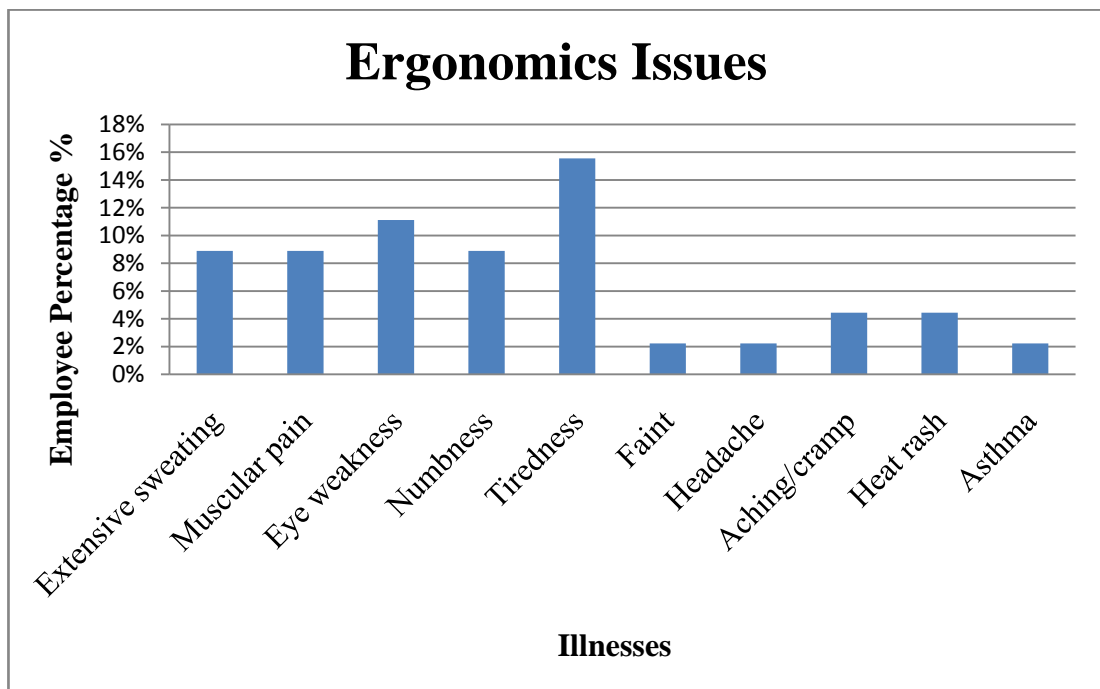


Figure 4.9: Illnesses due to poor ergonomics in the zoo

Out of 45 respondents 69% of them have illnesses as illustrated in above figure. It was found that approximately 16% of respondents have tiredness. Doing of repetitive works and other physical factors as high temperature and poor condition of machineries might be the causes for the tiredness. Also the study was found that, comparatively high percentages have illnesses as eye weakness, extensive sweating, muscular pain and numbness.

Moreover, there are less percentage of respondents who have illnesses as faint, headache, aching/cramp, heat rash and asthma.

Summary of the questionnaire survey results

Table 4.4 : Summary of the questionnaire survey results

INDIRECT ERGONOMIC RISK FACTORS	ERGONOMICS ISSUES
<ul style="list-style-type: none"> • Age limit • Work experience • Number of working hours 	Discomforts <ul style="list-style-type: none"> • Low back pain • Discomforts in thigh/knee • Discomforts in hand/wrist
ERGONOMIC RISK FACTORS	
Physical Factors	Illnesses
<ul style="list-style-type: none"> • Exposure to dust • Exposure to odour • Poor condition of tools • Poor condition of machines • Improper placement of machines 	<ul style="list-style-type: none"> • Tiredness • Eye weakness • Extensive sweating • Muscular pain • Numbness
Organizational Factors	
<ul style="list-style-type: none"> • Poor work design • Poor communication 	
Cognitive Factors	
<ul style="list-style-type: none"> • Lack of work training • Lack of involvement in decision making 	

4.4 INTERVIEW ANALYSIS WITHIN CASE STUDY

4.4.1 Background to the case study

The organization is a zoological garden where exhibit animals, carry out animal conservation, welfare and education. It has 380 employees and about 310 of them are operational level employees who work under animal, garden and supportive sections. All the operational level employees in the zoo are males and working from 8.30 a.m to 4.15 p.m .

4.4.2 Discussion on interview process findings

To make the interview process comfortable, the information was divided into five major points as, background information of the organization, organization assessment related to ergonomics, employees and his work environment, effect of ergonomics towards the job and actions proposed to overcome the ergonomics

problems. The interviewee was the human resource manager who is responsible for the health and safety of the occupants in the zoo.

In the zoo, there are workers who do the manual handling related tasks such as, lifting of garbage bins, sweeping. Also some workers in animal section use high pressure pipes to clean the animal enclosures. Therefore, this may occur unexpected injuries as musculoskeletal disorder and low back pain. Issues like expose to dust and odor also will badly affect to the employee's health.

Organizational assessment related to ergonomics

Regarding the organizational assessment related to ergonomics, the interview disclosed that the workers in the zoo are not 100% efficiency and the facilities in the workplace are not enough. The manager stated that, *“Actually, the workers are not 100% efficiency. There is about 75%-80% efficiency rate. The facilities available in the workplace are not enough for them. This may affects to reduce the efficiency. Also, since our zoo is a government owned service supplying institute, we are not practicing daily target achievement method. So, sometimes this may also lead to reduce the efficiency. But, annually we measure the efficiency of each employee and pay incentives for it”*.

Further, with regards to the organizational assessment related to ergonomics the interview revealed that to some extent the workers are satisfied with the working environment. But due to some reasons as stress and expose to odour some are not satisfied. With regards to this the manager stated that, *“I think to some extent they are satisfied with the work environment. But, sometimes especially the workers in animal section do their work in stress. Because, they have to engaged with dangerous animals and always expose to odour”*.

