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Use of scientific ergonomic programs to improve organisational performance

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Declaration

I hereby declare that this submission is my own and to the best of my knowledge, it neither contains material previously published nor written by another person, nor material that to a major extent has been accepted for the award of any other degree at Durban University of Technology or any other educational institution. I also declare that the intellectual content of this thesis is a product of my work. Any contribution made to the research by others especially in the use of equipment for sample analysis has been explicitly acknowledged in the dissertation.

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Ms. Riashna Roopnarain

Dedication

I dedicate my dissertation to my parents who have been my source of inspiration and gave me strength when I was discouraged. Without their constant love and support, this dissertation would not have been possible. To my late brother Revaan, you have been my pillar of strength throughout this journey, your zest for life has motivated me and inspired me to be the best version of myself. We always spoke about this day and I know that you are proudly looking down from heaven upon me and smiling, I wish I could share this celebration and success with you.

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“Great things in business are never done by one person. They are done by a team of people” – Steve Jobs

No undertaking of any project is possible without the contribution of many people. I may not be able to single out all those who offered their help and support during this dissertation. However, there are individuals without whom this would not have been possible.

First and foremost, I am extremely grateful to my parents, Anitha and Viren Roopnarian for their unconditional love and support throughout my life. Thank you both for giving me the strength and inspiration to reach for my dreams and achieve my goals. My siblings, Riyan and late brother Revaan, I am thankful for your constant cheering and encouragement to help me be the best version of myself. To my husband Nerosh, thank you for being so understanding and supportive during the final months of my studies.

Finally, I would like to express my deep and sincere gratitude to my research supervisors Mr Mendon Dewa and Prof K Ramdass for their constant guidance and support throughout this study, without their guidance and support this dissertation would not be possible.

Abstract

The packaging industry is characterised by ineffective ergonomic programs that are inadequately implemented thereby failing to yield benefits for the organisations. The study aims to determine an effective scientific ergonomic program that focuses on improving the organisation's overall performance by aligning these programs with the organisation's business strategy. A quantitative research methodology with a questionnaire as the research instrument was adopted for this study. A quantitative analysis was conducted at two sites of a liquid packaging company in South Africa using a sample of 70 participants from the production and engineering departments. The data collected in this study were analysed with descriptive statistics.

The findings on the anthropometric and physiological factors revealed that the employees at the packaging sites were generally satisfied with the workstation design. However, it was found that several factors hindered the effective implementation of ergonomics in the packaging industry, and these include awareness in the subject of ergonomics, job task design, human-computer interaction, disconnection between employees and organisational strategies and poor implementation of anthropometric and physiological factors. The findings on the factors related to illumination also revealed that the light reflections, shadows, or flicker from the fluorescent tubes could be prevented. Additionally, a high percentage of the respondents also disapproved of the current lighting conditions that need to be addressed to prevent any risk of injury or poor performance related to lighting and illumination. The findings also demonstrated that there was a need for an improvement plan concerning noise and vibration at the packaging sites.

It was also found that there is a huge gap in knowledge about the basic principles and fundamentals of ergonomics. While most workers understood their job expectations none of them understood how factors such as safety procedures, operational performance, and employee best practices fitted into the bigger picture of the organisation. An effective ergonomic program that incorporated systems engineering risk assessment methodology, was developed, embracing a probability of occurrence matrix, ratings of criticality and rating of consequences. It was recommended that the organisation should train employees on ergonomics best practices to create an

effective program that will address operational gaps and enhance the organisation's overall performance.

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List of Abbreviations

HIS	Human-System Integration
IDC	Industrially Developing Countries
MMH	Manual Materials Handling
MSDs	Musculoskeletal Disorder
NIH	National Institute of Health
NIOSH	National Occupational Safety Health
OS&H	Occupational Safety and Health
PPE	Protective Plant Equipment
QWL	Quality of Work Life
TQM	Total Quality Management
VDT	Visual Display Terminals

Keywords

Anthropometry

Environmental Ergonomics

Ergonomics

Human Factors

Illumination and Lighting

Information Tasks

Noise and Vibration

Precision Tasks

Programs

Risk Assessment

Systems Engineering

Task Design

Work Posture

Research Outputs

1. Roopnarain, R., Dewa, M., and Ramdass K.R. 2019. Use Of Scientific Ergonomic Programs To Improve Organisational Performance, *South African Journal of Industrial Engineering*, November 2019, Vol 30(3), pp 1-8.

CHAPTER 1 : BACKGROUND OF THE STUDY

1.1 Introduction

Organisations have attempted for many years to improve their overall performance by focusing on tangible assets such as equipment and financial resources rather than the employees who are the key contributors to an organisation's growth (Chareonsuk, 2008). The ignorance of this subject can lead to high disengagement levels, poor performance, and an escalation in work-related ailments such as repetitive strain injuries (Bordia, 2011).

Ergonomics is defined as the scientific discipline that explores the interaction of humans with the equipment and tools that are used to performing tasks and other activities (Groover, 2007). It uses the knowledge of human limitations and abilities when designing systems, organisations, jobs, machinery and products (Bridger, 2017).

The essence of ergonomics is to enhance performance, health and safety. Important aspects such as work schedule, job design, interpersonal aspects, career concerns, and organisational characteristics, all have a direct impact on the attainment of these objectives (Kitila, 2018). Enhancing scientific ergonomic programs in the working environment will build an effective and highly productive workforce that will strive to ensure that business goals and objectives are met (Afroz, 2021).

Organisations should place high investment on their most valuable assets to ensure that their employees can work at their optimum. Committing to this investment will ensure that organisations are guaranteed to achieve their long-term goals and objectives by fostering a high-performance team (Kamel, 2019). This study will focus on determining an effective scientific ergonomic program that can be implemented in the packaging industry to assist in improving the overall performance of employees and create a productive and efficient working environment that will deliver organisational effectiveness. Two packaging sites based in Cape Town and Durban have been used for the study. The sites selected for the research were based on the severity of the prevailing conditions.

1.2 Research Background

In the packaging manufacturing industry, ergonomic programs fail to leave a mark of importance to many organisations. Companies in the South African manufacturing sector lack the awareness of the benefits ergonomics can have to the organisation's overall performance. It has been found that ergonomics in industrially developing countries is not well accepted in practice and is thus not comprehended as an integral part of worker wellbeing or organisational success (Ngcamu, 2009).

As stated by Bassey-Duke (2015), the findings of ergonomic researchers are rarely taken from a highly controlled, laboratory-based study into the non-controlled field to establish the impact that the findings may have on the physical workers in a real-life context. The perception that ergonomics favours workers at the expense of organisational performance is one of the key hurdles that restrict the acceptance of ergonomics in the industry (Lee, 2005; Ngcamu, 2009).

In addition, ergonomics deficiencies such as awkward, constrained working postures and poor workstation design are a major contributing factor to poor performance and quality in an organisation (Ngcamu, 2009). Many organisations were not aware of the relationship between ergonomics deficiencies and poor quality or performance and this scenario demonstrates that much is yet to be done in raising awareness about the benefits of ergonomics in South Africa and other industrially developing countries (Ngcamu, 2009).

Since many companies have been exposed to high worker compensation costs due to labour injuries, ergonomics in the South African industry has progressed gradually over the years. The lack of research programs conducted in the manufacturing industry shows that ergonomics is still a foreign topic to many. The perception that ergonomic programs are primarily associated with the occupational health and safety department prevents other departments from reaping the benefits of ergonomic interventions. The availability of research performed on ergonomic programs in the packaging sector is noted to be limited, therefore the study aims to research aims to raise more awareness and contribute further knowledge to this flourishing industry. The research performed in this study focused on areas relating to Anthropometry, Work Station Design, Posture, Task Design, Illumination and Lighting and Noise and Vibrations at two of the

packaging sites based in Cape Town and Durban. Since there had been no ergonomic study performed in the past the current ergonomic conditions had to be determined. Chapter three indicates the research methodology applied to determine these findings and the framework adopted.

1.3 Research Problem

The discipline of ergonomics is often misunderstood in industrially developing countries and there are very few practical examples to illustrate the benefit of ergonomic intervention programs due to the lack of awareness and recognition (Helali, 2009). Based on the background study, it can be inferred that a lack of awareness and understanding exists in the manufacturing packaging sector. A recent study conducted by Nord and Vanje (2018), where the study aimed to illuminate the knowledge areas needed by ergonomists and occupational safety and health engineers in the manufacturing sector, it was deduced that organisations in this sector are not proactive enough on an organisational level to address concerns on this subject and found it to be a challenge in convincing employees to address these concerns due to a gap in knowledge and skills in this area.

Research in the ergonomics space is known to be scarce hence the need to understand professional skills and knowledge areas that are needed in organisations to develop an effective ergonomic program (Eliasson, 2017). One of the obstructions that restrict the dissemination of knowledge and acknowledgment of ergonomics in the manufacturing industry is the perception that ergonomics benefits the workers at the expense of organisational performance (Ngcamu, 2009).

Employees at a packaging organisation are unable to perform tasks at their optimum due to the lack of scientific ergonomic program interventions. It was established that the tasks or activities that were characterised by ergonomics deficiencies affected the quality of output and overall organisational performance. As stated by Kamel (2019), ergonomics is a vital element of how an organisation realises its competitive edge in implementing continuous improvement strategies. Hence, the need for ergonomic programs to be exploited effectively in the organisations is vital to ensure maximum employee satisfaction and improve the performance of an organisation.

1.4 Aim of the study

The study aims to assess employees' perception of the current ergonomics scenario of the packaging industry, to determine the current ergonomics gaps and condition of the packaging industry and to develop and integrate an effective ergonomic program with the current work processes that will contribute to organisational improvement.

1.5 Research Objectives

a. To assess employees' perception of the current ergonomics scenario of the packaging industry
b. To determine the current ergonomics gaps of the packaging industry.
c. To develop and integrate an effective ergonomic program with the current working processes that will contribute to organisational improvement.

1.6 Research Questions

The construction of research questions is crucial as it forms a guideline throughout the research. Many scholars have pointed out the importance to develop innovative research questions that will lead to opening new research problems and possibly address long-standing issues. The following research questions formulated in this study were aligned with the objectives to ensure that the outcome of the study is achieved. A central research question was defined, followed by sub-research questions that are key to the objectives of this study.

a. How to develop and implement a scientific ergonomic program that will help improve an organisations performance?
    a. What is the employees' perception of the current ergonomics status of the packaging industry?
    b. What are the current ergonomics gaps of the packaging industry?
    c. How to develop and integrate an effective ergonomic program with the current working processes that will contribute to organisational improvement?

1.7 Research methodology

A quantitative research method was used in the form of a questionnaire in order to identify the state of the current ergonomic situation. The rationale behind utilising a quantitative research methodology is that it can enable the identification of current gaps and concerns regarding ergonomic programs on-site, through the analysis of data.

Two sites of a packaging liquid company in South Africa were selected for the study and a total of 100 surveys were distributed to the packaging organisations based in Cape Town and Durban, of which 70 (70% return rate) responded by returning the relevant documentation.

All ergonomic factors related to anthropometry, posture, tasks, human-computer interaction, illumination, noise, and vibration are included in this research. The targeted population selected for this research was based on the experience of artisans, packers, operators, supervisors and quality controllers in both the maintenance and production department, thus we can confirm the reliability of the participants' expertise and information provided to conduct a study that would enhance the research findings.

The feedback received from the surveys was then analysed and studied to identify gaps found in factors relating to ergonomics at both packaging sites. The results were analysed using kurtosis and skewness test. Statistical Package for the Social Sciences (SPSS) software version 26 was used derive the Cronbach's Alpha for assessing reliability of the research instrument and for correlational analysis. The data determined the employee’s perception of the current ergonomic gaps at the site and helped develop a proposed solution that will address the research objective of creating an ergonomic program that will contribute the organisational improvement.

1.8 Format of dissertation

Chapter 1 - Introduction

The chapter gives an introduction and highlights the motivation of the study, purpose, research background, research objectives, questions, the problem statement and the significance of the study.

Chapter 2 - Literature Review

This chapter is characterised by a review of literature such as research journals, articles and books related to the impact ergonomics has in the manufacturing sector. These sources have provided significant insights to the current research available and research gaps identified in ergonomics programs in the packaging sector.

Chapter 3 - Research Methodology

The chapter outlines the research and design methodology that was used and includes data analysis, collection, validation of information. The chapter also indicates the reasons behind the quantitative approach were selected and the research design and research framework that was used

Chapter 4 – Results and Findings

The chapter covers the results and discussion of research findings from the questionnaire that was distributed to the study sample. It also presents an in-depth analysis of the data that helped to identify the current gaps at the sites used in this study.

Chapter 5 - Conclusions and Recommendations

Chapter 5 consists of recommendations and the conclusion of the study that was conducted. It presents the steps taken to develop an effective ergonomic program that would contribute to performance improvement within the organisation. The key benefits of the ergonomic program are also discussed.

1.9 Significance of the study

This study significantly adds value to the limited knowledge about ergonomics in the manufacturing sector. The outcomes of this research will help the organisation adopt a proactive approach in addressing organisational gaps that are a result of the lack of ergonomic initiatives. The study will also help employees understand the relationship between ergonomics and overall organisational improvement and can help researchers and professionals in the manufacturing sector to develop new strategies and programs concerning ergonomics.

1.10 Conclusion

The essence of this chapter was to introduce the study objectives and the motivation for the research. The reasons for conducting this study were provided through focusing on the research background; problem statement; research objectives; research questions and their significance. It was noted that employees at a packaging organisation are unable to perform tasks at their level due to the lack of scientific ergonomic program interventions. Furthermore, the chapter has presented the dissertation layout. The next chapter will entail a detailed review of literature relating to ergonomics in the manufacturing sector, and in particular the liquid packaging industry.

CHAPTER 2 : REVIEW OF LITERATURE ON ERGONOMICS

2.1 Introduction

While research on ergonomic programs implemented in the packaging industry is limited, ergonomics applied in the manufacturing sector as a whole has proven to be an essential factor. Management in organisations is beginning to understand and value benefits in ergonomic programs. The implementation of ergonomic programs in an organisation can lead to positive outcomes that focuses on improving productivity and reduces risk to safety and health in the work place (Burgess-Limerick, 2018). This chapter focuses on review of literature relating to ergonomics, balance theory and several health promotions, anthropometric and physiological factors of ergonomics.

2.2 Background of Ergonomics

In a dynamic economy where organisations strive to perform at their optimum to remain ahead of their competitors, managers seek methods and tools to improve the performance of their organisation's most valuable assets, its people (Kamel, 2019). Ergonomics plays a key role in ensuring that the work environment is designed in a way that is conducive for employees to excel at their performance. It studies staff psychology and physiology of the working conditions, which is a complex system amongst humans, machines and the environment (Górny, 2017).

The goal of implementing ergonomic interventions and the exploitation of ergonomic science is to achieve a suitable and logical relationship between work and employees, where employees can attain maximum productivity and desirable production (Brito *et al.,* 2019). Ergonomic science has been recognised as a scientific discipline that explores the limitations and capabilities of humans, equipment and their environment, and exploits this knowledge to improve the design of equipment that people use and how they work. Ergonomics is considered as a crucial component or driver of how an organisation can attain its strategic goals. A study performed by Dul and Neuman (2009) highlighted how ergonomics goes beyond health and safety and how it can add value to an organisations business strategy. In order for an organisation to understand the full benefits of ergonomics, it will have to intentionally integrate ergonomics into all strategic goals and at all levels of the organisation (Shukla *et al*., 2017).

According to Dul and Neumann (2009), in order to further explore how ergonomics can be linked to strategy the firm's strategy must be divided into strategic areas. The following areas are:

a) Business function strategies: Each business function will have their own strategic goals. Middle management and their staff from these functions often have different 'languages' of their daily business. In this arena ergonomics must show that it can support the chosen strategies, tactics and performance indicators within the business functional field.

b) Cross-functional strategies: This arena involves two or more business functions hence there are several corresponding middle managers and employees from these business functions that will be primary stakeholders. Total quality management (TQM) is an example of a cross-functional strategy. Here ergonomics must show that it can add value to the cross-functional strategies and tactics.

c) Corporate strategy: In this arena the top management of the organisation is involved. An example of a corporate strategy would be a cost strategy in order to compete on the basis of low costs. In this arena ergonomics must show that it can add value to the business strategy for realizing competitive advantage.

Programs that would empower the employees in terms of decision-making at work are proven to directly lessen psychosocial strain and its undesirable health ramifications (Chung, 2018). These programs create favourable conditions for the improvement of work processes, and thus ensuring acceptable ergonomic working conditions for effective human labour (Górny, 2017).

Employees can improve work methods or carry out impressive low-cost ergonomic improvements on equipment, if a culture that nurtures ergonomics is created in an organisation (Abarghouei and Nasab, 2012). According to Dul and Neumann (2009), both physical and psychological human aspects are considered in ergonomics; and the essence is to seek solutions in both technical and organisational spheres. The performance aspects could include lead-time, output volume, production flexibility, operating cost and quality levels.

In the past, managers did associate ergonomics with health issues and no relation to organisational effectiveness was perceived (Dul *et al.*, 2012). This impeded the success and growth opportunities that scientific ergonomic programs entailed. Economic goals and human well-being come together, and ergonomics training is the best preliminary approach for educating computer users about office ergonomics in office working environments (Shukla et al., 2017).

According to Beno *et al.* (2010), ergonomic programs have benefits for the state and a mean saving of all social benefits. They positively influence the employees as well as the organisation. In a study conducted by Beno *et al.* (2010), it was found that the monitoring of the company benefits is important in the evaluation of ergonomic programs. These company benefits include the following:

a. Reducing the number of spoiled products or goods;
b. Decreasing the sick leave of workers and occupational diseases;
c. Healthy quality work environment; and
d. An increase in labour productivity.

Olabode and Adesanya (2017) posted that employee benefits that characterise ergonomic programs include the following:

a. Minimizing the manifestation of physical and mental tiredness;
b. An enhancement of the physical and mental state of an employee;
c. A positive influence in the social domain;
d. Motivation for higher performance;
e. Improvement in self-realisation that leads to a positive impact on the economic status quo of an individual.

McGowan (2019) posted that society benefits that characterise ergonomic programs include the following:

a. Better standards of living for the citizens;
b. Better health in the society;
c. Huge cost-savings derived from disability payments, sick benefits, pensions of orphans and widows;
d. Huge cost-savings derived from unemployment and social benefits;

e. Growth and development in organisations.

2.3 System Engineering Tools and Risk Management

Ergonomics is known as a systems discipline applying a systems philosophy and systems approaches (Wilson, 2014). Even within the traditional ergonomics applied to industrial workplaces, physical work, and manual handling, and equipment used within them, leading ergonomists worldwide have clearly seen that we can only usefully address the relevant human factors concerns at a systems level, whether it is referred as systems ergonomics, or participatory ergonomics/design (Haines et al 2002; Wilson 2014). According to Rouse (2010) human system integration as an element of systems engineering concerned with understanding, designing and supporting human roles and performance in complex systems (Wilson, 2014). The Defense Acquisition Guidebook (DAG) outlines System Engineering in the following categories:

a) Technical Management Processes
b) Technical Processes for designing systems
c) Technical Processes for product realization

Each of these categories consist of inputs to processes and guidelines in ensuring successful system implementation. A key component in the technical process for realization is the Risk Management which examines the technical risks of deviating from the program plan (DAG, 2000). Ergonomic risk assessment methods which look at multiple physical exposures in an integrated model of risk prediction are often used to direct industrial prevention initiatives (Jones, 2007).