Employee and his work environment

Regarding the relationship between employee and his work environment, the interview disclosed that there should be a good relationship between employee and his physical work environment and a well physical environment may increase the worker's satisfaction level. With regards to the above statement the interviewee stated that *“Actually there should be a good relationship between employee and his physical work environment. Otherwise, the worker cannot perform his tasks in*

comfort. A well physical environment may increase the worker's satisfaction level". Further he revealed that, "A proper work environment increases the satisfaction of the employee and they are willing to perform the tasks well. This may leads to achieve the organizational goals and objectives. A proper relationship reduces the absenteeism and work place accidents. Actually, our organization is not 100% successful but has created the environment so as to run".

Also, the interview reveled that, the zoo is following local rules and regulations for fire safety to ensure the effective working environment. And the attention on ergonomics in the zoo is very poor. With regards to that the manager stated *"Actually, the attention on ergonomics is less in our zoo. Most of the workers in animal and garden section are suffering from muscular and back pains. Because, every day they carry heavy garbage bins and sweep the roads frequently. They are not aware to do the tasks in correct ergonomically way. We have provided PPE's for them. But, even we instructed to wear the PPE's, they are not practicing it"*. Further, he disclosed that, the workers in the zoo should protect by implementing a proper health and safety management including ergonomics principals. Since there is no proper health and safety manual and training on ergonomics in the zoo, the workers are not aware about the ergonomics. If implement ergonomics principals in the zoo, can increase the worker efficiency by reducing absenteeism, accident costs.

Effect of ergonomics towards the job

Regarding the effect of ergonomics towards the job, the interview disclosed that due to disorders caused by poor ergonomics, the workers get absent and have to replace another for the task. From this, the efficiency of the worker may also get reduce. In addition, due to the ergonomic discomforts, the workers get unsatisfied. Pertaining to the complaints from the employees regarding the discomforts of the working environment, the interviewee stated that *"Actually, the working environment in the zoo is not 100% comfortable to work. Some workers are complaining about the bad condition of machineries and tools. Also, some are complaining regarding their work space. They say the space that has provided them is not enough to do the tasks"*.

Most of the operational level workers in the zoo are suffering from back pains and a few of them have some skin diseases. With regards to the remedial actions taken for

over come from occupational diseases or illnesses, the manager revealed that, “*Actually, we have provided PPE’s as masks and ear plugs for all sections to reduce the expose to dust, odor, noise and etc. Also we have provided safety gloves and boots for animal and garden sections to prevent from skin diseases*”. In addition, the interview disclosed that, some workers in the zoo have taken about 14 days for injuries due to animal bits. For slippages and ergonomic related issues have loss about 2-3 days. The management replace another worker who familiar with the injured ones tasks. But efficiency get slow. Further the manager stated that, above problems affect to high absenteeism and it might reduce the productivity.

Actions proposed to overcome the ergonomics problems

Regarding the actions proposed to overcome the ergonomics problems, the interviewee disclosed that “*Actually, a proper training on ergonomics and PPE’s should be given for the workers in the zoo. In addition, a proper health and safety manual including ergonomics principals should be prepared. The equipments and machineries use in all the sections should be maintained properly*”.

4.4.3 Validation of findings

The findings of the observations and preliminary questionnaire survey have been validated with the results of the interviews as following Table 4.5,

Table 4.5: Validation of findings of the research

Ergonomic Risk factors	Results of the observations	Results of the preliminary questionnaire survey
<u>Physical Factors</u>		
Exposure to dust	√	√
Exposure to odour	√	√
Poor condition of tools	√	√
Badly designed tools	√	X
No use of PPE’s	√	X
Repetitive works	X	X
Awkward postures	√	√
Lifting heavy things (Force)	√	√
Improper placement of machines	X	X
Condition of machines	X	√

Organizational factors		
Lack of communication	X	X
Lack of work design	√	√
Poor organizational culture	X	X
Cognitive factors		
Lack of training	√	√
Mental work load (Stress)	√	√
Lack of involvement in decision making	X	X
Lack of skill performance	X	X
Discomforts		
Pains in knee	√	√
Pains in fingers	X	X
Low back pain	√	√
Pins in ankle	X	X
Pains in leg	√	√
Pains in neck	√	X
Pains in hand	√	√
Pains in shoulder	√	X
Illnesses		
Eye injuries	X	X
Muscular pains	X	√

Summary of interview process analysis

All the findings of the interview process has illustrated under five broad headings as background information of the organization, organization assessment related to ergonomics, employees and his work environment, effect of ergonomics towards the job and actions proposed to overcome the ergonomics problems. The interview disclosed that there is about 75%-80% efficiency rate among the employees in the zoo and the facilities available in the workplace are not enough for them. Also, the zoo is following local rules and regulations for fire safety to ensure an effective working environment. As well as, the attention on ergonomics in the zoo is very less. Most of the operational level workers in the zoo are suffering from back pains and a few of them have some skin diseases. As suggestions the interview stated that, a proper training on ergonomics and PPE's should be given for the workers in the zoo and a proper health and safety manual including ergonomics principals should be prepared. Also, the equipments and machineries use in all the sections should be maintained properly.

CHAPTER 05

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The preceding Chapter analyzed and discussed the findings of the empirical study. However, this Chapter is focused on illustrating conclusions and recommendations of the analysis and discussion performed in the previous Chapter. In first, conclusions drawn on the overall research problem is presented. Subsequently, recommendations are presented under the sub divisions of implication to zoos, safety and health sector and government. Finally, the new research directions emerging from this study are elaborated.

5.2 CONCLUSIONS

The purpose of this section is to illustrate the conclusions from the analyzed research findings. The aim of this study was to evaluate the current practice of ergonomics with special reference National Zoo in Sri Lanka and this was the basis for the empirical study.

Ergonomics can be described as a system of interaction between components in the workplace, which include the worker, the work environment (both physical and organizational), the task and the workspace. Ergonomics developed into a recognized field during World War II, when for the first time, technology and the human sciences were systematically applied in a coordinated manner. The primary objective of ergonomics is to ensure a good fit between the workers and their jobs, thereby maximizing worker comfort, safety, efficiency and productivity. However, ergonomics have not yet well penetrated relevant fields in industries in developing countries, such as Sri Lanka.

The study reviewed what was emphasized in literature and the findings have been broadly explored through data collected from observations, pilot survey and the interviews.

A comprehensive literature survey identified the concept and elements of ergonomics, the ergonomic risk factors and the ergonomic issues in zoos. The elements of ergonomics are Physical, organizational and cognitive ergonomics. In addition, through the literature survey it could identify force, work posture, repetition, contact stress, duration, temperature, vibration, illumination and work rate as the risk factors which cause ergonomic issues in a work environment.

As per the results of the observations, the physical risk factors in the zoo are lifting heavy things, awkward postures, repetitive works, expose to dust, expose to odour, poor conditioned tools, badly designed tools and no use of PPE's. Similarly, the organizational risk factors are lack of team work, lack of work design, lack of communication and poor organizational culture. Lack of training, stress, lack of involvement in decision making and lack of skill performance are the cognitive risk factors. According to the accident records of the zoo, there were health issues due to poor ergonomics such as low back pain, pains in legs and etc. Lifting of heavy garbage bins, carrying of wheel barrows and cleaning of animal enclosures are the main causes for the health issues.

As per the results of the pilot survey, the indirect ergonomic risk factors are age limit, work experience and number of working hours. According to the satisfaction level analysis, the identified physical factors are, exposure to dust, exposure to odour, improper placement of machines, poor condition of machines and poor condition of tools. It was found that, the organizational factors as the poor work design and cognitive factors are as lack of involvement in decision making and lack of work training. Similarly, the results of the RII analysis found that, exposure to dust, exposure to odour and poor condition of tools are the highest ranking for physical risk factors. The factor of poor work design was at the top of the ranking for organizational factors. For cognitive factors, lack of work training is the highest in ranking. Lack of involvement in decision making also can be identified as a high risk factor exists in the zoo.

In addition, it indicated that the discomforts among operational level employees are high due to poor ergonomics and the resulted in low back pain, discomforts in thigh/

knee and discomforts in hand/wrist. The illnesses found are revealed as tiredness, eye weakness, extensive sweating, muscular pain and numbness.

For the aspect of organizational assessment related to ergonomics, it was reviewed that there is about 75%-80% efficiency rate among operational level employees and lack of facilities in the work place might have affected on the efficiency. The interviewee viewed that there should be a good relationship between employees and his physical work environment and a well physical environment may increase the worker's satisfaction level. Accordingly, it is evident that the ergonomics in the zoo is at a very low level. The workers do not follow correct ergonomics postures and not wear the PPE's. In addition, there is no health and safety manual and training on ergonomics in the zoo. As the effect of poor ergonomics they had to replace employees and as a result the efficiency goes down with new workers. According to information, some operational level workers in the zoo are complaining on the lack of space for work.

The results of the observations and preliminary questionnaire survey were validated with the results of interview process. Through that, could confirm the risk factors of exposure to dust, exposure to odour, poor condition of tools, poor condition of machines, no use of PPE's, poor work design and lack of training are existing in the zoo. Also the identified discomforts and illnesses are low back pain, pain in legs, pain in hands and muscular pains. To overcome such ergonomics issues there existing, need for proper training on ergonomics and PPE's that should be given for the workers in the zoo and a proper health and safety manual including ergonomics principals should be prepared. Also, the equipments and machineries used in all the sections should be maintained properly. In addition to that, a work rotation plan with age of the workers should be implemented and work training programs should be conducted.

Finally it can be concluded that the current practice of ergonomics in the zoo exists at a low level.

5.3 RECOMMENDATIONS

Considering the findings of the research, followings can be recommended to the administration of the zoos, health and safety sector and government.

5.3.1 Suggestions to zoos

This study was carried out to evaluate the current practice of ergonomics in a National Zoo in Sri Lanka. However, most of the suggestions can be relevant to the private zoos as well. Those zoos can improve the ergonomic practices in the workplaces and reduce the ergonomics issues among operational level employees.

The machines in the workplace should be place properly by facilitating ease of access. In addition to reduce the discomforts, the machines should be installed after considering the body heights and should be adjustable. Also, the machines and tools used in all the sections need to be frequently maintained and it is vital to prepare a maintenance schedule. As well as a proper spaced working area should be provided for the works to perform the tasks in comfort. And the facilities like new technological ergonomically designed tools, adjustable working tables and tools should be provided for the workers. Since the awareness of the operational level workers in the zoos on PPE's is less, a practical training on this should be given by the persons who are expert in health and safety and it is possible to monitor it daily. In addition, precautions should be taken to reduce the high dust and odour level in working environment.

A proper health and safety manual is essential for any workplace as a zoo is not exceptional. In addition, work procedures need to be prepared for each task and should be updated and communicated it for all levels properly. Furthermore, the involvement of operational level employees in a zoo is very important for decision making process. In every morning before commencing works there shall be a briefing session and should get the workers involvement to discuss the issues and ideas. This assists to reduce the workers stress.

5.3.2 Suggestions to health and safety sector

The officers who are responsible for health and safety management should have a plan of actions to increase the awareness of ergonomics in organizations in Sri Lanka. Further, they should commit for providing guidance for organizational practitioners to implement ergonomics in the workplaces.

5.3.3 Suggestions to government

Government should implement procedures to fulfill the requirements of organizational practitioners by providing financial allocations to get PPE's and ergonomically designed tools and machines. In addition, the government should provide guidance and local standards to implement ergonomics programs within workplaces.

5.3.4 Contribution to knowledge

Since ergonomics have not yet well penetrated into relevant fields in industries in developing countries such as Sri Lanka, this research is an attempt to contribute to the body of knowledge of the subject in its might was. Particularly, the present condition of ergonomics in the zoo has been evaluated in the research after the identification of ergonomic risk factors and ergonomics issues in the zoo. The contribution of this research to the body of knowledge can be identified as follows.