According to a study performed by Hugo (2009) the bridge concept between Ergonomics and System Engineering is connected through Human Factor Engineering.

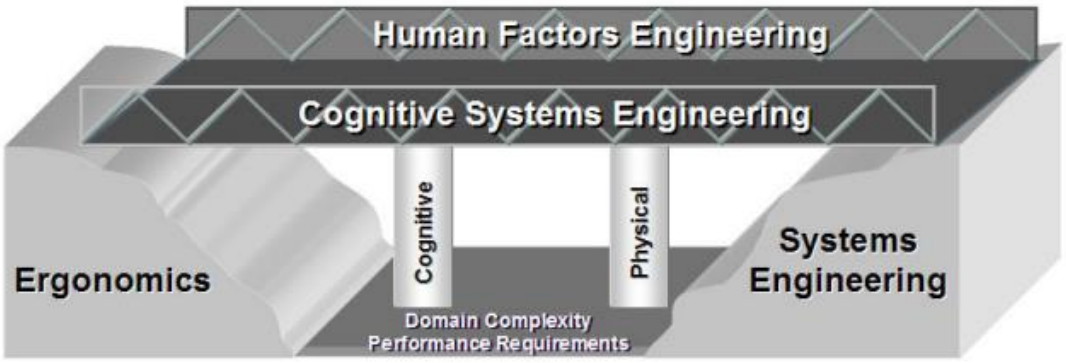

Figure 2-1: The bridge between Ergonomics and System Engineering

Source: Hugo (2009)

Figure shows that the gap of domain complexity and work performance demands that it exists between Ergonomics and Systems Engineering which is bridged by Human Factors Engineering, with Cognitive Systems Engineering as an important part (Hugo, 2009). While some may question the importance of Ergonomics in relation to System Engineering, researchers have illustrated that the integration of both subjects can make an important contribution to any process or project implemented at an organisation.

2.4 The Balance Theory

Originally developed by authors Smith and Carayon (1996), the Balance Theory emphasises the impact of work on job stress, and worker outcomes such as worker health, job satisfaction, well-being and safety (Groover, 2007). This theory proposes a job redesign approach that strives to attain an optimal job design through five elements (Habibi *et al.,* 2012).

Figure 2.1 shows a model of work systems and it comprise the following elements:

a. The individual
b. The job/task
c. Equipment and technologies
d. Physical environment
e. Organisation

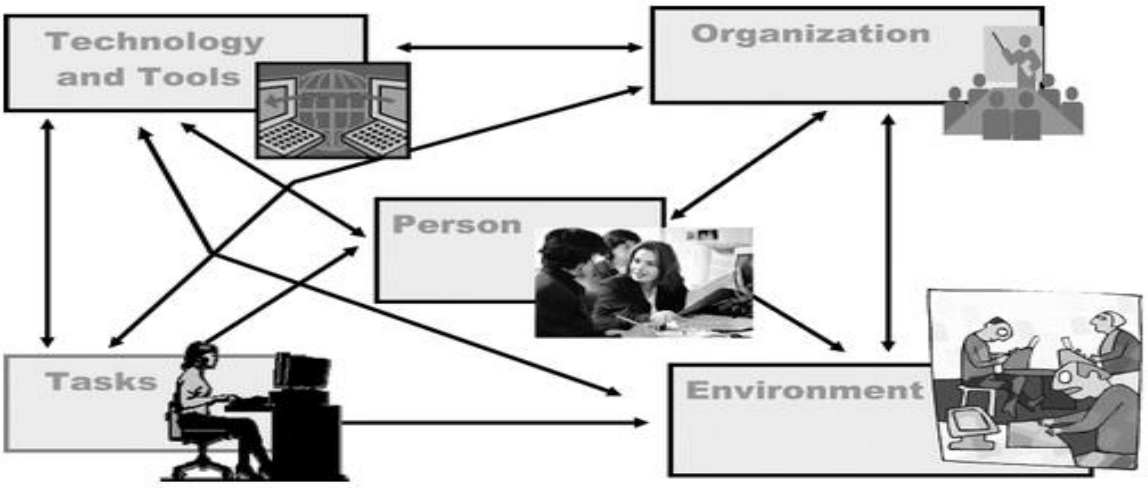

Figure 2-2: Model of Work Systems

Source: Groover (2007)

The attributes of the individual will include personality, physical health, skills and abilities, experience, motivation, goals and needs. Factors that would categorise a job are the job demand (work pressure, cognition), job content and machine pacing (De Jonge and Dormann, 2017). The work environmental factors that impact productivity include lighting, noise, air quality, temperature and layout (Sarode, 2014). The degree of technology has an impact on the worker if he is not adequately skilled (Groover, 2017; Peng, 2018). Organisational factors include training and support, shift work, and opportunities for promotion.

These factors interact with one another to produce a stress load that can be either physical stress or psychological stress. These stresses, over a while can have adverse effects and result in lack of performance as well as health and safety problems. The Balance theory postulates that the work system imposes these stress loads, which generate an individual's psychological and physiological reactions (Smith and Carayon, 1996).

The above five factors which constitute the Balance theory are further influenced by other factors such as economic conditions, changes in technology, demographic trends, and changes in corporate and employment practices (Olabode and Adesanya, 2017). These factors include restructuring and re-organising of companies, quality improvement plans, virtual corporations, networked organisations, teamwork, workforce diversity, information and computer technology (McGowan, 2019).

The objective of the Balance theory is to improve performance and motivation through a balance of different elements in the work system. A balanced organisation can be accomplished when employees are stimulated to take initiatives for improving their work systems and the overall organisational design (Bridger, 2017). The methodology applied by the Balance theory serves as an informative guide when investigating ways of developing and implementing ergonomic programs in an organisation. It was created to develop a more holistic and integrated approach to the design of work systems by identifying elements that bridge the gaps in various areas such as organisational design, job design, job stress, ergonomics and human factors. The objectives of the Balance Theory are broad and aims at achieving improvements in worker health, job satisfaction, safety, and well-being (Groover, 2007).

2.5 Health Benefits of Ergonomics

While ergonomics is known to have numerous benefits that focus on the betterment of the employee, the main contributing factor to an employee's performance that is often overlooked is the employee's health (Olabode and Adesanya, 2017). Incorporating ergonomic practices with the job processes and task objectives ensures health promotion and encourage a safe working environment.

Workers in the manufacturing industry sometimes operate in high-risk working environments that are more vulnerable to injuries. The most common disorder that is caused by the negligence of ergonomic practices is musculoskeletal disorders (MSDs). MSDs are conditions that involve the tendons, nerves, muscles, and supporting body structures (Fasanya and Shofoluwe, 2018). Ergonomics scientific literature stipulates that it is vital to create a healthy workplace (Schröer et al., 2014). Musculoskeletal disorders are mainly associated with the conditions of the working environment.

The main focus of an ergonomic program intervention is to increase productivity while reducing musculoskeletal disorder (MSDs) (Abarghouei and Nasab, 2012). Health promotion can also be perceived as behavioural promotion that focuses on 'health' concepts, as well as psychosocial concepts such as attitude, function, behaviour and activity (Rhodes *et al.*, 2019). Other factors that contribute to health promotion related to anthropometric and physiological factors.

2.6 Anthropometry

Anthropometry is a branch of human sciences that studies the physical dimensions of people, through the systematic measuring of weight, size, and proportions of the human body to achieve fit, comfort and usability in design (Hallbeck *et al.,* 1998; da Silva, 2015). The word ‘anthropometry’ is derived from the Greek word “anthropos”, meaning human. Anthropometry is considered to be a subdiscipline of anthropology as well as a field of ergonomics, when associated with the design of equipment for human usage, allowing people to interact efficiently and safely with their workplaces (Górny, 2017).

Physical anthropologists, designers, engineers and ergonomists have applied the study of anthropometry to establish physical geometry, layout, adjustments, mass properties, strength, and functional capacities of the human body (Hallbeck et al., 1998; da Silva, 2015). It is important to note that there is need to adjust consumer products such as clothes, vehicles, office workspaces, and assembly lines to minimize the negative effects on the user and maximise the usability (Chuan *et al.,* 2010).

Dianat *et al.* (2018) posited that anthropometric data can hold great importance in the engineering field to ensure that equipment is designed and manufactured to suit the requirements of the workers. An understanding of body size and proportions is crucial for the design and size of protective plant equipment (PPE).

Anthropometric data can be used to provide body size information so that manufacturers of design equipment can cater to a diverse population. Defining the target population or determining the intended users of the equipment are critical strides in the ergonomic design process. As stated by da Silva (2015), the ergonomic design process requires knowledge of body dimensions that are relevant to the functioning of the equipment as well as whom it should fit. However, these body dimensions are only applicable if they are drawn from a sample of a population that represents the body size.

Anthropometric data captured per sample size can be extremely useful when designing workstations and operator task layouts (Dianat *et al.,* 2018). It is advised that industrial and ergonomic engineering techniques used to design safe and productive workstation designs that rely on maxima and minima should provide

"generous" estimates for the needs of most users (Górny, 2017). This information can also be beneficial to create an anthropometric family of cases to better design future equipment and workstations with regard to geometry and layout and to reach the desired accommodation range.

2.7 Work Posture

According to Bridger (2017), 'working posture', a term that is embraced within the physical ergonomics sphere, refers to the orientation and alignment of the human body and its segments in a work setting. The working posture that is adopted by a worker is a direct expression of the interaction between the individual factors, task demands, tools being utilised and the workstation design (Chung, 2018).

Workers must adopt a correct working posture to prevent any risk of injuries that could lead to musculoskeletal disorders. Many factors can affect the working posture in the working environment, hence all these factors indicated in Figure 2.2 must be monitored and facilitated ergonomically. The posture that is ultimately adopted depends on the resolution between task objectives and the extent to which individual factors and the workstation design can facilitate the task objectives (Ngcamu, 2009).

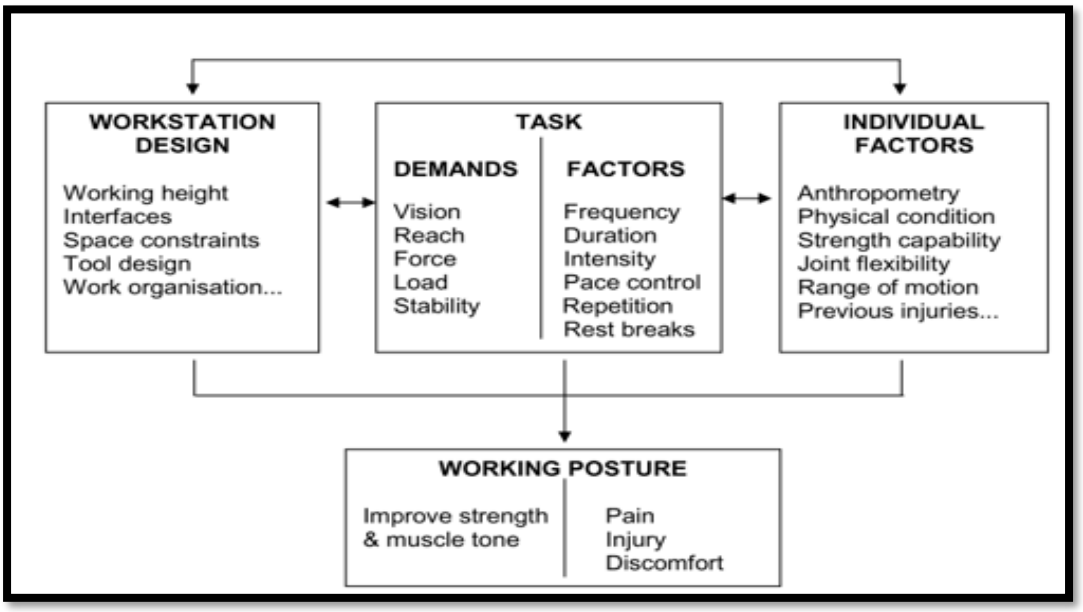

Figure 2-3: Factors affecting working posture

Source: Ngcamu (2009)

The awkward working postures that involve stooping, twisting, and extended reaches have become embedded and acknowledged as intrinsic motions of many jobs that require manual effort from the human operators (Colombini and Occhipinti, 2018). Work postures is commonly associated with the development of MSDs, where awkward postures have a higher risk of MSD development (Sarkar, 2016). Due to trunk and spinal loading, static muscular contractions, all of which are aggravated by force application inherent in most tasks, awkward working postures are perceived to be a health concern (Palmer *et al.,* 2017).

It was found that fatigue, discomfort, MSDs and injury are also intertwined events that are linked to cumulative exposure to working in awkward postures (Ngcamu, 2009; Bridger, 2017). However, in contrast, following a reduction in worker exposure to awkward working postures, Bazazan *et al.* (2019) reported improvements in performance. However, the mechanisms and processes driving these changes were not elucidated and there was a lack of evidence to substantiate why this occurred. Concerning different postures; seated, standing, lying and stooping postures have been considered in numerous studies in terms of their relative influence on employee performance (Fasanya and Shofoluwe, 2018). According to Baker *et al.* (2019), it has been reported that faster reaction times occur while standing, however although faster reaction times were attained, the speed-accuracy trade-off cannot be ruled out in cases where the number of errors committed also increase.

The evidence from the literature demonstrated that awkward working postures have profound physiological, psychophysical and biomechanical influence on the individual, although there are no definitive results concerning whether they would affect work performance (Palmer *et al.,* 2017; Bridger, 2017).

2.8 Task Design

According to Bozekova (2010), ergonomics can aid to allocate tasks to either machines or people, as well as when designing the system elements in order to realise production goals without adversely affecting the human operator. Ergonomics is also known to have a crucial role in the design of tasks to ensure high efficiencies at the work place (Perry, 2010).

Identifying the correct types of tasks and ensuring they are applied through the correct channels in the organisations is important. For example, highly repetitive tasks that are performed without the provision of adequate rest-pauses is a concern since the residual strain would compound the muscular strain experienced (Bazazan *et al.,* 2019). Static work should be kept to a minimum and where unavoidable, job rotation and regular rest-breaks should be implemented to promote optimum functioning of muscles and reduce the risk of injury (Palmer *et al.,* 2017).

However, Rucco *et al.* (2018) stated that most tasks are characterised by both dynamic and static components of posture, and hence muscle activity at varying degrees. For instance, in order to maintain postural control, a precision task would involve static contraction of the major muscle sets. However, the hand-arm system would be involved in motion and manipulation that is accomplished by continuous contracting and relaxation of appropriate muscles (Colombini and Occhipinti, 2018).

2.9 Precision tasks

While manual materials handling (MMH) remains an issue of concern in industrially developing countries, amplified automation, new technology and processes have led to an on-going transformation of the nature and profile of work in industrial firms (Ngcamu, 2009). The evolution of technology has led to high prevalence of more fine, light manipulative tasks such as precision tasks, which are extremely monotonous (Colombini and Occhipinti, 2018). Precision tasks are characterised by quick, precise hand movements that require high levels of skill. These tasks are primarily manipulative, cognitively and visually demanding. However, precision tasks have historically been perceived to be less risky when compared to heavy manual materials handling tasks, since they were generally considered to light manual tasks (Palmer *et al.,* 2017).

Many tasks in industry are executed with the employees adopting awkward working postures or poor workstation layouts, especially precision tasks since they require harmonised involvement of postural and mental processes (Dianat *et al.,* 2018). Even though awkward working postures and poor workstation design have been reported to be harmful to the health of employees, the concurrent effect of such ergonomic

deficiencies on performance outcomes are not entirely comprehended, and hence further research is required to focus on these areas (Ngcamu, 2009) .

As stated by Nag and Gite (2020), when precision tasks are performed under awkward postures, there is need for more attention to ensure that the concurrent effects on performance outcomes and individual responses are taken into consideration. The role of awkward working postures in mediating precision task performance also has to be understood, given that task performance outcomes are a combination of interactive processes that involve the task, environment, and the worker (Chung, 2018).

2.10 Illumination and Lighting

More attention has been paid to lighting in recent years, with strive to unveil its effect on cognitive ergonomics (Hu *et al.,* 2018). When human activities are performed indoors, it is essential to have good illumination so as to provide a satisfactory environment for the user. A study performed by Hu *et al.* (2018) showed the effect of controllable task lighting and its effect on the productivity of workers. In this study, the workers were allowed to select high lighting conditions. This study showed that when controllable lighting was used, there was a significant increase in productivity due to improved visual performance, the various biological effects of light, and other psychological aspects (Hu *et al.,* 2018).

Lighting in the environment can be hazardous to our health if exposed without caution hence a study conducted by Górny (2017) identified the health hazards associated with lighting, and these include:

a. Ultraviolet, infrared, and visible radiation can cause damage to human eyes and skin;
b. Inadequate lighting conditions can lead to strain of eyes;
c. Too little or too much light, reflections, and glare can cause discomfort and a severe strain to the eyes;
d. Poor lighting can cause headaches, indigestion, and giddiness.

Double vision, watering, and reddening of eyes and reduced focus are also caused by poor lighting conditions. According to a study by Seiferlein *et al.* (2020), workplace illumination effects were studied on the subjective mood in an office environment. It

was found that the variable lighting setup had a significant positive effect on the subjective mood of the workers in the office (Hu *et al.,* 2018).

The majority of the existing investigation on lighting ergonomics has focused on hardcopy documentation. However, with the introduction of industry 4th revolution, further research needs to be performed to monitor the effects of lighting on visual display terminals (VDT's) as most companies are finding ways to transform. Previous studies have demonstrated that there is a negative correlation between cognitive ergonomics, and colour temperature and illumination of environmental lighting (Hu *et al., 2018*). The brain is characterised by a strong cognitive ability, hence a good short-term memory at low colour temperature and illuminance, but is vulnerable to fatigue when exposed to high colour temperature (Westland *et al.,* 2017).

In a study performed by Hu *et al*. (2018), the appropriate lighting environment should have a moderate colour temperature when considering a fatigued brain. For instance, the colour temperature of 4,000K in classroom lighting aids students to undergo less brain fatigue and operate at best learning efficiency. However, the optimum illuminance varied with the colour temperature, for example, at the colour temperature of 2,700K, the best illuminance was 300lx, and at 4,000K was 750lx (Hu *et al., 2018*). It is also not recommended to adopt the illuminance of 500lx at 4,000K, 750lx at 2,700K, or 500lx at 6,500K or set the colour temperature to 6,500K. It was proved from the study that moderate colour temperature and illuminance fit in with long-term reading, while high illuminance is suited for short-term reading with heavy brain fatigue.

Due to the introduction of the 4th industrial revolution, the progress of information technology and information interaction has been progressively transferred from hard-copy documentation to visual display terminal (VDT), hence, VDT has become dominant at workplace in modern times (Hawkridge *et al.,* 2018). To ensure the working efficiency of a visual display terminal, it is essential to establish the effect of lighting condition, which is a crucial determining factor of cognitive ergonomics. It has been found that after 8 hours of LED lighting, the VDT working mode produces moderate brain fatigue (Hu *et al*., 2018).

A study conducted by Hu *et al.* (2018) showed how illuminance and lighting affect reaction times under different work modes. Figure 2.3 shows the individual effects of

illuminance and colour temperature on cognitive ergonomics in dissimilar working modes. As illustrated in Figure 2.3, under the single or multi-working mode, the illuminance for the optimal reaction time of VDTs does not change.

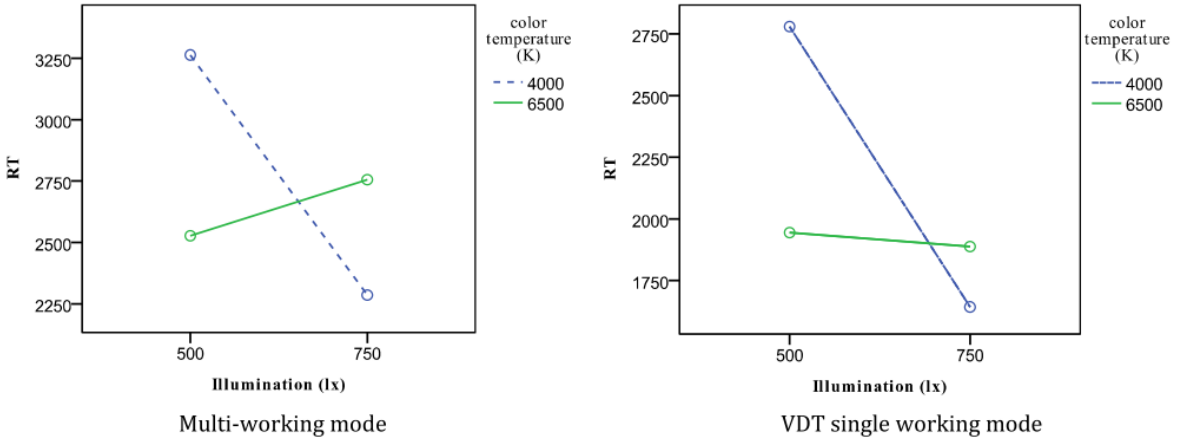

Figure 2-4: Effects of colour temperature on cognitive ergonomics

Source: Hu *et al.* (2018)

From the study performed by Hu *et al.* (2018), it was concluded that the reaction time is deeply dependent on working mode, illuminance and colour temperature. However, the lighting conditions have no impact on accuracy. The illuminance had a substantial effect on the reaction time in the multi-working mode. It has also been found that when compared to moderate illuminance, the information was identifiable much faster at high illuminance. The study also revealed that in short-term information identification of about 30 minutes, illuminance had no substantial effect on eye fatigue, and the difference in information identification speed was largely attributable to the influence of illuminance on cognitive effectiveness. The study concluded that the single working mode of VDTs, the single working mode of hard-copy documents, and the multi-working mode had identical performance on colour temperature. The optimal colour temperature was 4,000K, a value that was also recommended for office lighting in man-machine engineering and design manuals (Hu *et al.,* 2018).

Glimne and Österman (2019) posited that another effect caused by poor lighting is glare. As it pertains to VDT, glare can be classified by its effect (discomfort glare versus disability glare). Discomfort glare might generate a subjective feeling of discomfort in visual display terminal operators without a reduction in short-range performance. On

the other hand, disability glare would cause a diminution in performance by interfering with a person's ability to differentiate entities (Górny, 2017). The consequences of visual discomfort can influence the speed and accuracy of visual performance, as well as various forms of eyestrain, which eventually can lead to migraines.

Mesloub and Ghosh (2020) suggested that maintaining ambient illumination of office area at below 420 lux would minimise discomfort glare. Contrast glare is generated when the ambient illumination is too high, and this glare causes the brightness of the screen's background to increase. Hence the characters are "washed-out" i.e., the contrast between characters and screen background is reduced (Górny, 2017).

According to Skowranek and Skowranek (2017), a ceiling light source that delivers surrounding illumination on the display surface is sufficient to produce a reflected luminance 2 of 75 nits (candela per meter) will cause the display image to appear lower in contrast. Another important factor is that low ambient illumination is widely preferred to reduce reflected glare (Górny, 2017). The recommended ambient illumination is between 250 and 500 lux for performing visual tasks of low contrast or very small size such as reading hand writing in medium pencil. This describes the condition of the typical document that either a word processing or data entry operator would use (Górny, 2017).

The proposed National Standards for Human Factors Engineering of Visual Display Workstations, concluded that an illuminance between 200 to 500 lux, measured on the work surface, is normally sufficient in workplaces with visual display terminals (Helander, 2005). The Illuminating Engineering Society of North America, basing on typical document luminance contrasts, recommended that a number 3 pencil or softer, handwritten documents should be illuminated to between 500 to 1000 lux. They also recommended typewritten documents with a good ribbon must be illuminated between 200 to 500 lux (Helander, 2005).

In conclusion, lighting factors must be taken into consideration when designing the workplace. The lighting condition influences cognitive ergonomics of both VDTs and hard-copy documents, and these two are not completely independent of each other. In social and industrial activities, there are frequent interactions between the single or multi-working modes (Hu *et al.,* 2018).

2.11 Noise and Vibration

According to Naravane (2009), people working in industries are exposed to noise every day. The level of industrial noise exposure is becoming worse and it is causing a great amount of damage to human health and wellness. As stated by the Occupational Noise Exposure Regulations in the United States, there are regulations for limiting the amount of exposure to noise in industries, which is 90 dBA for one eight-hour period (Naravane, 2009). Workers in all kinds of industries face noise exposure be it textile, concrete, iron and steel, and so on hence safety measures must be in place.

In a previous study conducted by Lee *et al.* (2017) which focused on different industries ranging from iron and steel, textile, and so forth, it was seen that the noise intensities detected at these industries were above 80 dBA. The outcome of the surveys and studies revealed that some of the workers were disturbed by the high noise present at their workplace; some were facing hearing problems and some faced nervous situations due to exposure to noise (Lee *et al.*, 2017).

According to Bies *et al.* (2017), the various industrial noise control techniques are:

a) Performing proper maintenance of industrial equipment can help in preventing noise that is made by poorly maintained equipment;
b) The operating procedures should be such that the worker is exposed to a minimum amount of noise intensities. The distance between the noise and worker can be increased, the worker can be relocated and at times placed in a booth or room and inspect work, if possible, to avoid exposure;
c) The replacement of noisy equipment is another good way of reducing industrial noise;
d) The presence of reflecting surfaces leads to building up the sound levels. Hence, room treatments should be undertaken to prevent the ill effects of noise;
e) The location of the equipment is very critical to noise control and hence the equipment should be placed in such a way that it causes minimum exposure to noise;
f) Acoustical shields, barriers, and lagging or wrapping can be used to reduce the effect of noise on human performance;

g) Workers should use ear-muffs, ear plugs, and canal caps to help them protect themselves from undesirable sound levels;
h) The noise factor should be taken into consideration during phases such as the construction of buildings, the establishment of machinery at various locations.

The effect of noise on humans in various environments such as the workplace and home is a major part of the study of environmental ergonomics (Lee *et al.*, 2017). According to Reinten *et al.* (2017), the study of the effect of noise on human performance takes place in non-auditory task performance and auditory task performance. Auditory task performance deals with interference with communication skills in general (Naravane, 2009).

Various studies have been conducted on the effects of noise on tasks and the effects are variable (Bies *et al.,* 2017). Sometimes the task performance increases with noise, sometimes it decreases and at times, it remains unaffected (Lee *et al.*, 2017). Six different factors affect human performance under the influence of noise and these include work day length, acclimatisation, motivation, type of work, the aspect of work being studied, and other types of stress.

The presence of occupational noise in various workplaces can have serious consequences on the health of the workers in such atmospheres (Bies *et al.,* 2017). The major concern of long exposure to occupational noise is noise-induced hearing loss. Noise pollution is considered an environmental factor that affects the health, comfort and performance of humans (Lee *et al.*, 2017). As time passes, the amount of noise pollution in the air is rapidly increasing and along with it, various health hazards and medical problems. The presence of industrial noise in a working environment has serious consequences on the performance and productivity of workers as it can lead to severe illnesses (Kitila, 2018).

Another study conducted by Mandeep (2015) showed the effect of continuous, periodic and intermittent noise on industrial inspection tasks, it revealed that higher errors were found when the workers were exposed to continuous and random noise. The errors were not affected by the presence of different noise intensities. Hence, noise has a varied effect on tasks and performance depending on whether it is a vigilance task, inspection task, or recall task (Palmer *et al.,* 2017).

Vibration is another factor that affects human performance. Vibration is known to mainly affect simple tasks such as reading and writing. It also affects workers' manual control and vision. Hand-held vibrating tools lead to a condition called vibration-induced white finger (Bies *et al.,* 2017). Vibration can also lead to the development of carpel tunnel syndrome, especially when the job involves repetitive and forceful exertions (Kitila, 2018).

2.12 Analysing Environmental Ergonomics

As stated by Reinten *et al.* (2017), the effect of environmental ergonomics on human responses can be analysed using four methods. These methods subjective, objective and behavioural methods. Subjective methods make use of questionnaires, responses from people, focus groups, and use of simple rating scales. These methods are quite easy to perform and have the advantage of carrying out analysis of psychological responses. However, it is important to note that they do have limitations since they are difficult to design and cannot be applied to all situations *(*Naravane, 2009; Shukla *et al.*, 2017).

Objective methods give a direct measure of human response such as body temperature. Research techniques assigned to objective methods take consideration of measurement and recording of the physiological body reaction to physical activity and kinematic parameters of movements that are performed in a given task or activity (Mynarski *et al.,* 2013).

Behavioural methods deal with the study of various changes like changes in posture and adjusting to the environment. The key benefit of these methods is that they do not interfere with what is being measured. However, it is difficult to analyse the cause and effect of any action using these methods (Naravane, 2009). Research on knowledge of objects and other subjects has traditionally employed methods that collect behavioural responses as behavioural adjustments represent the first response to altered conditions (Bauer and Just, 2019).

2.13 Research gap

The findings of existing literature revealed the importance of ergonomics in all industries. However, although there is an extensive amount of research on ergonomic interventions and tools that have been conducted, current research provides a signal to change from today's reactive and isolated approach but rather into a more holistic and proactive approach (Nord Nilsson and Vänje, 2018). The "holistic" approach to office ergonomics not only integrates the engineering and cognitive perspectives, but will cover a range of issues and workspaces addressed by an ergonomist (O'Neill, 2011).

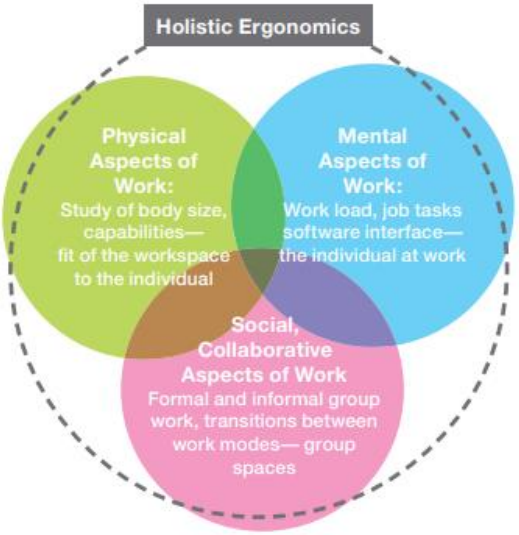

Figure 2-5 : The scope Holistic Ergonomics

Source: O'Neill (2011)

The study performed by O'Neil (2011) highlights how holistic ergonomics is applied to the design of a much wider range of workspaces that go beyond an individual workstation. The holistic ergonomics approach encourages collaborative work spaces where ergonomic activities are integrated between various departments that will benefit the whole organisation. More focus should be placed on preventive principles and decreasing employees' un-ergonomic behaviours (Khandan, Maghsoudipour and Vosoughi, 2012). To reduce discomfort and risk of injury ergonomists focus on elements such as work posture, task design, precision tasks, illuminations and lighting and noise and vibration. Holistic ergonomics provides the inspiration for a healthy and

productive workspace by going beyond the healthful benefits of the elements highlighted in this study by applying a collaborative culture that recognizes broader organisational and workplace issues (O'Neill, 2011).

The current research displays a need for an ergonomic intervention that will enforce organisations to adopt ergonomic principles that will contribute to organisational performance improvement. The objectives of this study aim to address these gaps and develop a solution that can be applied in the packaging sector.

2.15 Conclusion

The literature review demonstrated that value of ergonomics extends beyond health and safety since it contributes to organisations strategies, to improve overall performance. This can be accomplished if it is internalized as part of the company's culture and if ergonomics is given priority by top management and is broadly communicated and implemented at all levels. The main downfall in organisations is that managers generally associate ergonomics with health issues and not with organisational goals, effectiveness, and efficiencies. The discipline and profession of ergonomics should be holistic, management need to understand the physical, cognitive and social (and increasingly today emotional) characteristics of people in order to enhance the interactions they have with equipment, information, environments and other elements (Wilson, 2012). It is crucial that organisations consider implementing ergonomic programs, as workers play a pivotal role in helping organisations attain their goals. Advanced technologies with which humans interact today constitute complex systems that require a high level of integration from both the design and management perspectives (Karwowski, 2012).

With the introduction of the fourth industrial revolution, systems become more complex, design for interaction between hardware, information system and people become an integral part for systems and processes to be effective. Human-system integration (HIS) is seen as an element of systems engineering that is concerned with comprehending, designing and supporting human roles and performance in multifaceted systems. Being proactive about work ergonomic pertains foreseeing ergonomics problems and quality risks, basing these on practical experience and scientific research. A key objective of this dissertation was to ascertain the relationship

between these influences on individuals and their work performance. The main question under investigation is the impact ergonomic programs have on the overall organisational performance. The following chapter describes the methodology used to study the current ergonomic conditions at the packaging sites.

CHAPTER 3 : RESEARCH METHODOLOGY

3.1 Introduction

A research methodology describes the explicit path, techniques or procedures that are used by a researcher to conduct the research (Creswell, 2014). This chapter describes the methodology that was used to study the current ergonomic conditions at the packaging sites. It focuses on the research design, research philosophy and framework that was adopted to conduct the study. The target population, research instrument, pilot study and ethical issues are also discussed in this chapter.

3.2 Research Design

A research design is a blueprint or overall strategy for the assemblage, measurement, and analysis of data that is chosen to integrate the different elements of a study in a logical and coherent manner (Marshall and Rossman, 2014). This study adopted a descriptive research design that sought to describe the assess employees' perception of the current ergonomics scenario of the packaging industry and determine the current ergonomics gaps. The research design focused on providing systematic information about the current ergonomics scenario of the packaging industry. The research design conducted on the sites was also regarded as exploratory. Since the nature of the research is addressed in an industry where there are high levels of uncertainty and ignorance in the topic of scientific ergonomic programs, the exploratory method would be regarded as the most appropriate.

The key objective of exploratory research is to ascertain the boundaries of the environment in which the research problem, situations or opportunities of interest are likely to reside, and then identify the variables or salient factors that would be relevant to the research. Two packaging organisations within South Africa based in Cape Town and Durban were approached and invited to participate in the survey. One of the objectives was to understand and identify the current gaps of the packaging companies, to achieve that a questionnaire was created.

3.3 Research Philosophy

There are essentially two schools of thought that hold absolutely dissimilar views about the research design and research process, concerning knowledge and science, and these include positivism (quantitative) and phenomenology (qualitative) research. According to Rhodes (2013), qualitative research approach focuses on comprehending a phenomenon from a proximate perspective using a non-numerical approach, while quantitative approach has a tendency to illuminate a given scenario that characterise a larger number of individuals by using survey methods. Qualitative research is predominantly exploratory research that is exploited to comprehend underlying opinions, reasons, and motivation for a phenomenon and leans more on subjective methods rather than objective methods of analysis (DeFranzo, 2011). Conversely, quantitative research is used to quantify problem by generation of numerical data or data that can be transformed into useable statistical analysis. Essentially, quantitative research uses numerical data to identify trends and variable relationships through analysis of statistics.

The research conducted for this study was quantitative. The reason for utilising this methodology is because it allows for the identification of current gaps and concerns regarding ergonomic programs on-site, through the analysis of data. The sample population selected for the study has been selected from the engineering and production departments and more in-depth knowledge was required regarding the subject matter and could be provided through the completion of questionnaires. The advantage of utilising quantitative research is that large sample sizes sometimes necessitate the drawing of research conclusions that are generalisable.

3.4 Research framework

Figure 3.1 shows a research framework applied in developing an ergonomic scientific program. A bottom-up framework that commences with eliciting information on human factor engineering from knowledge bases and literature on ergonomics is initial developed. The relevant ergonomic elements anthropometry, physiological factors, work posture, task and information design, human interaction, illumination and noise and vibration identified from the findings of the literature review was selected and indicated in the questionnaires developed. Once the questionnaire feedback was

collected and analysis was conducted, the different Systems engineering tools were reviewed from the findings of the literature to identify an effective ergonomic intervention. Data analysis is thereafter conducted to establish the current state of ergonomic programs and determine ergonomic programs that would integrate tools and techniques from systems engineering. An effective scientific ergonomic program is ultimately developed to improve organisational performance.

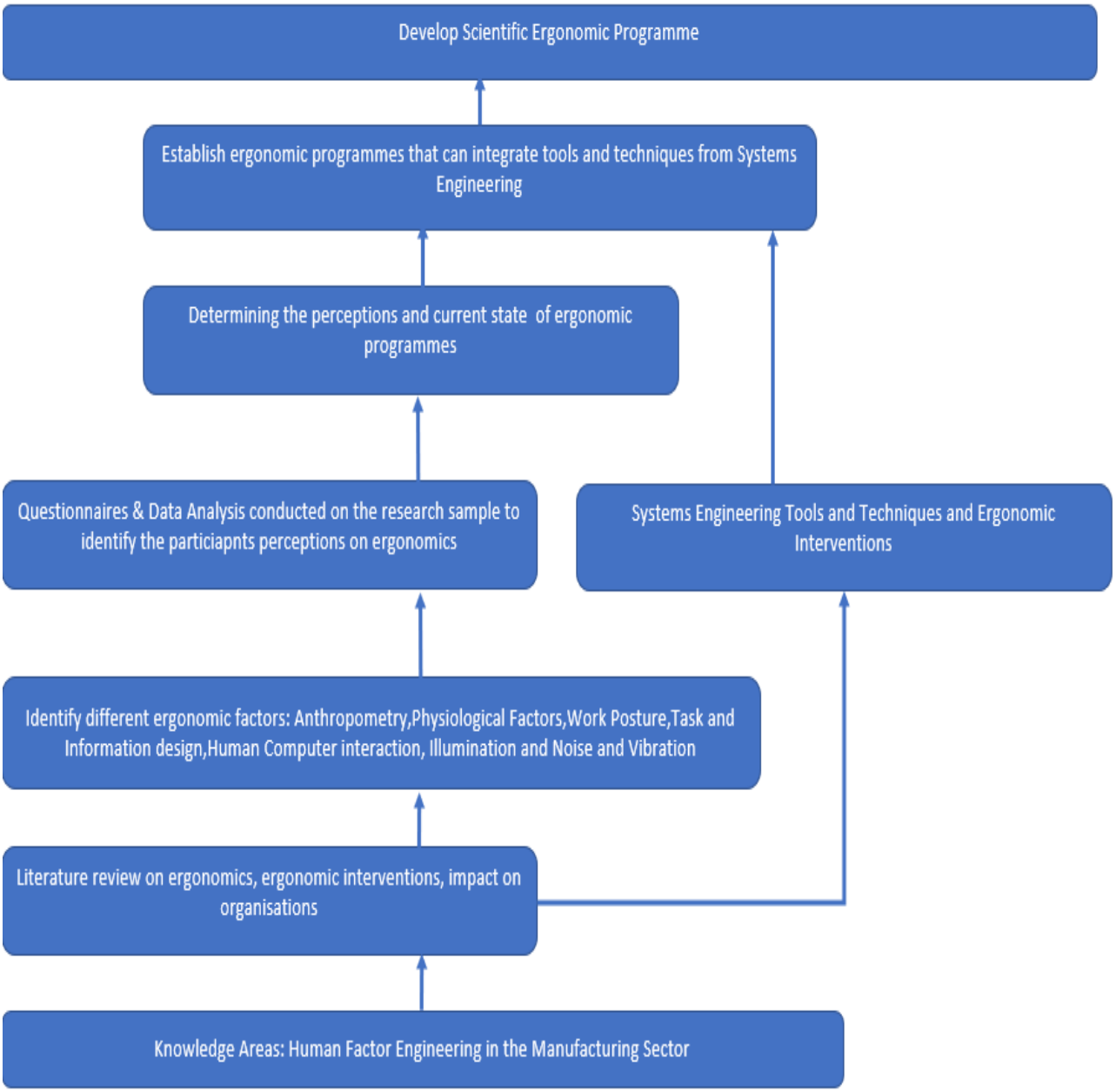

Figure 3-1: Framework for developing an ergonomic scientific program

3.5 Target Population and Sample Size

The target population for this research focused on the engineering team and production team from the two sites that comprised of machine operators, maintenance supervisors, artisans and operators. The Table below presents a record of the various teams from the different sites who will be participants in the survey. A sample size of 70 staff was used for this research.