- Vast review of literature on the concept of ergonomics as a means of achieving occupational health and safety.
- Identification of ergonomic risk factors in a work place, standards and guidelines related to ergonomics and domains of ergonomics based on the literature.
- Familiarization with the ergonomics in the zoos and common ergonomic practices in Sri Lankan context by reviewing literature.
- Recognition of the current ergonomic related issues and their risk factors in the zoos based on the selected case.
- Evaluation of the present condition of ergonomics in the zoos based on the selected case.

- Providing of recommendations and methods of minimizing the ergonomic issues in zoos.

Validation of Recommendations with the recommendations of interview process

- The equipment and machineries use in all sections to be frequently maintained.
- A proper training on PPE's should be given.
- A proper health and safety manual including ergonomics principals should be prepared.

5.4 FURTHER RESERCH DIRECTIONS

Further research areas could be identified while doing this research. Such further research could help in application of these results in practice.

- The same research study can be extended by conducting further case studies that represent international Zoos in other parts of the world. It will be interesting to discover whether the new cases replicate the results discovered through this research study and the applicability of such guidelines.

• A study on same unit of analysis in different contexts

The findings of this study can be changed into different contexts, especially, to measure the impact of ergonomics on performance of operational level employees in zoos.

• Same concept for different group of employees in same case

The concepts in literature survey can be change into different contexts as, 'the office ergonomics issues among employees in zoos' and 'the impact of office ergonomics on performance of employees in zoos'.

• Same study on different unit of analysis

The unit of analysis in this research was a National Zoo in Sri Lanka. Further, the similar research study can be applied to evaluate the current practice of ergonomics in private zoos in Sri Lanka.

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APPENDIX A

QUESTIONNAIRE FOR WORKERS**Ergonomics problems of operational level employees in National Zoo in Sri Lanka.****Section 01: General Information**

1. Name of the organization:
2. Age of employee:

Below 25 yrs	35-4	<input type="checkbox"/>	<input type="checkbox"/>		Up to 55	<input type="checkbox"/>
25-35	45-55	<input type="checkbox"/>	<input type="checkbox"/>			
3. Sex:

Female	<input type="checkbox"/>	Male	<input type="checkbox"/>
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4. Type of work (Employee position):
5. Division:
6. Time on position/job:

Less than 1 month	<input type="checkbox"/>	Greater than 1 month	<input type="checkbox"/>
3 months to 1 yr	<input type="checkbox"/>	5 yrs to 10 yrs	<input type="checkbox"/>
Greater than 10 yrs	<input type="checkbox"/>		
7. Duty roster:

Shift	<input type="checkbox"/>	Daily	<input type="checkbox"/>
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8. Number of hours involved in the work:

Below 8 hrs	<input type="checkbox"/>	8 hrs	<input type="checkbox"/>
12 hrs	<input type="checkbox"/>	More than 12 hrs	<input type="checkbox"/>
9. Are you involved in overtime work?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
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10. How many hours involve in overtime work?

1 hr 2 hrs
 3 hrs More than 3 hrs

Section 02: Causes for the ergonomics issues in the work place

11. Please mark your satisfaction level relevant to your workplace condition and work pattern. Put a “X” mark on the relevant number.

1 –Highly dissatisfied 3 –Somewhat satisfied 5 –Highly satisfied
 2 - Dissatisfied 4 –Satisfied

Sub category	Causes	Level of satisfaction				
		Highly dissatisfied	Dissatisfied	Somewhat satisfied	Satisfied	Highly satisfied
Physical factors	Force	1	2	3	4	5
	Static posture	1	2	3	4	5
	Repetitive work	1	2	3	4	5
	Lighting level	1	2	3	4	5
	Temperature level	1	2	3	4	5
	Awkward posture	1	2	3	4	5
	Exposure to dust	1	2	3	4	5
	Exposure to odour	1	2	3	4	5
	Placement of machines	1	2	3	4	5
	Condition of machines	1	2	3	4	5
	Condition of tools	1	2	3	4	5
	Vibration level of machines	1	2	3	4	5
Organizational factors	Rest time	1	2	3	4	5
	Working hours	1	2	3	4	5
	Team work	1	2	3	4	5
	Communication	1	2	3	4	5
	Work design	1	2	3	4	5
Cognitive factors	Involvement in decision making	1	2	3	4	5
	Fatigue	1	2	3	4	5
	Work training	1	2	3	4	5
	Mental work load	1	2	3	4	5

12. Please indicate the percentage of above risk factors for ranking.

Risk factor	Percentage %									
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Physical factors										
Force										
Static posture										
Repetitive work										
Lighting level										
Temperature level										
Awkward posture										
Exposure to dust										
Exposure to odour										
Placement of machines										
Condition of machines										
Condition of tools										
Vibration level of machines										
Organizational factors										
Rest time										
Working hours										
Team work										
Communication										
Work design										
Cognitive factors										
Involvement in decision making										
Fatigue										
Work training										
Mental work load										

Section 03: Ergonomics issues

13. If you have experienced regarding the following type of discomforts due to the job, please put a “√” mark on the relevant box.

Neck	<input type="checkbox"/>	Upper back shoulder	<input type="checkbox"/>
Hand/Wrist	<input type="checkbox"/>	Low back	<input type="checkbox"/>
Elbow/Forearm	<input type="checkbox"/>	Thigh/Knee	<input type="checkbox"/>
Ankle/Foot	<input type="checkbox"/>	Lower leg	<input type="checkbox"/>
Fingers	<input type="checkbox"/>	Shoulder	<input type="checkbox"/>
Other	<input type="checkbox"/>		

If other, please mention the part of the body:

If you have experienced regarding the following type of illnesses due to the job, please put a “√” mark on the relevant box.

Headache	<input type="checkbox"/>	Numbness	<input type="checkbox"/>
Aching/cramp	<input type="checkbox"/>	Tiredness	<input type="checkbox"/>
Swelling	<input type="checkbox"/>	Breathing problems	<input type="checkbox"/>
Loss of colour	<input type="checkbox"/>	Faint	<input type="checkbox"/>
Extensive sweating	<input type="checkbox"/>	Heat rash	<input type="checkbox"/>
Loss of hearing	<input type="checkbox"/>	Allergy	<input type="checkbox"/>
Muscular pain	<input type="checkbox"/>	Eye weakness	<input type="checkbox"/>
Asthma	<input type="checkbox"/>		

If you have other illness, please mention:

14. When did you first notice the above discomfort/illness?

Within 6 months After 6 months More than 1 yr

15. How many times did you have the above health problem/problems within the last year?

16. Have you taken medical treatment for the health problem/problems? If yes what was the diagnosis?

Yes

No

17. How many days have you absent for the work due to above health problem/problems?

1 day

2 days

3 days

More than 3 days

18. How many days have you on modified duty due to above health problem/problems?

1 day

2 days

3 days

More than 3 days

19. Have you changed the job due to these health problem/problems?

Yes

No

APPENDIX B

සේවකයන් සඳහා ජ්‍යෙෂ්ඨතාවලිය

ශ්‍රී ලංකාවේ ජාතික සත්වෝද්‍යානයෙහි මෙහෙයුම් සේවකයන් අතර පවතින සේවක වැඩ පරිසරය හා සම්බන්ධ ගැටලු

පලමු කොටස : සාමාන්‍යව තොරතුරු

1. අයතනයේ නම:

2. සේවකයාගේ වයස

25 ට අඩු 35-45 50 ට වැඩි

25-35 45-55

3. ස්ත්‍රීග පුරුෂ භාවය

ස්ත්‍රී පුරුෂ

4. රැකියාවෙහි නියුතු කාර්යය

5. අංශය

6. සේවා කාලය

මසකට අඩු මසකට වඩා වැඩි

මාස තුනේ සිට අවුරුද්ද දක්වා අවුරුදු 5 සිට ක්වා

අවුරුදු 10 ට වඩා වැඩි

7. සේවයේ නියැලෙන වේලාව

දිවා රාත්‍රීය මාරුව දිවා

8. දිනකට සේවයේ නියැලෙන පැය ගණන

පැය 8 ට අඩු පැය 8

පැය 12 පැය 12 ට වැඩි

9. ඔබ අතිකාල සේවයේ නියැලෙන්නේද?

ඔව් නැත

10. කොපමණ පැය ගණනක් අතිකාල සේවයේ නිරතවන්නේද?

පැයක් පැය 2

පැය 3 පැය 3ට වැඩි

දෙවන කොටස: වැඩ පරිසරය හා සම්බන්ධ ගැටලු වලට හේතු

11. ඔබගේ වැඩ පරිසරය හා රැකියාවේ ස්වාභාවය සම්බන්ධ පහත සඳහන් සාධක කෙරෙහි ඔබගේ ආකල්ප මට්ටමට අදාළ කොටුවේ සඳහන් අංකය “X” ලකුණින් සඳහන් කරන්න.

1 - ඉතා අසතුටුදායකයි 3 - මධ්‍යලස්ථයි 5 - ඉතා සතුටුදායකයි

2 - අසතුටුදායකයි 4 - සතුටුදායකයි

උප කොටස	හේතු	ආකල්ප මට්ටම				
		ඉතා අසතුටුදායකයි	අසතුටුදායකයි	මධ්‍යලස්ථයි	සතුටුදායකයි	ඉතා සතුටුදායකයි
භෞතික වැඩ පරිසරය හා සේවකයන් සම්බන්ධ සාධක	කාර්යයන් ඉටුකිරීමේදී යෙදීමට සිදුවන බලය	1	2	3	4	5
	එකම ඉරියව්වෙන් වැඩ කිරීමට සිදුවීම	1	2	3	4	5
	එකම කාර්යය නැවත නැවත කිරීමට සිදුවීම	1	2	3	4	5
	වැඩ පරිසරයේ ආලෝකය	1	2	3	4	5
	වැඩ පරිසරයේ උෂ්ණත්වය	1	2	3	4	5
	කාර්යයන් ඉටු කිරීමේදී ශරීරයට යෙදීමට සිදුවන අපහසු ඉරියව්වෙන් යෙදීමට සිදුවීම	1	2	3	4	5
	වැඩ පරිසරයේ පවතින දූවිල්ල	1	2	3	4	5
	වැඩ පරිසරයේ පවතින දුර්ගන්ධය	1	2	3	4	5
	යන්ත්‍රසූත්‍ර ස්ථානගතකර ඇති ආකාරය	1	2	3	4	5
	යන්තුසූත්‍ර රේචල තත්වය	1	2	3	4	5
	මෙවලම්වල තත්වය	1	2	3	4	5
	කාර්යයන් ඉටු කිරීමේදී යන්තුසූත්‍රතව සිදුවන කම්පනය	1	2	3	4	5
ආයතනය හා සේවකයන් සම්බන්ධ සාධක	වැඩ කරන අතරතුර ලැබෙන විවේක කාලය	1	2	3	4	5
	දිනකට වැඩ කිරීමට සිදුවන පැය ගණන	1	2	3	4	5

	සාමූහික ක්රියාකාරකම්	1	2	3	4	5
	විවිධ පාර්ශව සමඟ සන්නිවේදනය	1	2	3	4	5
	වැඩ නිර්මාණය වී ඇති ආකාරය	1	2	3	4	5
සේවකයන්ගේ හා ඔවුන්ගේ මානසික තත්වය හා සම්බන්ධ සාධක	කාර්යයන් ඉටුකිරීමේදී නිරණගැනීමට ඇති හැකියාව	1	2	3	4	5
	රැකියාව නිසා ඇතිවන වෙහෙස	1	2	3	4	5
	රැකියා පුහුණුව සිදුවන ආකාරය	1	2	3	4	5
	කාර්යයන් ඉටුකිරීමේදී මනසින් කිරීමට සිදුවන වැඩ ප්රමාණය	1	2	3	4	5

තෙවන කොටස : වැඩ පරිසරය හා සම්බන්ධ ගැටලු

12. රැකියාව හේතුවෙන් ඔබගේ ශරීරයේ පහත සඳහන් අවයවයන්හි යම් අපහසුතාවයක් ඇතිවී ඇතිනම් හෝ දැනට පවතිනම් අදාළ කොටුවෙහි “√” ලකුණ යොදන්න.