Table 3-1: Sample size at the Cape Town and Epping Site

Cape Town Site: Epping	
Trade	Participant count
Bagger Operator	28
Machine Operator	8
Gate Keeper	1
Setter	1
Quality Control Inspector	2
Technician	1
Demand Planner	1
HOD PET	1
Grand Total	43

Table 3-2: Sample size at the Durban Pinetown Site

Durban: Pinetown Site	
Trade	Participant count
Bagger Operator	4
Machine Operator	10
Setter	4
Quality Control Inspector	1
Technician	4
HOD PET	1
Material Controller	3
Grand Total	27

A total of 100 surveys were distributed to the packaging organisations based in Cape Town and Durban, of which 70 (70% return rate) responded by returning the relevant documentation. At the Cape Town site, 41 staff members from the production team and 2 staff members from the Engineering team responded. At the Durban site, 22 staff members from the production team and 5 staff members from the Engineering team responded.

3.6 Research Instrument

A questionnaire as shown in Appendix H was developed and used to identify the causes to which employees attribute poor performance in the industry. The survey consisted of 37 questions that related to the different factors in ergonomics and were adapted from the handbook of Human Factors and Ergonomics by author Karwowski (2012). Appendix H shows the questionnaire that was used in this research. A survey is a good way of getting a picture of the current state of a group: a community, an organisation, an electorate, a set of corporations, a profession. In this study, the questionnaire had been designed to generate outputs that will help achieve the outcome of identifying the current state the employees have on ergonomics.

The questionnaire consisted of two sections, Section A was about the demographic information and Section B consisted of thirty-seven questions relating to ergonomics. The information requested in Section A consisted of open-ended and closed-ended options, where participants filled in their physical information such as age, height, gender, and work tenure. The idea behind the construction of the questionnaire format was to make the questionnaire as simple as possible and easy to understand.

Section B consisted of thirty-seven questions relating to the ergonomic factors that may affect their working environment. The questions were divided into seven categories that looked at anthropometric and physiological factors, work posture, task design, information tasks, human-computer interaction, illumination and noise and vibration. To simplify the questionnaire, the participants could respond to the questions by selecting options from a 5 –point Likert type scale. A comment column was also added to provide flexibility to the participant should they want to add more information to the questionnaire.

3.7 Pre-Testing

According to Howard (2018), questionnaire pretesting is a simple technique to measure in advance whether a questionnaire causes problems for respondents or interviewers. In this study, the questionnaires were first communicated to management who reviewed the content and context of the questions to verify if their employees will be able to understand and complete the questionnaires. Before going live with the questionnaires, the questionnaire was reviewed by the management of both packaging companies based in Cape Town and Durban, to ensure the content on the questionnaire was aligned with the knowledge capacity of the employees.

This was necessary as some of the language used in the questionnaire could be perceived to be technical. This is particularly important in the industrial developing countries context where managers often have a broad range of responsibilities and very little ergonomics background (Brito et al., 2019). No additional changes were required to be made as the questions related to ergonomics were considered to be all-inclusive and utilised a common language that could be understood by managers and their employees.

3.8 Administration of Questionnaires

The questionnaires were administered face-to-face with no management present on both Cape Town and Durban sites to ensure that participants did not feel victimized and were able to provide an honest response. The duration of each session varied from thirty minutes to forty minutes as it was dependent on the level of understanding that respondents had on the ergonomic elements addressed in the questionnaire. All respondents also had the option of remaining anonymous in the event they were not comfortable in disclosing their personal details. Any questions that were not applicable to the respondents did not require a response. The face-to-face interaction ensured that all participants had the same understanding of the questions and they had equal opportunity to ask questions if further explanations were needed. This method also ensures that the responses are accurate and reliable.

A study performed by Reid and Reid (2005) found that participants' reasons for preferring participation in a face-to-face rather than in an online focused group were mainly related to the communication flow. Participants in the study found that face-to-face provided a coherent debate and that it was easier to follow the discussion. Similarly, it was found that the most vital perceived advantage of face-to-face was respondents' perception that it was easier to discuss with the participants and incorrect interpretations could be cleared immediately.

3.9 Data Analysis

Jebb, Parrignon and Woo (2017) defined exploratory data analysis as the statistical embodiment of inductive research, through its visualization and quantitative techniques. It comprises the research practices that allow researchers to detect empirical phenomena. Ergonomics strives to have a positive influence on worker health and output and is recommended as an effective tool for the alleviation of ergonomics deficits such as awkward working postures and MSD in industrial developing countries. This pertains particularly to the implementation of ergonomic programs, therefore, further research into these areas is required; this formed the basis for this study.

The data collected in this study were analysed with descriptive statistics. According to Ludico *et al.* (2010) studies employing a quantitative methodology summarises the

data numerically. The data that was collected concerning each research question was numerical; therefore, descriptive statistics, which displays patterns in the data, was the appropriate way to analyse the collected data (Bazeley, 2017).

The collected data was also categorical because the data was differentiated by the distinct categories relating to ergonomic programs, Anthropometry, Work Posture, Task Design, Information Tasks, Human-Computer Interaction, Illumination and Noise and Vibration. Since the data was comparative, the study used ordinal scales of measurement in interpreting the data. The data was also not interval, which would have combined nominal and ordinal scales of measurement (Bazeley, 2017). Once the data was collected, it was summarised numerically and tabulated for each category in order to identify the current state of the working environment. Statistical Package for the Social Sciences (SPSS) software version 26 was used derive the Cronbach's Alpha for assessing reliability of the research instrument and for correlational analysis.

3.10 Validity and Reliability

3.10.1 Internal and External Validity

Internal validity is vital in determining whether the conclusions that were made within the research accurately reflect what was being studied. According to Bloomfield and Fisher (2019), internal validity can be affected by the type of quantitative research that was chosen and the potential threats to internal validity that may influence the results of the research.

Bazeley (2017) posited ten essential threats to a study's internal validity were raised which can relate to this study. The first threat was history, which involves time passing during an experiment which can allow events to occur that can unduly influence the outcome beyond the experimental treatment (Creswell, 2014; Bazeley, 2017). The questionnaires for this study were completed at close intervals to prevent the risk of changes that may affect employee perspectives and at a time where a gap analysis was required to identify the current state.

The second threat to internal validity was maturation, which involves participants in an experiment who may mature or change during the experiment influencing the results of the research (Bazeley, 2017). Since one of the study objectives was to determine

the current state of the business operations, should any changes occur in employees, the perspective of the business operations should remain the same.

The third threat to internal validity is regression, where participants with extreme performance are selected for the research (Creswell, 2014). This study looked at all trades in the engineering and production department without taking employee ratings into account. The fourth threat to internal validity is selection, which involves participants who were selected based on certain characteristics (Creswell, 2014; Bazeley, 2017). Here again, this study looked at all trades in the engineering and production department without taking specific employee characteristics into account.

The fifth threat to internal validity is mortality, which involves participants who drop out during an experiment due to several reasons so that the outcomes for these participants would be unknown (Bazeley, 2017). This would have been a possible threat to the internal validity of this particular study as employees do leave however, this study was not experimental thus this change would pose no risk.

The sixth threat to internal validity is the diffusion of treatment, which was where the participants in the control group and the experimental group interact with one another (Creswell, 2014; Bazeley, 2017). This study did not utilize control and experimental groups, therefore, this threat to validity would not affect this study. The seventh threat to internal validity was compensatory and/or resentful demoralization, which occurs when the benefits of the study may be unequal or resented when only the experimental group gets the treatment (Creswell, 2014; Bazeley, 2017). One of the aims of this study is to identify a program that can benefit the company as a whole and not be restricted to just a sample. All participants of the study were made aware of this at the beginning of the study during the sensitisation.

The eighth threat to internal validity was compensatory rivalry, in this study no form of compensation was given, all participants were treated equally. The ninth threat to internal validity was testing, in which the participants become familiar with the outcome of the experiment and remember responses for later testing (Creswell, 2014; Bazeley, 2017). This threat to internal validity was not an issue in this study as there were no pre and post-tests performed.

The final threat to internal validity was instrumentation, where the instrument changes between the pre-test and post-test which impacts the scores on the outcome (Creswell, 2014; Bazeley, 2017). This study reviewed records and did not have a pre-test and post-test; therefore, this threat to internal validity posed no risk.

3.10.2 External Validity

External validity is vital for a study should the researcher want to apply the conclusions across multiple populations (Bazeley, 2017). When considering external validity, the researcher should consider to what extent would the conclusions be generalised to a wider population and/or across populations, settings, context, and time. There are two types known of external validity, the first is population validity, where generalisations are made based on people from similar groups and the second is ecological validity where generalizations can be made to similar situations or settings.

The population sample for this study did not discriminate in age, gender and period of tenure. The respondents that were selected were experts in their field and garnered enough experience to understand the relevance of this study. The sampling strategy deployed aimed to ensure that the feedback received from the respondents generated useful data that was aligned with the research objectives. Chapter 4 displays the demographics details of the respondents from both sites. The questionnaire was open to staff from the Engineering and Production department and included all relevant trades in the packaging site such as operators, packers, quality controllers, technicians and heads of department.

The study comprised of 70 sampled participants, 43 from the Cape Town site and 27 from the Durban site. All participants were given equal opportunity to respond to the questionnaire and were seated in a comfortable environment that avoided disruptions. This ensured that all answers provided were accurate and completed in an environment that encouraged free-flow thinking. The research method adopted in this study aimed to achieve valid and reliable data that supports internal and external validity.

3.10.3 Reliability

The most frequently used forms of reliability include test-retest reliability; parallel forms of reliability; inter-rater reliability; and internal consistency reliability. The test-retest reliability is used measure of stability of a research instrument over time, by assessing its reliability through administering the same instrument twice to a group of people and comparing to verify similarity of scores (Leppink et al., 2017). Parallel forms of reliability are derived from administering dissimilar versions after assessing the same group of individuals, while on the other hand, inter-rater reliability: is used to evaluate the extent to which different raters reach a decision in their assessment concerning a measure of reliability. Internal consistency reliability: is a measure of reliability used to assess the extent to which dissimilar test items that query the same construct would realise comparable results (Bazeley, 2017).

Table 3-3: Results for reliability statistics

Number of items	Cronbach's Alpha
39	0.843

SPSS software was used to compute the Cronbach's Alpha to assess internal consistency of the research instrument and Table 3.3 depicts a value of 0.843, which shows that the instrument was reliable. Due to the limitations imposed by Covid 19 pandemic, it was unnecessary to evaluate parallel forms of reliability and inter-rater reliability in order to maintain simplicity in the research process.

3.11 Elimination of Bias

According to Simundić (2013), research bias may cause one to draw incorrect conclusions and is potentially misleading. Thus, it is unethical and immoral to conduct biased research. Hence, it is vital that all researcher be aware of any potential sources of bias and initiate all potential actions to minimise the research bias (Simundić, 2013). All forms of bias were avoided in this study since the sample size did not discriminate against gender, age or race. All employees that fell within the research pool had equal opportunities of completing the questionnaire.

3.12 Ethical Considerations

All ethical considerations were taken and abided as per the National Institute of Health (NIH) Office of Extramural Research. Appendix A shows a certificate that is evidence that the researcher undertook an online training course on protecting human participants. Appendix B displays the IREC clearance letter (IREC 105/17) which ensured that the research proposal was reviewed by the Institutional Research Ethics Committee. Before participants could participate in the research all participants were required to read the letter of information and letter of consent (Appendix F and G). During the research sensitisation, all potential risks and procedures were discussed to ensure all participants were completely comfortable and that they understood the research outcomes and objectives. Participants also had the liberty of remaining anonymous should they not feel comfortable disclosing their names on the questionnaire and were assured that all feedback given on the questionnaires would remain confidential to prevent the risk of employees being subjected to victimisation.

A web-based software was used to detect plagiarism and Appendix E shows a Turnitin report for plagiarism. The similarity index was found to be less than 30%, and that is rendered to be acceptable according to the Durban University of Technology standards.

3.13 Conclusion

This chapter highlights the research methodology used in the study. The chapter indicates the reasons behind the quantitative approach were selected and the research design and framework that was used. It also described the size and nature of the sample, the data collection methods used, and ethical considerations. A quantitative research methodology was adopted, with a questionnaire as the research instrument. The methods used to maximise validity and reliability were outlined. Chapter 4 will expand on data analysis, research outcomes and discussion of the results.

CHAPTER 4 : RESULTS AND FINDINGS

4.1 Introduction

This chapter presents the statistical analysis of the research data. The responses from each question were tabulated for analysis. The data from both sites were also captured separately to simplify the interpretation of the statistics. The demographics and findings on ergonomic factors from packaging companies based in the Cape Town and Durban Epping Site are presented in this chapter.

4.2 Demographics

Table 4-1: Occupation of research participants

Occupation	Frequency
Bagger Operator	32
Machine Operator	18
Gate Keeper	1
Setter	5
Quality Control Inspector	3
Technician	5
Demand Planner	1
HOD PET	2
Material Controller	3
Total	70

Table 4-1 shows the occupation of research participants, indicating that a majority of the respondents were bagger operators followed by machine operators.

Table 4-2: Gender of research participants

Gender	Frequency
Male	67
Female	3
Total	70

Table 4-2 displays the gender split amongst the research participants. The responses were characterised by 67 male participants and 3 female participants from both packaging sites. A study performed by Perry (2010) showed that the muscles strength between male and females differ in relation to age and gender, hence it is important that the respondents indicate their age and gender as this will impact the type of response received.

Table 4-3: Age of participants

Age Category	Frequency
20 - 25 years	1
26 - 35 years	26
36 -45 years	22
> 45 years	20
Total	69
Missing	1
Total	70

Table 4-3 indicates the age categories for all the participants. The results show that a large number of participants fell in the age range of 26-35 years and 36-45 years, while one respondent chose not to indicate their age. According to the quarterly labour force, survey published in May 2019 by the Department of Statistics South Africa showed that the average working age in the country ranges between 15 – 64 years. A study written by Strasser (2017) which investigated the impact aging had on work performance from an ergonomics perspective highlights that age becomes a concern when it comes to vision, hearing or work activities that require muscle strength. Since the respondents age does impact the type of feedback given, it was necessary that this data was included in the questionnaire.

Table 4-4: Work Experience of research participants

	Frequency
< 2 years	7
2 - 5 years	19
6 - 10 years	21
> 10 years	23
Total	70

Table 4.4 displays the work experience amongst the participants. The results show that 19 of the workers have been working for 2-5 years, 21 workers between 6-10 years, while 23 workers have more than 10 years work experience and 7 workers less than 2 years. Work experience plays a fundamental role in the working environment as it helps employees to make decisions on events that have no traceability or history.

4.3 Ergonomic Factors

4.3.1 Anthropometric and Physiological Factors

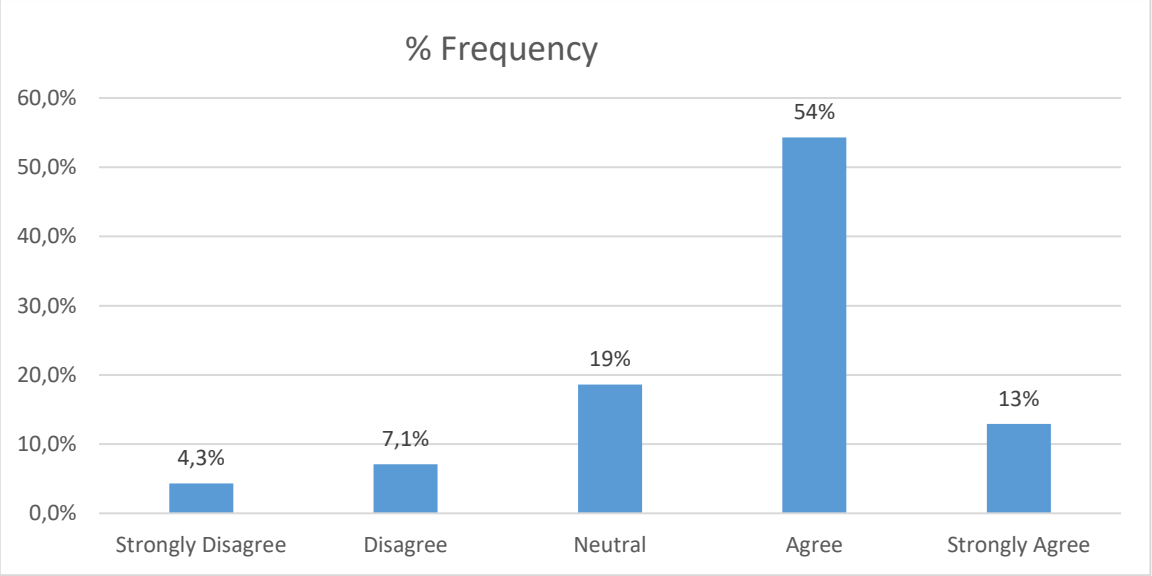

Figure 4-1: The workstations are designed to allow one to work effectively

The respondents were asked to express their perceptions concerning the statement "The work stations are designed in a way that allows you to work effectively". Figure

4.1 shows the respondents' extent of satisfaction with the workstation design. The statistics show that 54% agreed and 13% strongly agreed. About 4.3% of the respondents strongly disagreed, 7.1% disagreed, while 19% were neutral. The percentage of missing response where the participants felt the questions were not applicable is 2.6%, this is quite insignificant and will not affect the credibility of the results.

Appendix J displays an item mean statistic of 3.66; skewness is -1.061, while kurtosis is 1.173. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents were inclined to be more satisfied with their workstation design. The positive kurtosis value points out a steeper distribution. The results from Figure 4.1 demonstrates that the employees at the packaging sites are generally satisfied with the workstation design.