ගෙල උරහිසේ ඉහල කෙ	<input type="checkbox"/>		<input type="checkbox"/>
අත්/මැණික්කටුව කොන්ද	<input type="checkbox"/>		<input type="checkbox"/>
වැලමීට	<input type="checkbox"/>	දණහිස	<input type="checkbox"/>
පාදය/වලලුකර	<input type="checkbox"/>	යටිපතුල	<input type="checkbox"/>
ඇඟිලි	<input type="checkbox"/>	උරහිස	<input type="checkbox"/>
වෙනත්	<input type="checkbox"/>		

කරුණාකර වෙනත් අවයව නිබේනම් සඳහන් කරන්න.....

රැකියාව හේතුවෙන් ඔබගේ ශරීරයේ පහත සඳහන් සෞඛ්ය ගැටලු ඇතිවී ඇතිනම් හෝ දැනට පවතිනම් අදාළ කොටුවෙහි “√” ලකුණ යොදන්න.

හිසරදය	<input type="checkbox"/>	හිරිවැටීම	<input type="checkbox"/>
කෙණ්ඩා පෙරලීම මහන්සිය	<input type="checkbox"/>		<input type="checkbox"/>
ඉදිමීම	<input type="checkbox"/>	හුස්ම ගැනීමේ අපහසුතා	<input type="checkbox"/>
සමෙහි වර්ණය වෙනස්වීම	<input type="checkbox"/>	ක්ලාන්තය	<input type="checkbox"/>
අධික ලෙස දහඩිය දැමීම	<input type="checkbox"/>	රස්නය හේතුවෙන් සමේ ඇතිවන දුර්වලතා	<input type="checkbox"/>
ඇසීමේ අබාධ	<input type="checkbox"/>	අසාත්මිකතාව	<input type="checkbox"/>

මාංශ ජේෂින්වල ඇතිවන වේදනාව ඇසේ දුර්වලතා
 ඇදුම

කරුණාකර වෙනත් ගැටලු තිබේනම් සඳහන් කරන්න

13. ඉහත ඔබ සඳහන් කල සෞඛ්‍ය ගැටලුව/ගැටලු මුලින්ම ඔබ හඳුනා ගත්තේ කවද්ද?

මාස 6ක් ඇතුලත මාස 6 පසු අවු 1කට වඩා වැඩි

14. පසුගිය වර්ෂය තුල ඔබ කොපමණ වාරයක් ඉහත සෞඛ්‍ය ගැටලුවෙන්/ගැටලුවලින් පෙලුණේද?

15. ඉහත ඔබ සඳහන් කල ගැටලුව/ගැටලුවලට ප්රතිකාර ගෙන තිබේද? එසේ ලබා ගත්තේනම් එම සෞඛ්‍ය ගැටලුව/ගැටලුවලට හේතුව වූයේ කුමක්ද?

ඔව් නැ

16. ඉහත ඔබ සඳහන් කල සෞඛ්‍ය ගැටලුව/ගැටලු හේතුවෙන් කොපමණ දවස් ඔබ රැකියාවට නොපැමිණියේද?

එක් දවසක් දව දකක්

දවස් තුනක් දව නකට වඩා වැඩි

17. කොපමණ දවසක් ඉහත ඔබ සඳහන් කල සෞඛ්‍ය ගැටලුව/ගැටලු හේතුවෙන් ඔබ ඔබේ කාර්යය අවශ්යක ලෙස වෙනස් කලේද?

දවසක් දවස්

දවස් තුනක් දව නකට වඩා වැඩි

18. ඉහත ඔබ සඳහන් කල සෞඛ්‍ය ගැටලුව/ගැටලු හේතුවෙන් ඔබේ කාර්යය වෙනත් කාර්යයක් සමඟ මාරු කලේද?

ඔව් නැ

APPENDIX C

Respondents satisfaction level analysis on ergonomics risk factors																					
Respondent No	Physical factors												Organizational factors					Cognitive factors			
	Force	Static posture	Repetitive work	Lighting level	Temperature level	Awkward postures	Exposure to dust	Exposure to Odour	Placement of machines	Condition of machines	Condition of tools	Vibration level of machines	Rest time	Working hours	Team work	Communication	Work design	Involvement in decision making	Fatigue	Work training	Mental work load
1	3	3	4	4	4	3	1	1	2	2	2	3	3	4	3	3	3	2	2	1	3
2	3	3	3	3	3	3	2	3	3	2	2	3	3	3	3	4	4	5	3	2	3
3	3	2	2	3	3	1	2	2	1	2	2	3	3	3	3	3	2	1	2	1	3
4	3	2	2	3	3	1	2	2	1	2	2	3	3	3	3	3	2	1	2	1	3
5	3	3	2	3	3	3	3	3	2	2	2	4	3	4	4	4	1	1	3	1	3
6	3	3	2	3	3	3	3	3	2	2	2	2	4	3	4	4	1	1	3	1	3
7	3	3	2	3	3	3	3	3	2	2	2	2	4	3	4	4	1	1	3	1	3

8	3	3	3	4	4	3	3	3	4	3	3	3	3	4	4	2	3	2	3	3	3
9	3	3	3	2	3	2	2	3	3	2	2	3	2	3	4	4	2	2	2	1	3
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11	3	3	3	3	3	3	2	3	3	2	2	3	3	3	3	4	4	5	3	2	3
12	3	3	3	2	3	3	2	2	3	3	3	3	3	4	4	3	2	2	2	2	3
13	3	3	3	2	2	2	2	2	3	3	3	3	3	4	4	3	2	2	3	2	3
14	3	3	3	3	3	3	3	2	3	3	3	3	3	4	4	3	3	3	3	3	3
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19	4	3	3	4	3	3	2	2	3	3	3	3	4	4	4	4	4	2	2	2	3
20	3	2	1	3	3	2	3	1	1	2	2	3	3	4	4	3	1	2	3	2	3
21	3	2	2	2	2	3	2	2	2	2	2	2	3	3	2	2	2	2	2	2	3
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25	3	2	1	3	3	3	3	2	2	2	2	2	3	3	1	4	1	3	2	2	1
26	4	3	3	3	2	3	2	2	3	3	3	3	3	4	3	3	2	2	2	2	3