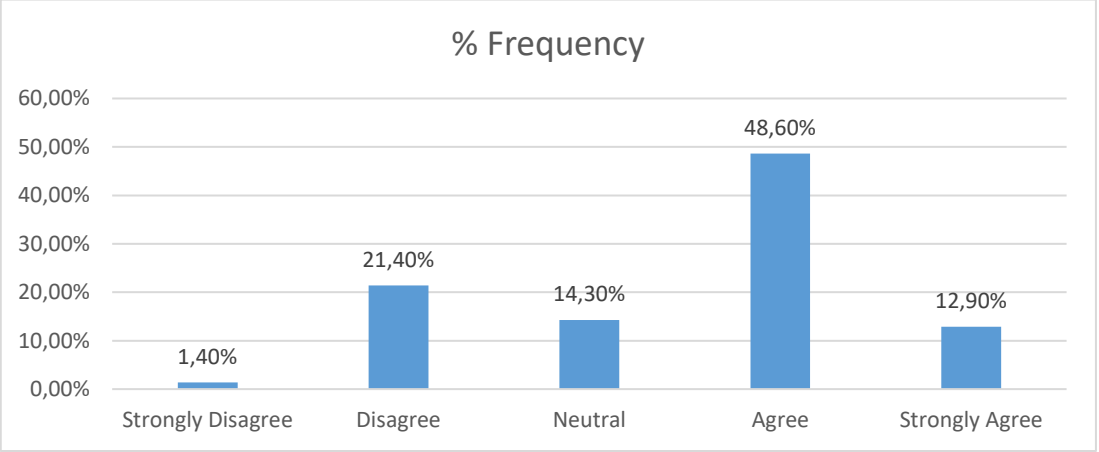

Figure 4-2: Sudden movements and force exertion present daily task activities

The respondents were asked to express their perceptions concerning the statement "There are sudden movements and force exertion present in my daily task activities". Figure 4.2 shows the respondents' extent of satisfaction with the work station design. The statistics show that 48.6% agreed and 12.9% strongly agreed. About 1.4% of the respondents strongly disagreed, 21.4% disagreed and 14.3% were neutral. The percentage of participants that felt the questions were not applicable is 1.4%, due to the insignificant percentage this will not affect the credibility of the results.

Appendix J displays an item mean statistic of 3.51; skewness is -0.49, while kurtosis is -0.73. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents are comfortable with the

movements in their daily task activities. The negative kurtosis value points out that the distribution has a lighter tail than the normal distribution. The results from Figure 4.2 indicate that most of the employees at the packaging sites are satisfied with the force movements present in their daily activities.

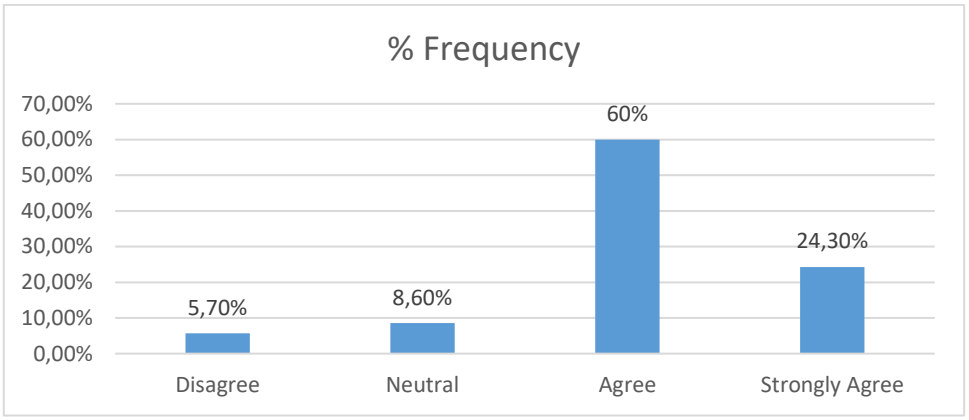

Figure 4-3: There is a variation in worker postures and movements

The respondents were asked to express their perceptions concerning the statement “There is a variation in worker postures and movements”. Figure 4.3 shows the respondents' perception related to uncomfortable movement linked to the posture and daily movements. The percentage of participants that felt the questions were not applicable is 1.4%. The statistics show that 60% agreed and 24.3% strongly agreed. About 5.7% of the respondents disagreed, and 8.6% were neutral.

Appendix J displays an item mean statistic of 4.04; skewness is -0.914, while kurtosis is 1.341. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents agree there is a variation in movement relating to work posture and daily movement. The positive kurtosis value points out a steeper distribution.

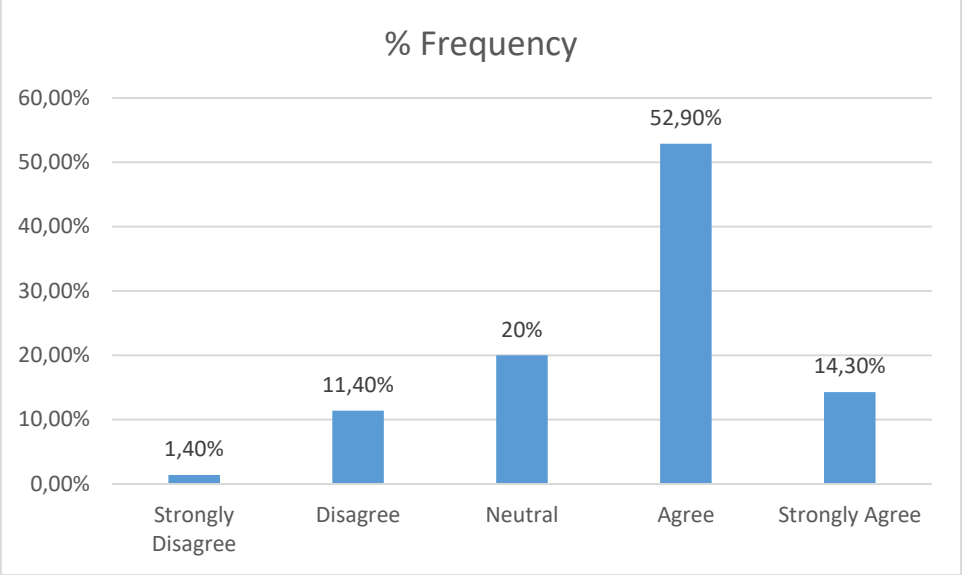

Figure 4-4: The duration of any continuous muscular effort is limited

The respondents were asked to express their perceptions concerning the statement "The duration of any continuous muscular effort is limited". The statistics show that 52.9% agreed and 14.3% strongly agreed. About 1.4% of the respondents strongly disagreed, 11.4% disagreed, while 20% were neutral.

Appendix J displays an item mean statistic of 3.67; skewness is -0.705, while kurtosis is 0.237. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that continuous muscular effort is limited. The positive kurtosis value of 0.23 points out a steeper distribution.

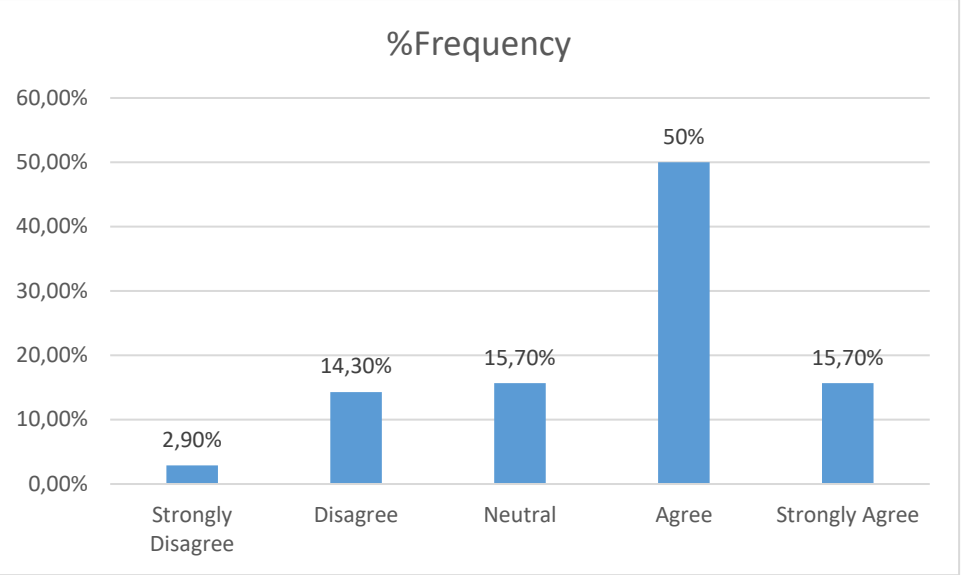

Figure 4-5: The breaks are of sufficient length and spread throughout the task

The respondents were asked to express their perceptions concerning the statement "The breaks are of sufficient length and spread throughout the task". Figure 4.5 shows the respondents' extent of satisfaction with the length of breaks. The statistics show that 50% agreed and 15.7% strongly agreed. About 2.9% of the respondents strongly disagreed, 14.3% disagreed, while 15.7% were neutral. The percentage of participants that did not provide a response is 1.4%, due to the insignificant percentage this will not affect the credibility of the results.

Appendix J displays an item mean statistic of 3.62; skewness is -0.736, while kurtosis is -0.03. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents were inclined to be more satisfied with the length of their break duration. The negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

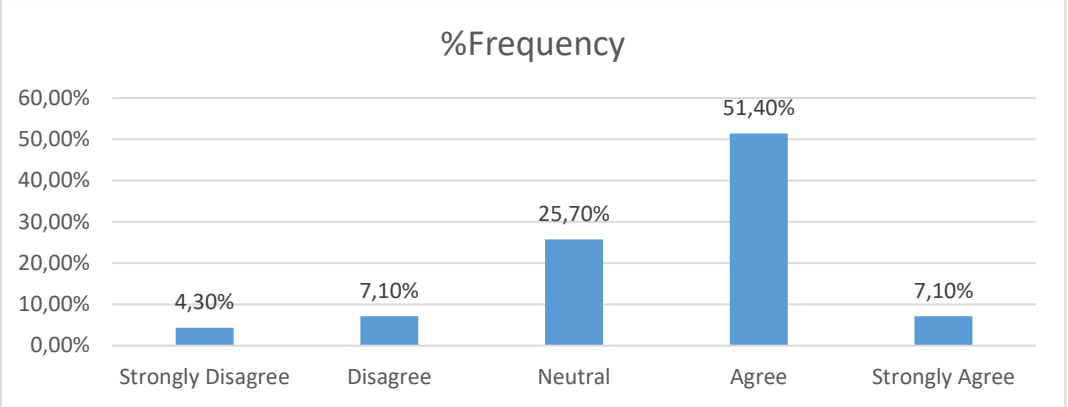

Figure 4-6: The energy consumption for each manual task is limited

The respondents were asked to express their perceptions concerning the statement "The energy consumption for each manual task is limited". The statistics show that 51.4% agreed and 7.10% strongly agreed. About 4.3% of the respondents strongly disagreed, 7.10% disagreed, while 25.7% were neutral. The percentage of participants that did not provide a response is 4.4%, due to the insignificant percentage this will not affect the credibility of the results as indicated in Appendix J.

Appendix J displays an item mean statistic of 3.52; skewness is -0.1, while kurtosis is 1.09. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the energy consumption is limited for manual tasks. The positive kurtosis value points out a steeper distribution.

4.3.2 Factors related to work posture

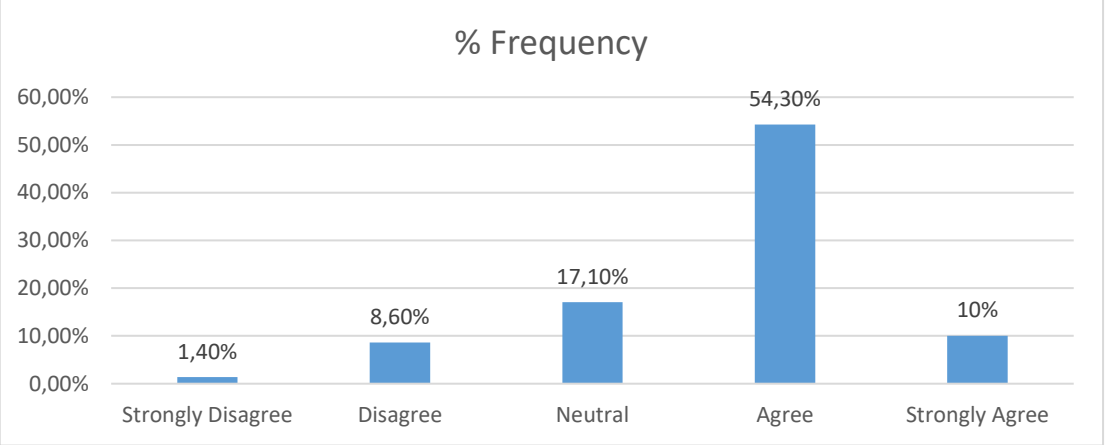

Figure 4-7: The height of the worktable is adjustable

The respondents were asked to express their perceptions concerning the statement "The height of the worktable is adjustable". Figure 4.7 results show that 54.3% agreed and 10% strongly agreed. About 1.4% of the respondents strongly disagreed, 8.6% disagreed, while 17.1% were neutral. The percentage of participants that did not own a worktable is 8.6% hence they did not provide a response.

Appendix J displays an item mean statistic of 3.69; skewness is -0.9, while kurtosis is 0.9. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the staff is satisfied with the worktable design. The positive kurtosis value points out a slightly steeper distribution.

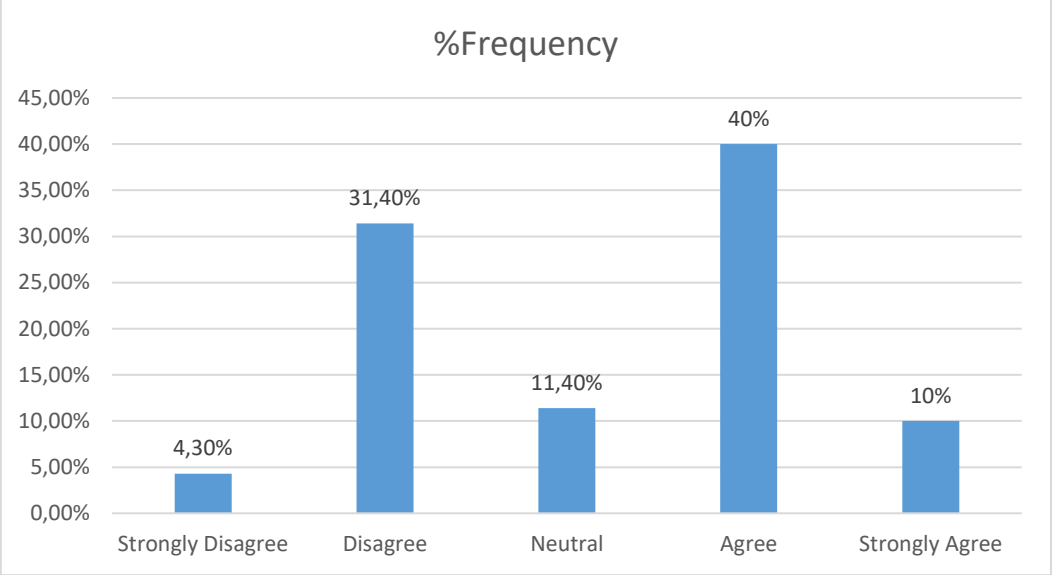

Figure 4-8: There are good seating instructions provided at work

The respondents were asked to express their perceptions concerning the statement "There are good seating instructions provided at work". Figure 4.8 shows the respondents' extent of satisfaction with the seating instructions provided in their working area. The statistics show that 40% agreed and 10% strongly agreed. About 4.3% of the respondents strongly disagreed, 31.4% disagreed, while 11.4% were neutral. The percentage of participants that felt the questions were not applicable or did not respond is 2.9%, due to the insignificant percentage this will not affect the credibility of the results

Appendix J displays an item mean statistic of 3.21; skewness is -0.2, while kurtosis is -1.2. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents a large percentage of the staff are not satisfied with the length seating instructions as the statistics have indicated that 50% of the respondents are satisfied. The negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

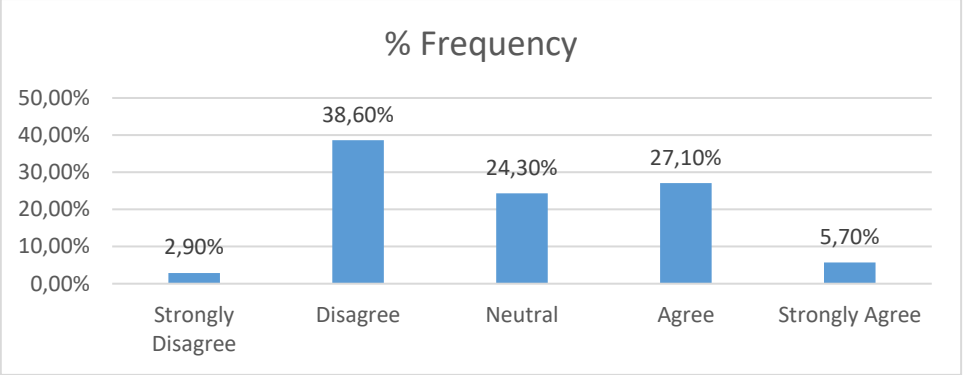

Figure 4-9: I often find it difficult to reach items around my workstation

The respondents were asked to express their perceptions concerning the statement "I often find it difficult to reach items around my work station". Figure 4.9 shows the respondents' extent of satisfaction with the seating instructions provided in their working area. The statistics show that 27.1% agreed and 5.7% strongly agreed. About 2.9% of the respondents strongly disagreed, 38.6% disagreed, while 24.3% were neutral. The percentage of participants that felt the questions were not applicable or did not respond is 1.4%, due to the insignificant percentage this will not affect the credibility of the results.

Appendix J displays an item mean statistic of 2.94; skewness is 0.3, while kurtosis is -0.9. The skewness value is positive, an indication that the distribution lies more to the left of the median. Since a sum of 41.5% were not satisfied, 24.3% were neutral and only 32.8% were satisfied reveals that improvement is required in this area. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

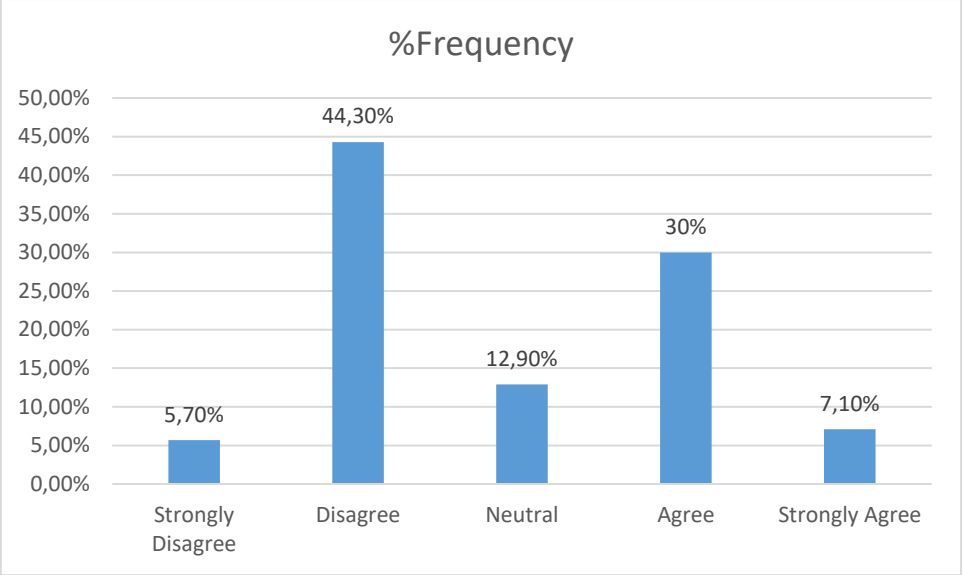

Figure 4-10: Sitting/standing alternated with standing/sitting and walking

The respondents were asked to express their perceptions concerning the statement "Sitting/Standing is often alternated with standing/sitting and walking". Figure 4.10 results show that 30% agreed and 7.1% strongly agreed. About 5.7% of the respondents strongly disagreed, 44.3% disagreed, while 12.9 % were neutral.