27	3	3	3	2	3	3	2	2	3	2	2	3	3	3	3	3	2	2	2	2	3
28	3	2	2	3	3	3	2	2	2	2	2	2	3	3	1	3	2	3	2	2	1
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36	3	3	4	2	2	2	2	2	3	3	3	2	3	3	4	3	2	2	2	1	3
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43	3	3	3	2	2	3	2	2	3	2	2	2	3	3	3	2	2	2	3	2	3
44	2	2	2	3	3	2	2	3	2	2	2	1	3	3	3	2	2	2	2	1	3
45	3	3	3	2	2	3	2	2	3	2	2	3	3	3	4	3	3	3	3	2	3

n= (=counta)	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Blanks (=countblank)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total(=sum)	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Counts (=countif)																						
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2	2	9	10	13	10	8	31	28	18	25	25	12	1	0	2	10	20	21	21	25	1	
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4	5	2	4	6	2	1	0	0	2	1	0	1	7	20	21	12	9	1	1	1	2	
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Total (=sum)	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Valid percentages																						
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3	84%	76%	62%	58%	73%	76%	29%	31%	47%	36%	38%	64%	82%	56%	44%	51%	22%	33%	49%	18%	89%	
4	11%	4%	9%	13%	4%	2%	0%	0%	4%	2%	0%	2%	16%	44%	47%	27%	20%	2%	2%	2%	4%	
5	0%	0%	2%	0%	0%	0%	0%	0%	2%	7%	7%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	

Calculating RII values

APPENDIX D

Respondent No	Physical factors												Organizational factors						Cognitive factors		
	Force	Static posture	Repetitive work	Lighting level	Temperature level	Awkward postures	Exposure to dust	Exposure to Odour	Placement of machines	Condition of machines	Condition of tools	Vibration level of machines	Rest time	Working hours	Team work	Communication	Work design	Involvement in decision making	Fatigue	Work training	Mental work load
1	6	5	3	3	3	5	10	9	7	7	7	5	5	3	5	6	6	8	7	9	5
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Blanks (=countblank)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (=sum)	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

Counts
(=countif)

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3	5	2	3	6	1	1	0	0	1	0	0	0	6	20	19	11	8	1	0	1	0
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7	2	9	10	13	9	6	4	5	9	6	7	12	1	0	2	9	4	0	20	4	1
8	0	0	0	0	1	2	27	23	9	19	18	0	0	0	0	1	17	21	1	21	0
9	0	0	3	0	0	2	0	3	3	0	0	3	0	0	2	0	6	4	1	10	2
10	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0

	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
$\Sigma(Wn)$	236	251	257	241	246	256	335	327	288	293	295	260	225	185	201	244	302	312	288	345	234
RII	0.52	0.56	0.57	0.54	0.55	0.57	0.74	0.73	0.64	0.65	0.66	0.58	0.50	0.41	0.45	0.54	0.67	0.69	0.64	0.77	0.52

APPENDIX E

INTERVIEW GUIDELINE

The information collected from this interview will only use in fulfilling requirement of dissertation BE 6518 for the award of M.Sc./ PG Diploma in Occupational Safety and Health Management.

Research Topic: The ergonomics issues of operational level employees in Zoos- A case of National Zoo in Sri Lanka.

Ergonomics can be described as a system of interaction between components in the workplace, which include the worker, the work environment (both physical and organizational), the task and the workspace.

The interview guideline was structured in five main headings as follows.

- ❖ Background information of the organization
- ❖ Organization assessment related to ergonomics
- ❖ Employees and his work environment
- ❖ Effect of ergonomics towards the job
- ❖ Actions proposed to overcome the ergonomics problems

The interviews will be conducted with one key participant of the Zoo. During the interview, a brief explanation about the theoretical background of the research will be provided in order to obtain valid information.

In order to collect the data accurately, tape recording (if permitted) and noting will be done while interview is processing. However, the actual name of the organization and the interviewee will not be revealed and will not be disclosed under any circumstance to maintain confidentiality. The interview will be conducted based on the following guidelines.

Researcher:

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Organization name:

Interviewee's name:

Designation:

Date:

Venue:

Duration of the interview:

Background information of the organization

1. Can you give me brief introduction about your organization?
 - Company type:
 - Year of establishment:
 - Nature of the business:

Organization assessment related to ergonomics

2. Can you explain about the employment in this company? How many employees are engaging in animal section, gardening section and supportive section?
3. Are there any breaks, rest hours or worker changing within the ongoing process?
4. If yes, how often per a shift or a day?
5. Do the employees are efficiently carry out the work? If not why?.
6. Are there any disable employees or specialized employees in your organization?
7. If yes, what type of work they are carried out?
8. Do you give separate facilities for them?
9. According to your view, are the employees are satisfied with their work environment?

Employees and his work environment

10. What is your attitude regarding the relationship between employee and his physical work environment?
11. Do you believe that, the proper relationship between employees and work environment affect to the success of the organization?
12. Do you follow standard procedures to ensure the effective working environment? If yes, what are they?

13. Do you concern on ergonomics in your workplace?
14. What do you think about the attention given to the ergonomics especially in zoo in Sri Lanka?

Effect of ergonomics towards the job

15. Is there any affecting towards the job from the ergonomics?
16. If yes, please describe.
17. Are there any complaints from the employees regarding the discomforts of the working environment?
18. Are there any occupational diseases or illnesses for the operational level workers in the organization?
19. Did the organization get remedial actions to overcome those problems?
20. What about the near misses, medical treatments and injuries in the organization within recent years?
21. Generally, how many working hours loss because of accidents and ergonomic related cases?
22. Do above problems associated with high turnover, high absenteeism and/or poor productivity?