Appendix J displays an item mean statistic of 2.89; skewness is 0.3, while kurtosis is -1.1. The skewness value is positive, an indication that the distribution lies more to the left of the median, revealing that the majority of the respondents are satisfied with the spacing of the items on their workstations. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

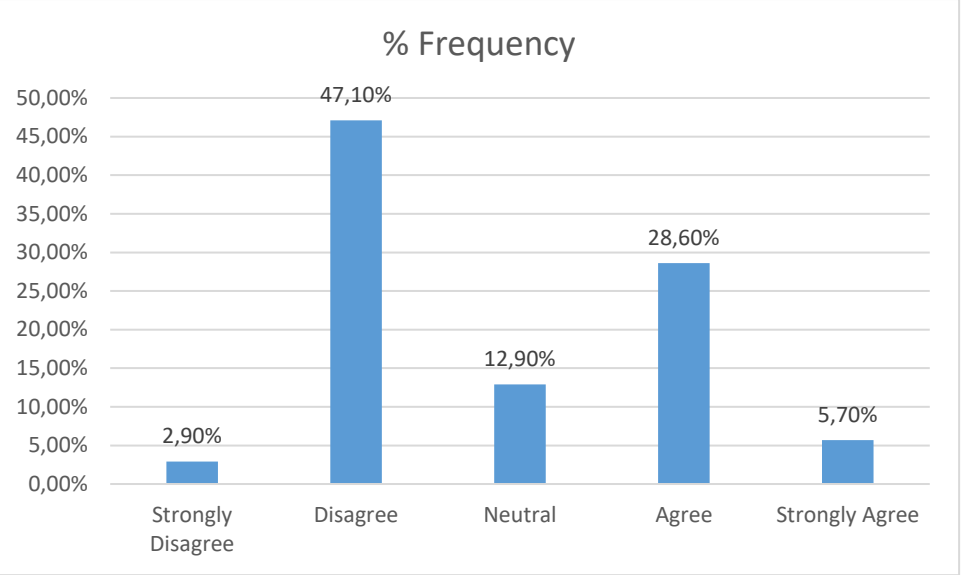

Figure 4-11: The current seating design prevents me from working effectively

The respondents were asked to express their perceptions concerning the statement "The current seating design prevents me from working effectively". Figure 4.11 results show that 28.6% agreed and 5.7% strongly agreed. About 2.9% of the respondents strongly disagreed, 47.1% disagreed, while 12.9 % were neutral. The percentage of participants that felt the questions were not applicable or did not respond is 2.8%, due to the insignificant percentage this will not affect the credibility of the results.

Appendix J displays an item mean statistic of 2.87; skewness is 0.4, while kurtosis is -1.1. The skewness value is positive, an indication that the distribution lies more to the left of the median, revealing that the majority of the respondents are satisfied with the seating design of their workstation. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

4.3.3 Factors related to design of tasks and jobs

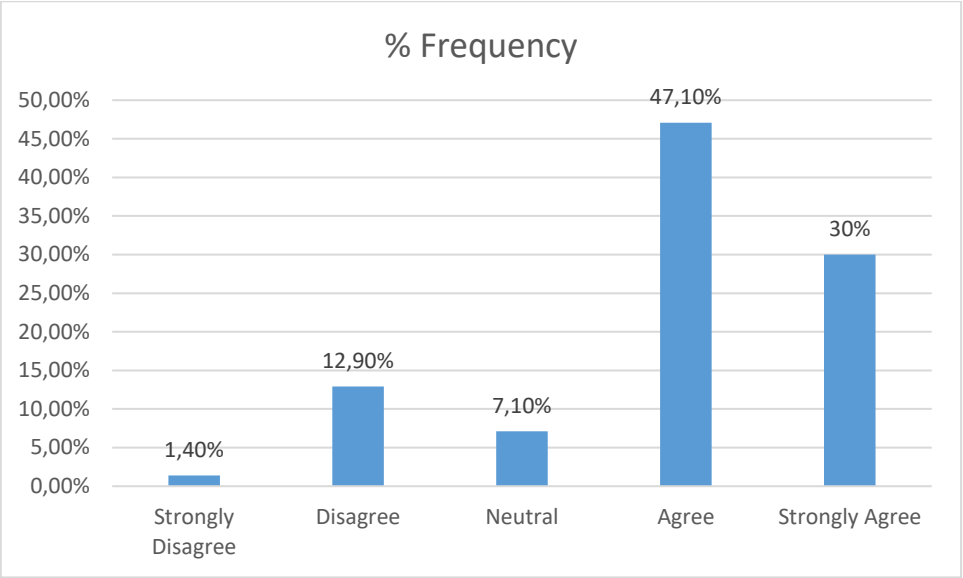

Figure 4-12: The job consists of more than one task

The respondents were asked to express their perceptions concerning the statement "The job consists of more than one task". Figure 4.12 results show that 47.10% agreed and 30% strongly agreed. About 1.40% of the respondents strongly disagreed, 12.90% disagreed, while 7.10 % were neutral. The percentage of participants that felt the questions were not applicable or did not respond is 1.5%, due to the insignificant percentage this will not affect the credibility of the results.

Appendix J displays an item mean statistic of 3.93; skewness is -0.1, while kurtosis is 0.27. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the majority of the respondent's jobs consist of more than one task. A positive kurtosis value points out a steeper distribution. Elton *et al.* (2013) suggested that managers should be aware of job rotation as an organisational strategy at the administrative level and should provide adequate training to workers in various tasks and not forget the ergonomic contexts of each task. Job rotation can be an important intervention when ergonomic principles are deployed, helping to minimise hazards, even if it is not possible to fully implement rotation (Elton *et al.,* 2013; Padula *et al.*, 2014).

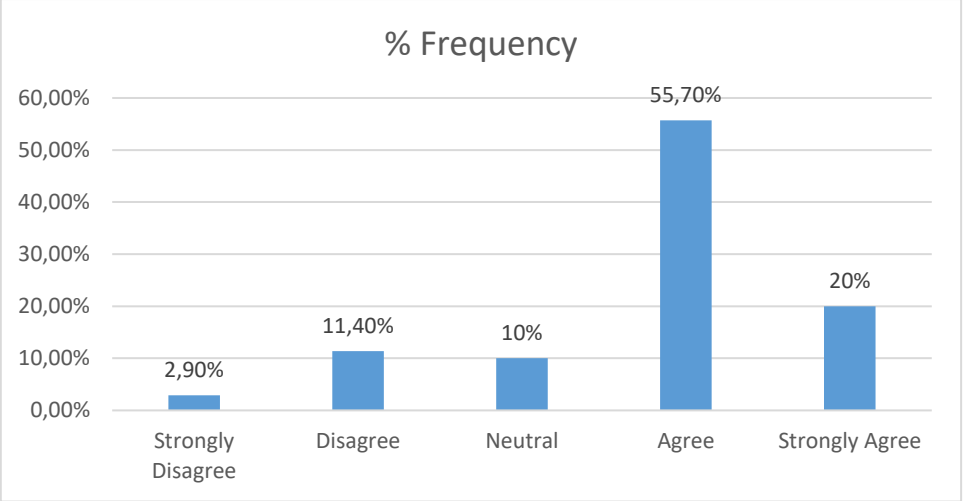

Figure 4-13: The tasks performed to contribute to problem-solving

The respondents were asked to express their perceptions concerning the statement "The tasks performed contribute to problem-solving". Figure 4.13 results show that 55.7% agreed and 20% strongly agreed. About 2.9% of the respondents strongly disagreed, 11.40% disagreed, while 10 % were neutral.

Appendix J displays an item mean statistic of 3.79; skewness is -1, while kurtosis is 0.7. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the majority of the respondent's tasks involve problem-solving. A positive kurtosis value points out a steeper distribution.

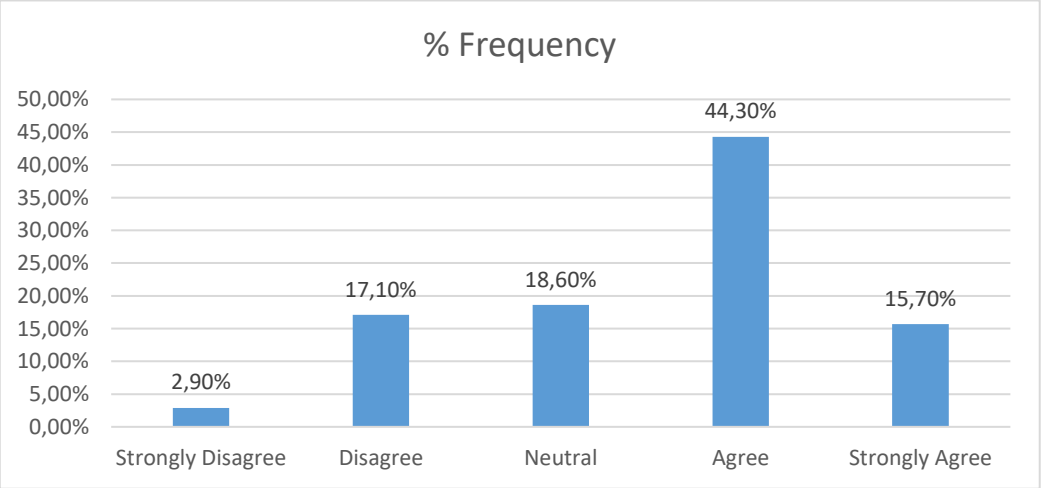

Figure 4-14: Sufficient possibilities for communication between workers

The respondents were asked to express their perceptions concerning the statement “There are sufficient possibilities for communication between workers”. Figure 4.14 results show that 44.3% agreed and 15.7% strongly agreed. About 2.9% of the respondents strongly disagreed, 17.10% disagreed, while 18.60 % were neutral. The percentage of participants that felt the questions were not applicable is 1.4%, due to the insignificant percentage this will not affect the credibility of the results.

Appendix J displays an item mean statistic of 3.54; skewness is -0.53, while kurtosis is -0.5. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the majority of the respondents are satisfied with the communication channels implemented at the site. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution. Communication is essential to understand the work task and team members’ work, poor communication can lead to confusion and psychological strain among workers (Sakthi Nagaraj and Jeyapaul, 2020).

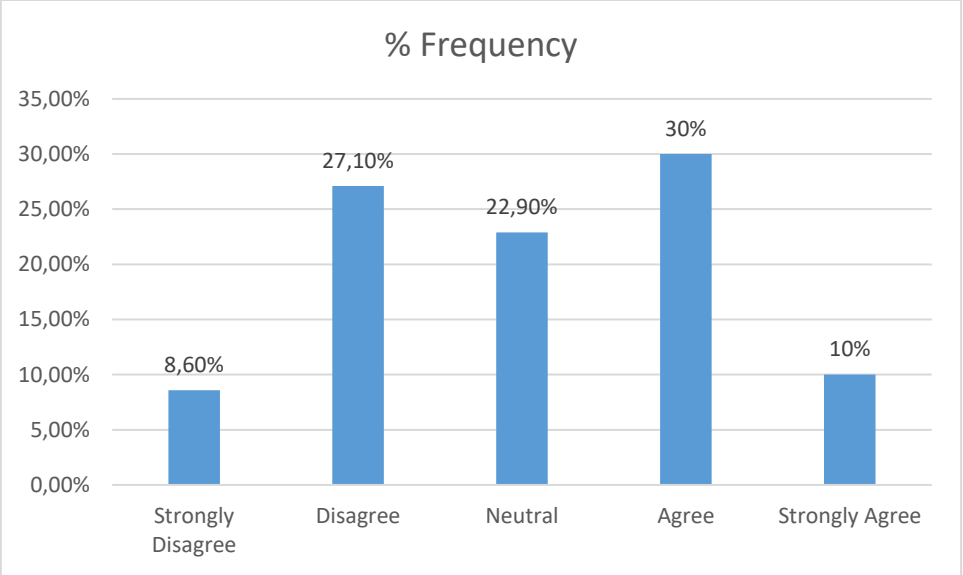

Figure 4-15: Workers decide independently on how the tasks are carried out

The respondents were asked to express their perceptions concerning the statement “Workers can decide independently on how the tasks are carried out”. Figure 4.15 results show that 30% agreed and 10% strongly agreed. About 8.60% of the respondents strongly disagreed, 27.10% disagreed, while 22.90 % were neutral. The percentage of participants that felt the questions were not applicable or did not respond

is 1.4%, due to the insignificant percentage this will not affect the credibility of the results

Appendix J displays an item mean statistic of 3.06; skewness is -0.06, while kurtosis is -0.1. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the majority of the respondents have the opportunity to make decisions independently. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

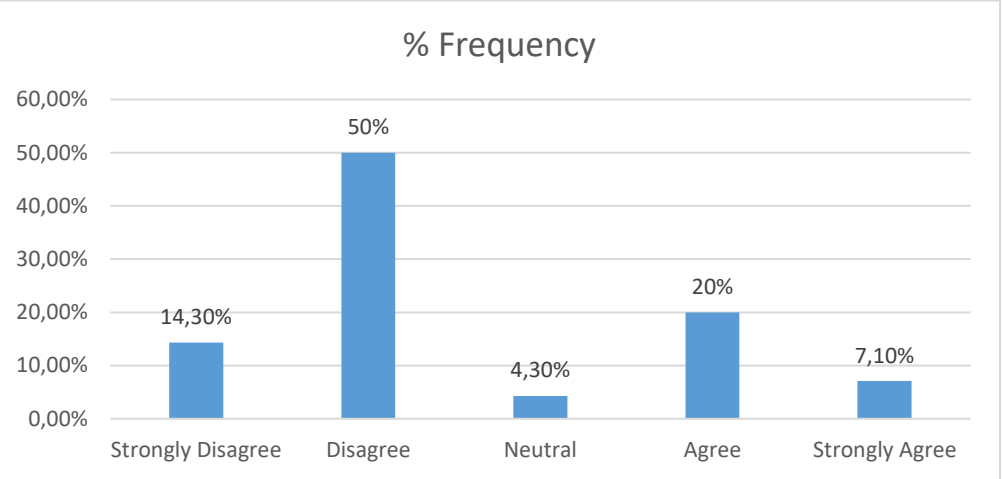

Figure 4-16: My job allows me to take part in management decisions

The respondents were asked to express their perceptions concerning the statement “My job allows me to take part in management decisions”. Figure 4.16 results show that 20% agreed and 7.10% strongly agreed. About 14.30% of the respondents strongly disagreed, 50% disagreed, while 4.30% were neutral.

Appendix J displays an item mean statistic of 2.54; skewness is 0.7, while kurtosis is -0.7. The skewness value is positive, an indication that the distribution lies more to the left of the median, revealing that the majority of the respondents are involved in decisions made by management. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

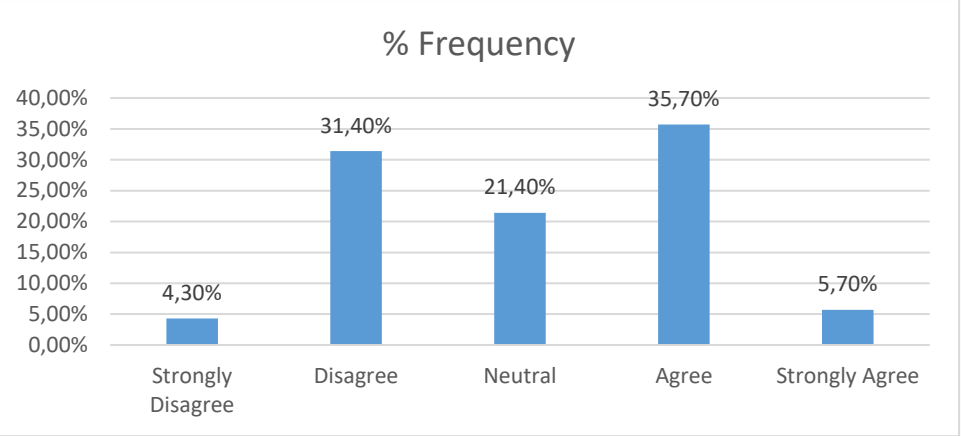

Figure 4-17: Sufficient information provided to control the assigned tasks

The respondents were asked to express their perceptions concerning the statement "There is sufficient information provided to control the assigned tasks". Figure 4.17 results show that 35.7% agreed and 5.70% strongly agreed. About 4.3% of the respondents strongly disagreed, 31.4% disagreed, while 21.40 % were neutral.

Appendix J displays an item mean statistic of 3.07; skewness is -0.07, while kurtosis is -1. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the majority of the respondents are satisfied with the information provided to control the assigned tasks. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

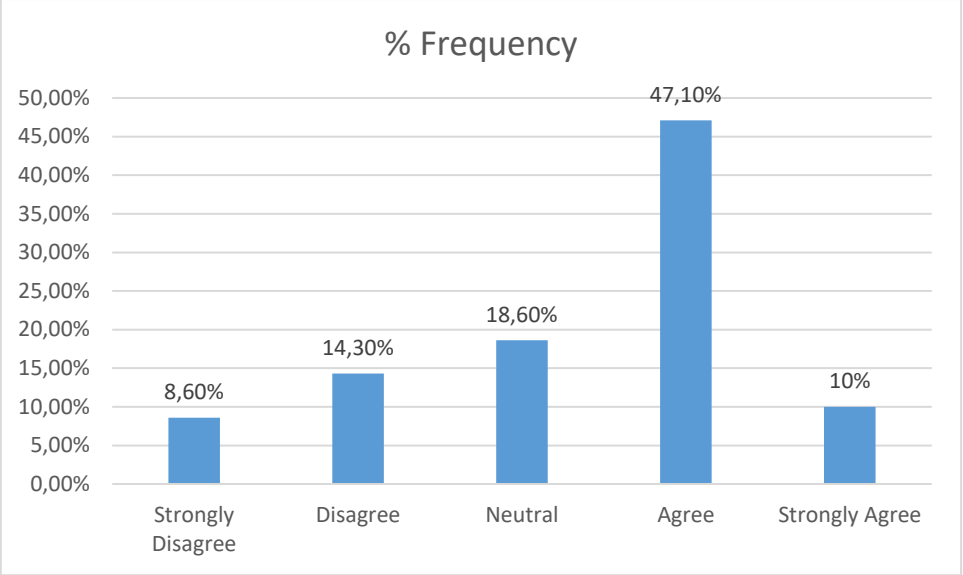

Figure 4-18: Tasks are deployed to the correct skill level of people

The respondents were asked to express their perceptions concerning the statement "Tasks are deployed to the correct skill level of people". Figure 4.18 results show that 47.10% agreed and 10% strongly agreed. About 8.6% of the respondents strongly disagreed, 14.3% disagreed, while 18.6% were neutral.