Actions proposed to overcome the ergonomics problems

23. Do you have any plans to improve the performance of the employees through the ergonomics?

APPENDIX F: EXAMPLE OF THE INTERVIEW TRANSCRIPT

Organization name: National zoo in Sri Lanka

Interviewee's name: Mr. A (Name is not disclosed to maintain confidentiality)

Designation: Human Resources Manager

Venue: Zoo premises

Duration of the interview: 30 minutes

Background information of the organization

1. Can you give me brief introduction about your organization?
 - Company type: Zoological Garden
 - Year of establishment: 1936
 - Nature of the business: Exhibit animals, animal conservation, animal welfare and education.

Organization assessment related to ergonomics

2. Can you explain about the employment in this company? How many employees are engaging in animal, garden and supportive sections?

Yes, the total workers in animal, garden and supportive sections are about 310.
3. Are there any breaks, rest hours or worker changing within the ongoing process?

Yes, we give breaks within the ongoing process
4. If yes, how often per a shift or a day?

We give 30 minutes for lunch break. Also give 15 minutes for tea break in the morning and evening.
5. Do the employees are efficiently carry out the work? If not why?.

mmm. Actually, the workers are not 100% efficiency. There is about 75%-80% efficiency rate. The facilities available in the workplace are not enough for them. This may affects to reduce the efficiency. Also, since our zoo is a government owned service supplying institute, we are not practicing daily target achievement

method. So, sometimes this may also lead to reduce the efficiency. But, annually we measure the efficiency of each employee and pay incentives for it.

6. Are there any disable employees or specialized employees in your organization?

mmm. No

7. If yes, what type of work they are carried out? –

8. Do you give separate facilities for them? –

9. According to your view, are the employees are satisfied with their work environment?

I think to some extent they are satisfied with the work environment. But, sometimes especially the workers in animal section do their work in stress. Because, they have to engaged with dangerous animals and always expose to odour.

Employee and his work environment

10. What is your attitude regarding the relationship between employee and his physical work environment?

Actually there should be a good relationship between employees and his physical work environment. Otherwise, the worker cannot perform his tasks in comfort. A well physical environment may increase the worker's satisfaction level.

11. Do you believe that, the proper relationship between employees and work environment affect to the success of the organization?

Yes of course. A proper work environment increases the satisfaction of the employee and they are willing to perform the tasks well. This may leads to achieve the organizational goals and objectives. A proper relationship reduces the absenteeism and work place accidents. Actually, our organization is not 100% successful but has created the environment so as to run.

12. Do you follow standard procedures to ensure the effective working environment?

If yes, what are they?

mmm. Actually, we follow local rules and regulations for fire safety. As an example, we have provided fire extinguishers for each building. The fire department checks these and should get the fire clearance. And we are maintaining an accident record book.

13. Do you concern on ergonomics in your workplace?

Actually, the attention on ergonomics is less in our zoo. Most of the workers in animal and garden section are suffering from muscular and back pains. Because, every day they carry heavy garbage bins and sweep the roads frequently. They are not aware to do the tasks in correct ergonomically way. We have provided PPE's for them. But, even we instructed to wear the PPE's, they are not practicing it.

14. What do you think about the attention given to the ergonomics especially in zoo in Sri Lanka?

Definitely it is very important. We should protect the worker by implementing a proper health and safety management including ergonomics principals. Actually in here, there is no proper health and safety manual, the training on health and safety including ergonomics is very less. So the workers are not aware about it. Considering the time, attitudes and cost, it is difficult to implement ergonomics principals. But if we implement the ergonomics principals in the zoo, we can increase the worker efficiency by reducing absenteeism, accident costs. Also, the workers may become satisfy due to reduce the stress.

Effect of ergonomics towards the job

15. Is there any affecting towards the job from the ergonomics?

mmm. Yes

16. If yes, please describe.

Actually, if you looked at our accident record book, you can see most of the accidents are back pain, upper shoulder pain, pain in hands/legs and etc. Due to such disorders, the workers get absent and have to replace another for it. So, the efficiency of the worker may also get reduce. In addition, due to such discomforts, the workers become unsatisfied.

17. Are there any complaints from the employees regarding the discomforts of the working environment?

Yes. Actually, the working environment in the zoo is not 100% comfortable to work. Some workers are complaining about the bad condition of machineries and tools. Also, some are complaining regarding their work space. They say the space that has provided them is not enough to do the tasks.

18. Are there any occupational diseases or illnesses for the operational level workers in the organization?

mmm. Yes. As I said before, most of the operational level workers are suffering from back pains. And a few of them have some skin diseases.

19. Did the organization get remedial actions to overcome those problems?

Actually, we have provided PPE's as masks and ear plugs for all sections to reduce the expose to dust, odor, noise and etc. Also we have provided safety gloves and boots for animal and garden sections to prevent from skin diseases.

20. What about the near misses, medical treatments and injuries in the organization within recent years?

Actually, in our accident report you can see most of the accidents have been happened due to slippage. In second, back pains have been recorded. Also, some pains in hand, shoulder, neck and leg have been recorded. In addition, some injuries due to animal bites have been happened.

21. Generally, how many working hours loss because of accidents and ergonomic related cases?

mm. Some workers have been taken about 14 days for injuries due to animal bits. For slippages and ergonomic related issues we have loss about 2-3 days. We replace another worker who familiar with the injured ones tasks. But efficiency get slow.

22. Do above problems associated with high turnover, high absenteeism and/or poor productivity?

Not increase turn over. But it may affect to high absenteeism. This might leads to reduce the productivity.

Actions proposed to overcome the ergonomics problems

23. Do you have any plans to improve the performance of the employees through the ergonomics?

Actually, a proper training on ergonomics and PPE's should be given for the workers in the zoo. In addition, a proper health and safety manual including ergonomics principals should be prepared. The equipments and machineries use in all the sections should be maintained properly.