Appendix J displays an item mean statistic of 3.36; skewness is -0.7, while kurtosis is -0.35. The skewness value is negative, an indication that the distribution lies more to the right of the median. Although a sum of 57.1% agree that tasks are deployed according to the staff's capabilities, a large percentage of staff members disagree. This indicates that a large number of employees are performing tasks they are not equipped for and this will impact their performance. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

4.3.4 Factors related to Information Tasks

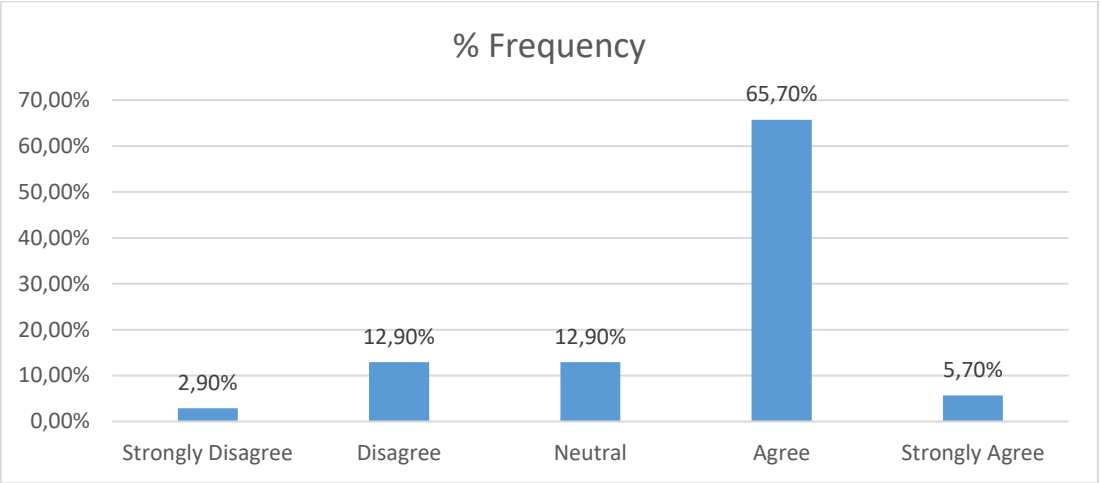

Figure 4-19: Information presented is simple and easily understood

The respondents were asked to express their perceptions concerning the statement "The information presented is as simple as possible and easily understood Figure 4.19 results show that 65.7% agreed and 5.7% strongly agreed. About 2.9% of the respondents strongly disagreed, 12.9% disagreed, while 12.9% were neutral.

Appendix J displays an item mean statistic of 3.59; skewness is -1.2, while kurtosis is 1. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents are satisfied with format of the information. The positive kurtosis value points out a steeper distribution.

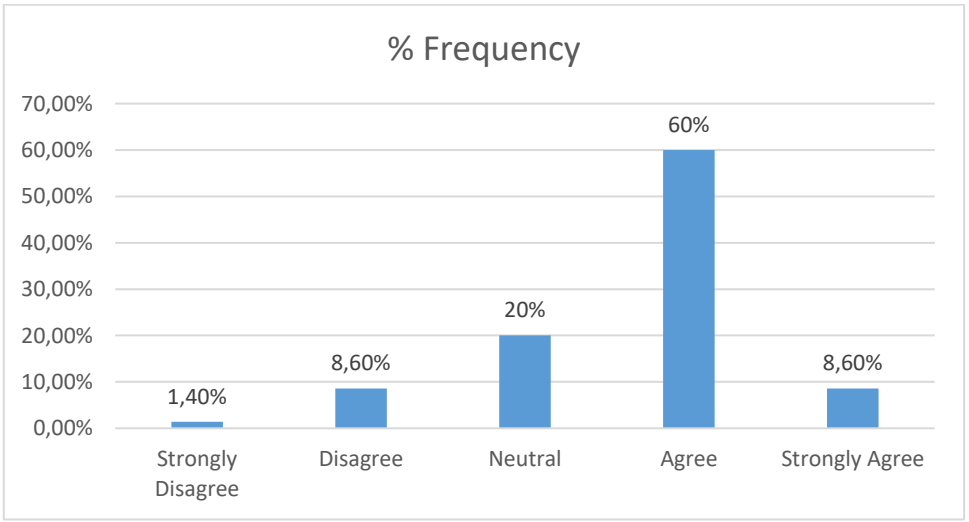

Figure 4-20: Information is easy to interpret and easily understood

The respondents were asked to express their perceptions concerning the statement “The information presented is as simple as possible and easily understood Figure 4.20 results show that 60% agreed and 8.6% strongly agreed. About 1.4% of the respondents strongly disagreed, 8.6% disagreed, while 20% were neutral.

Appendix J displays an item mean statistic of 3.67; skewness is -1, while kurtosis is 1.2. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents understand the information available to them. The positive kurtosis value points out a steeper distribution.

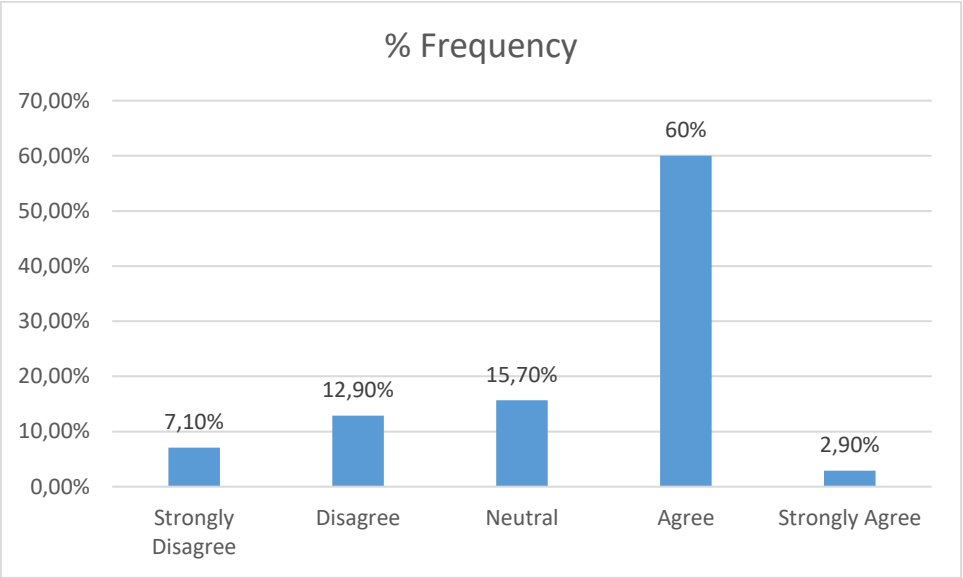

Figure 4-21: The method of displaying information selected is appropriate

The respondents were asked to express their perceptions concerning the statement “The information presented is as simple as possible and easily understood Figure 4.21 results show that 60% agreed and 2.9% strongly agreed. About 7.10% of the respondents strongly disagreed, 12.9% disagreed, while 15.7% were neutral.

Appendix J displays an item mean statistic of 3.39; skewness is -1.1 while kurtosis is 0.3. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents identify the relevance in the information available to them. The positive kurtosis value points out a steeper distribution.

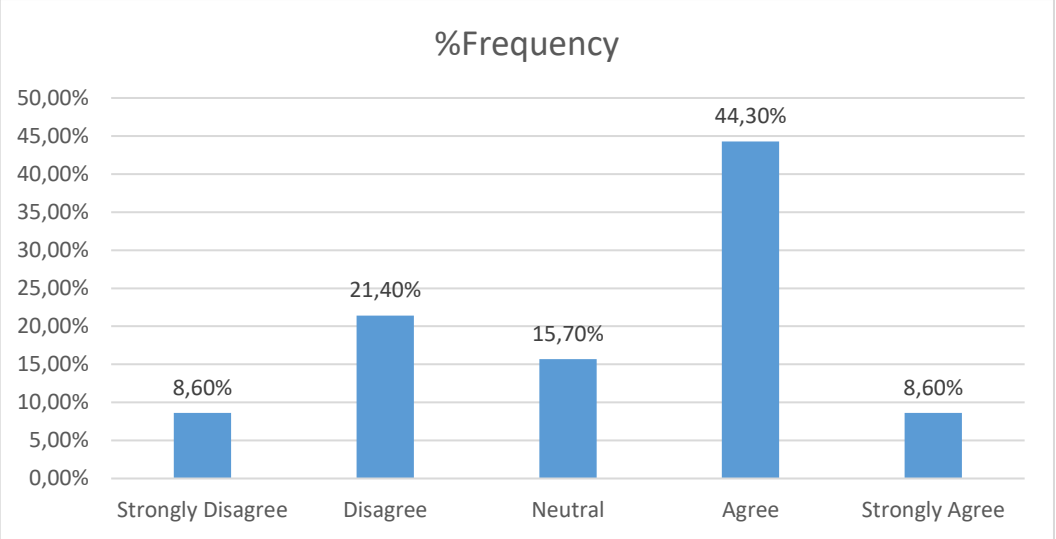

Figure 4-22: Diagrams are easy to understand

The respondents were asked to express their perceptions concerning the statement "Diagrams are easy to understand". Figure 4.22 results show that 44.3% agreed and 8.6% strongly agreed. About 8.6% of the respondents strongly disagreed, 21.4% disagreed, while 15.7% were neutral.

Appendix J displays an item mean statistic of 3.23; skewness is -0.5 while kurtosis is -0.8. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents are satisfied with the diagrams available to them. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

4.3.5 Human-Computer Interaction

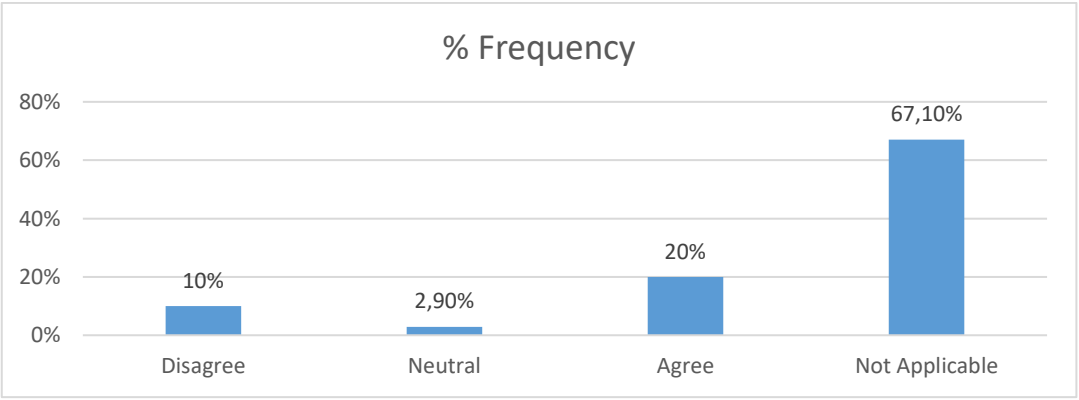

Figure 4-23: Touch screens used to facilitate operation by inexperienced users

The respondents were asked to express their perceptions concerning the statement Touch screens are used to facilitate operation by inexperienced users". Figure 4.23 results show that 20% agreed, 10% disagreed and 2.9% were neutral. About 67.10% found the question not applicable to their job role.

Appendix J displays an item mean statistic of 3.3; skewness is -0.7 while kurtosis is -1.5. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the majority of the respondents do not use touch screens or computers in their daily tasks. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

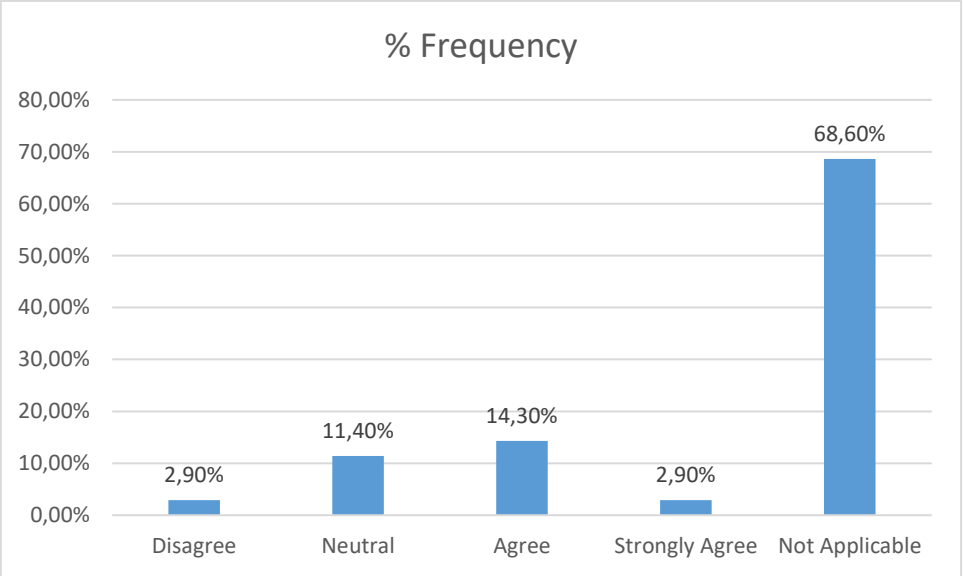

Figure 4-24: The numerical keypad layout is logical

The respondents were asked to express their perceptions concerning the logical layout of the numerical keypads used. Figure 4.24 results show that 14.3% agreed, 2.9% disagreed and 11.4% were neutral. About 68.60% found the question not applicable to their job role.

Appendix J displays an item mean statistic of 3.55; skewness is -0.2 while kurtosis is -0.2. The negative skewness value points out that the bulk of the distribution lies to the right of the median. The statement did not apply to a large portion of the sample size as 22 out of the 70 participants responded to the statement. The results of the respondents showed that the numerical keypad is logical for most of the employees where computer interaction is required. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

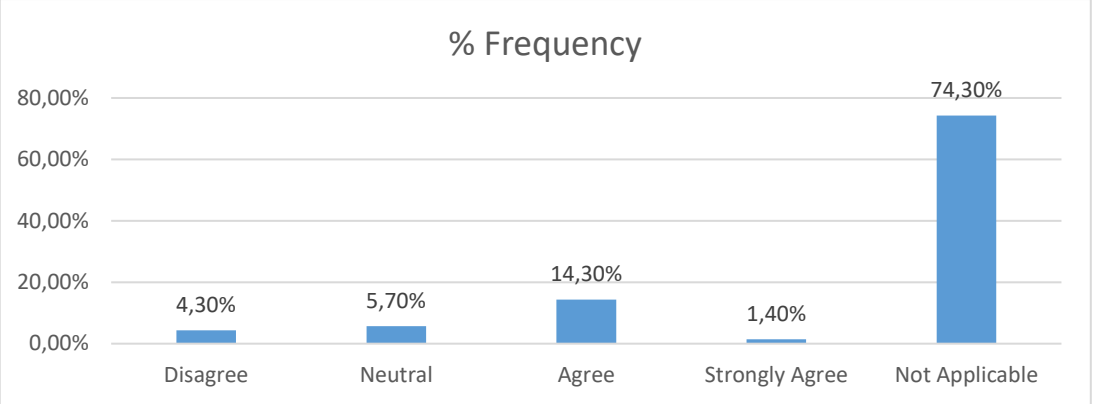

Figure 4-25: The QWERTY layout selected for the keyboard is used

The respondents were asked to express their perceptions concerning if the QWERTY keyboard is used. Figure 4.25 results show that 14.3% agreed, 1.40% strongly agreed, 4.3% disagreed and 5.7% were neutral. About 74.30% found the question not applicable to their job role.

Appendix J displays an item mean statistic of 3.50; skewness is -0.63 while kurtosis is -0.34. The negative skewness value points out that the bulk of the distribution lies to the right of the median. The statement did not apply to a large portion of the sample size as only 18 out of the 70 participants responded to the statement. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

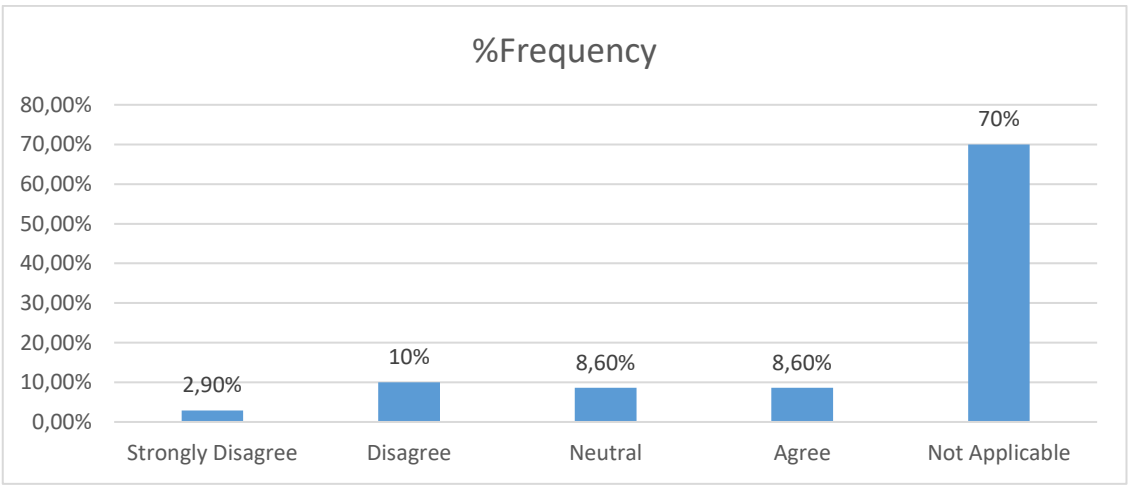

Figure 4-26: Concerns relating to computer interaction that affects my job

The respondents were asked their perception on whether there are concerns relating to computer interaction that affects their job. Since this question did not apply to many

of the research participants, a small response was obtained. Twenty-one out of the seventy participants responded. Figure 4.26 results show that 8.6% agreed 2.9% strongly agreed, 10% disagreed and 8.6% were neutral. About 70% found the question not applicable to their job role.

Appendix J displays an item mean statistic of 2.76; skewness is -0.63 while kurtosis is -0.34. The negative skewness value points out that the bulk of the distribution lies to the right of the median. The statement did not apply to a large portion of the sample size as only 22 out of the 70 participants responded to the statement. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

4.3.6 Illumination

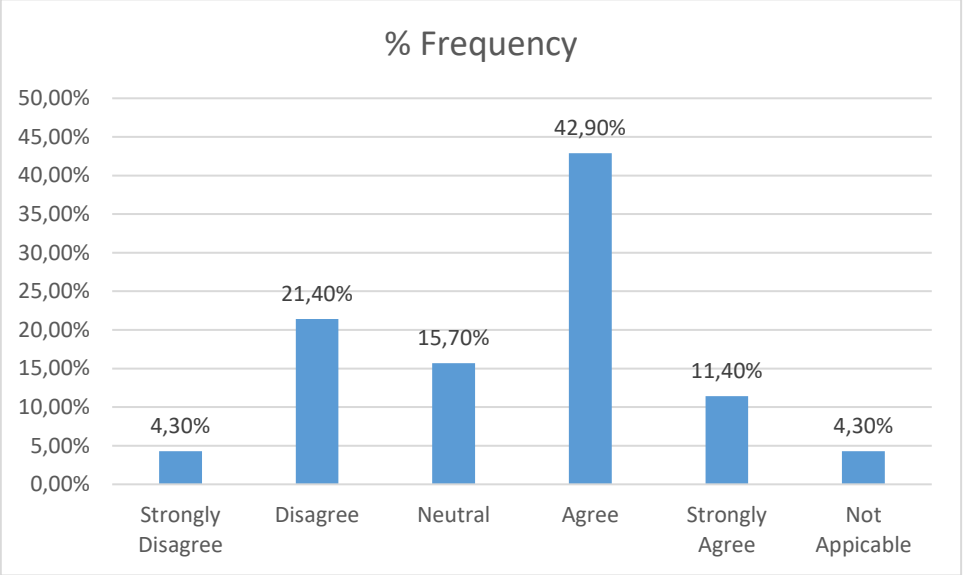

Figure 4-27: Light intensity for normal activities is in range of 200–800 lux

The respondents were asked if the light intensity for normal activities is in the range of 200–800 lux. Figure 4.27 results show that 42.9% agreed, 11.4% strongly agreed, 21.4% disagreed. 4.3% strongly disagreed and 15.7% were neutral. A percentage of 4.3% found the question not applicable to their job role.

Appendix J displays an item mean statistic of 3.37; skewness is -0.44 while kurtosis is -0.76. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that a large number of the sample agreed that the light intensity for normal activities is in the range of 200-800 lux. The percentage of

staff that did not agree is 25.7%, which indicates an ergonomic intervention is needed to improve the lighting range, 15.7% provided a neutral response which implies they are neither satisfied or dissatisfied. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

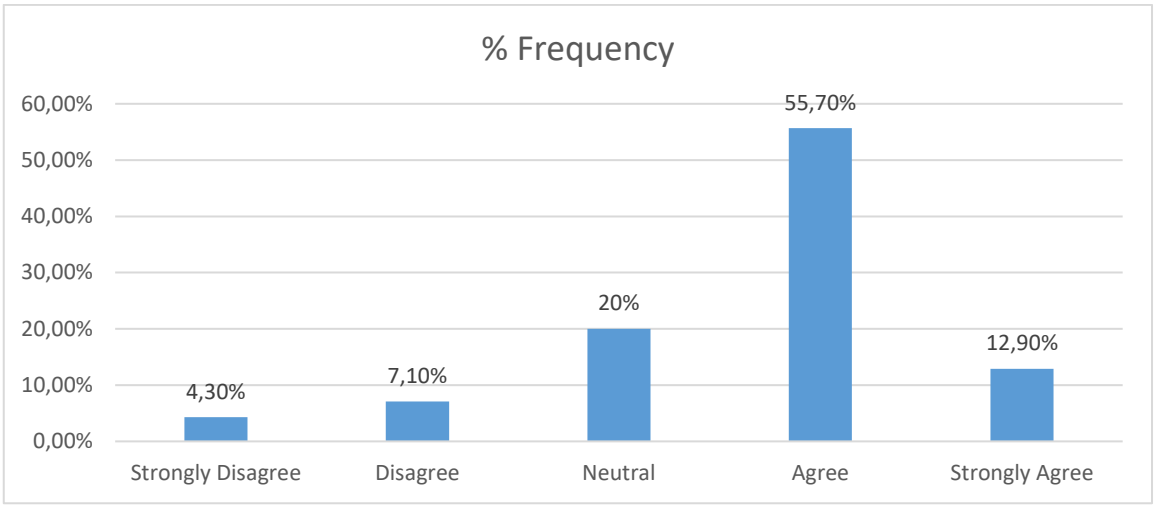

Figure 4-28: Information displayed is easily legible

The respondents were asked if the information on the training material and standard operating procedures at site was documented and displayed in a format that can be easily deciphered. The results in Figure 4.28 show that 12.9% strongly agreed, 55.7% agreed, 4.3% strongly disagreed, 7.1% disagreed and 20% was neutral. Appendix J displays an item mean statistic of 3.66; skewness is -1.05 while kurtosis is 1.2. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that a large number of the respondents are satisfied with the information displayed. A positive kurtosis value points out a steeper distribution.

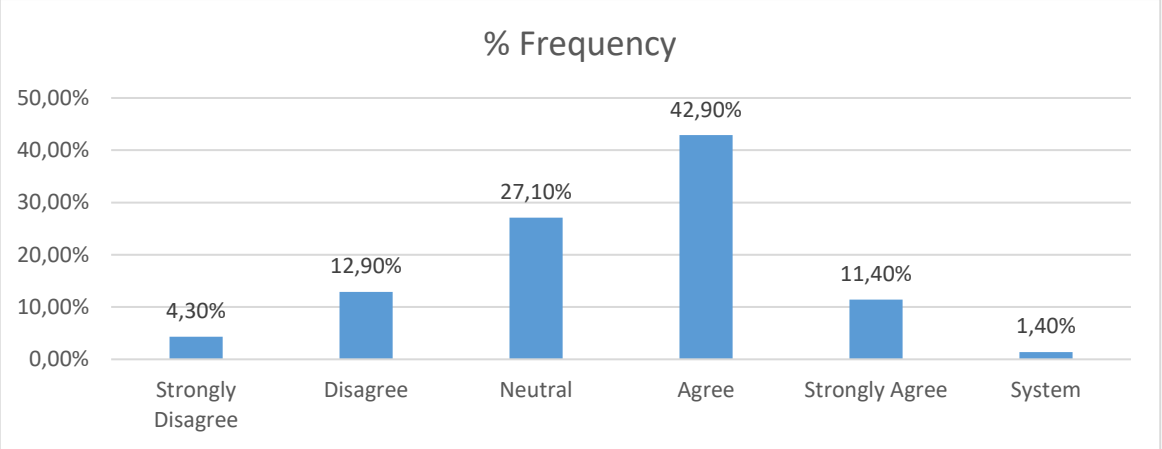

Figure 4-29: Ambient lighting is combined with localised lighting

The respondents were asked to express their perception of whether ambient lighting is combined with localised lighting. Figure 4.29 results show that 11.4% strongly agreed, 42.9% agreed, 27.1% were neutral, 12.9% disagreed and 4.3% strongly disagreed.

Appendix J displays an item mean statistic of 3.45; skewness is -0.57 while kurtosis is -0.06. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that a large number of the respondents are satisfied with the lighting in the workplace. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

In visual ergonomics, the level of ambient illumination is regarded as a critical factor when performing visual tasks. According to a study conducted by Elton *et al.* (2013), the visual acuity of visually impaired people improved dramatically with an increasing light level when identifying signs and wayfinding information in the 'real world'. Thus, ambient illumination should be regarded as a critical factor, which can affect the perception of raw materials, goods, equipment setting, and operation of equipment for the packaging firm.

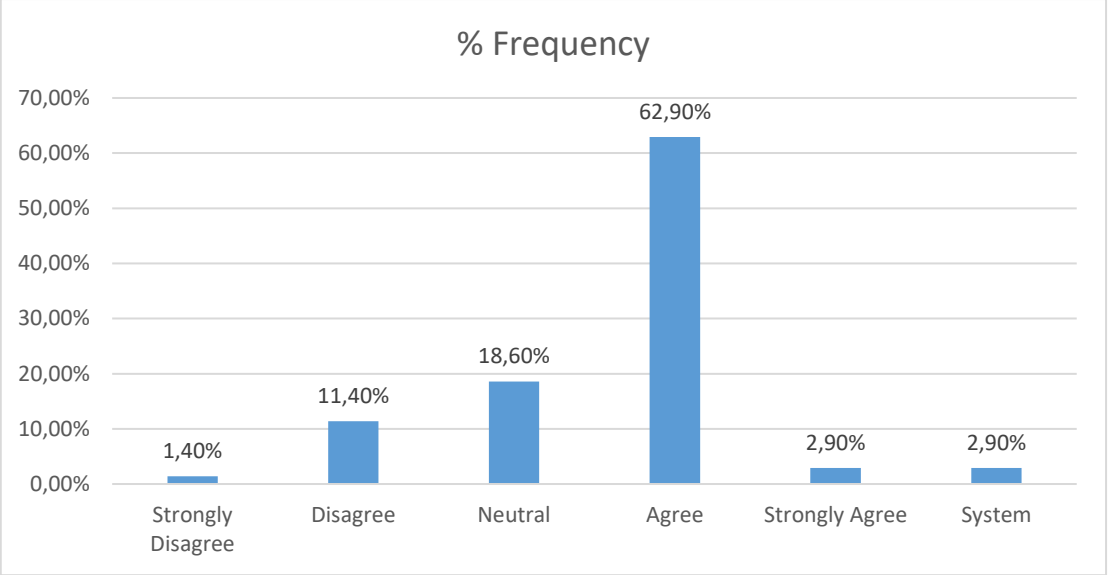

Figure 4-30: The light sources are properly screened

The respondents were asked to express their perception of whether the light sources used are properly screened. Figure 4.30 results show that 2.90% strongly agreed, 62.9% agreed,18.6% were neutral, 11.4% disagreed and 1.4% strongly disagreed.

Appendix J displays an item mean statistic of 3.56; skewness is -1.19 while kurtosis is -0.93. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that light sources at the site are screened as per requirements. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

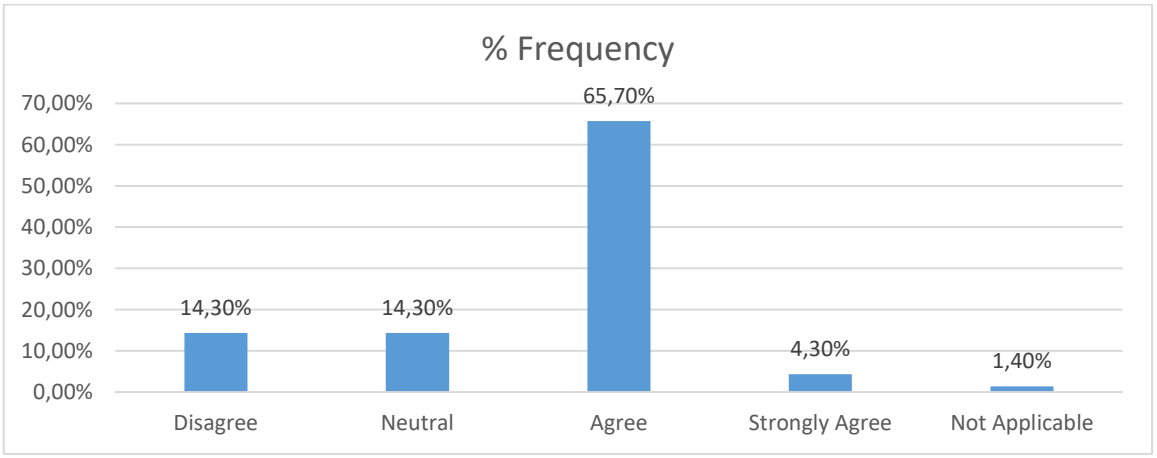

Figure 4-31: The light reflections, shadows, or flickers can be prevented

The respondents were asked to express their perception on whether the light reflections, shadows, or flickers from the fluorescent tubes can be prevented at the

site. Figure 4.31 results show that 4.3% strongly agreed, 65.7% agreed, 14.3% were neutral, 14.3% disagreed and 1.4% found the question not applicable.

Appendix J displays an item mean statistic of 3.61; skewness is -1.02 while kurtosis is 0.19. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that any lighting defects caused by the fluorescent tube can be prevented if needed. The positive kurtosis value points out a steeper distribution.

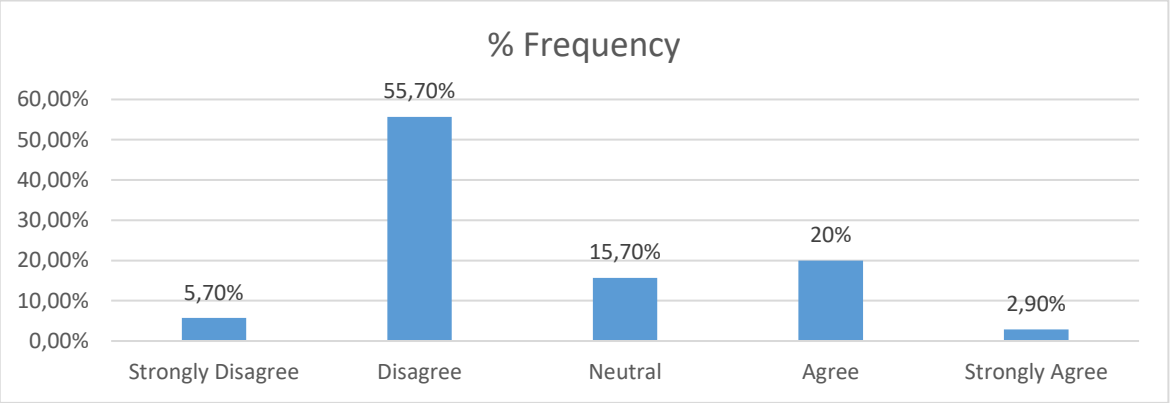

Figure 4-32: The lighting has negative implications for my sight

The respondents were asked to express their perception on whether the lighting at the site had a negative impact on their eyesight. Figure 4.32 results show that 2.9% strongly agreed, 20% agreed, 15.7% were neutral, 55.7% disagreed and 5.7% strongly disagreed.

Appendix J displays an item mean statistic of 2.59; skewness is 0.73 while kurtosis is -0.39. The skewness value is positive, an indication that the distribution lies more to the left of the median, revealing that the lighting at sight implicates no hard to the employee's eyesight. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

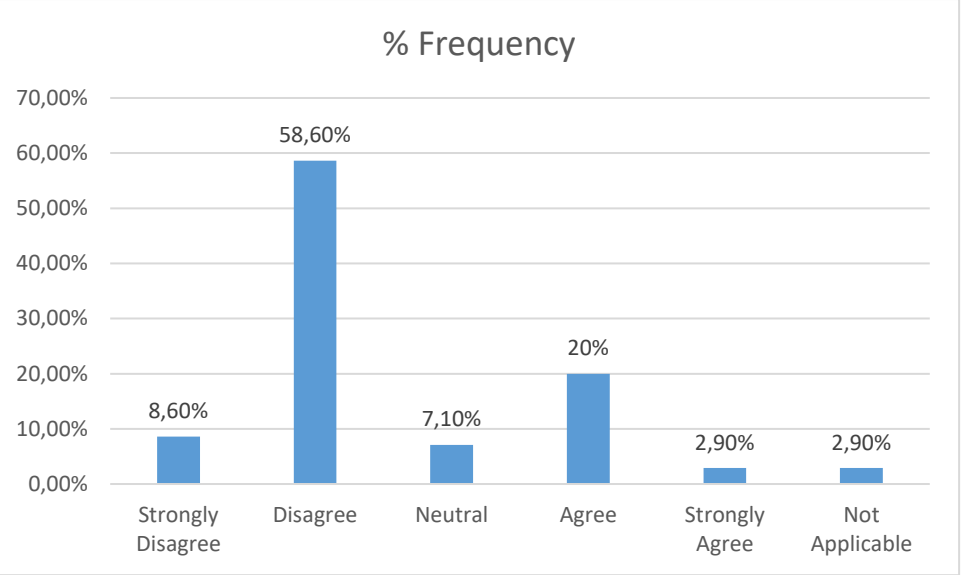

Figure 4-33: My vision has deteriorated since the start of my job

The respondents were asked to express their perception of whether their vision had deteriorated since the start of their employment. Figure 4.33 results show that 2.9% strongly agreed, 20% agreed, 7.1% were neutral, 58.6% disagreed, 8.6% strongly disagreed and 2.9% found the statement not applicable.

Appendix J displays an item mean statistic of 2.49; skewness is 0.84 while kurtosis is -0.28. The skewness value is positive, an indication that the distribution lies more to the left of the median, revealing that the current job of the respondents causes no harm to their vision. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

4.3.7 Noise and Vibration

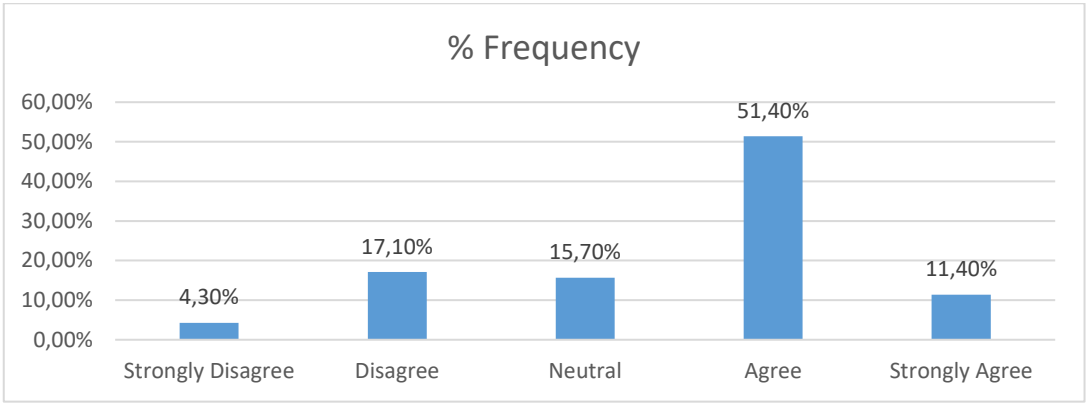

Figure 4-34: Adequate separation between workers and source of noise

The respondents were asked to express their perception of whether there is adequate separation between the workers and the source of the noise. Figure 4.34 results show that 11.4% strongly agreed, 51.4% agreed, 15.7% were neutral, 17.1% disagreed and 4.3% strongly disagreed. Appendix J displays an item mean statistic of 3.49; skewness is -0.7 while kurtosis is -0.25. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents are satisfied with the spacing between the worker's workplace and the source of the noise. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

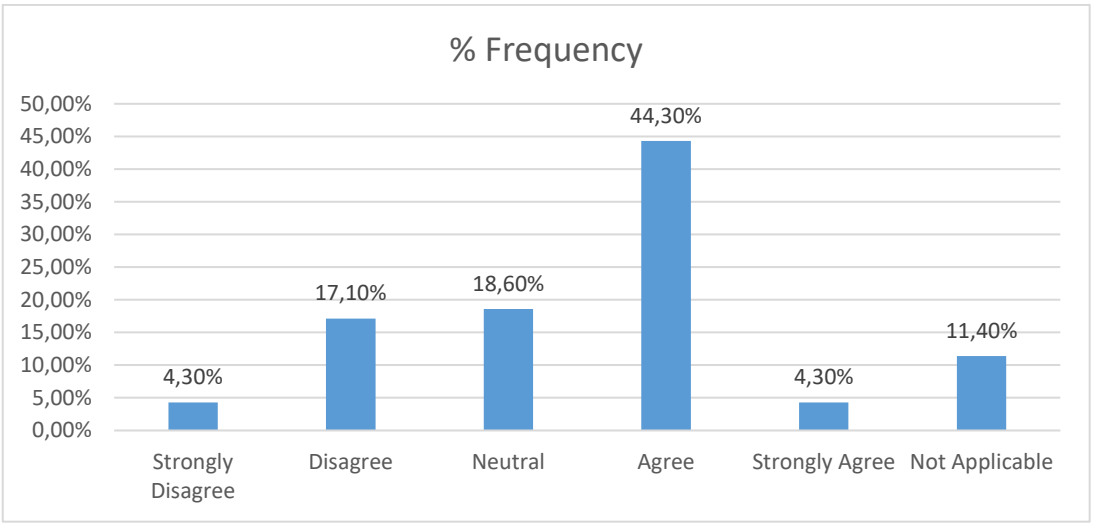

Figure 4-35: Sources of uncomfortable body vibration are recognised

The respondents were asked to express their perception concerning the statement "The sources of uncomfortable and damaging body vibrations are recognised". Figure

4.35 results show that 4.3% strongly agreed, 44.3% agreed, 18.6% were neutral, 17.1% disagreed, 4.3% strongly disagreed and 11.4% found the statement to be not applicable.

Appendix J displays an item mean statistic of 3.31; skewness is -0.66 while kurtosis is -0.42. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that the respondents recognise any harmful vibrations at the site. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

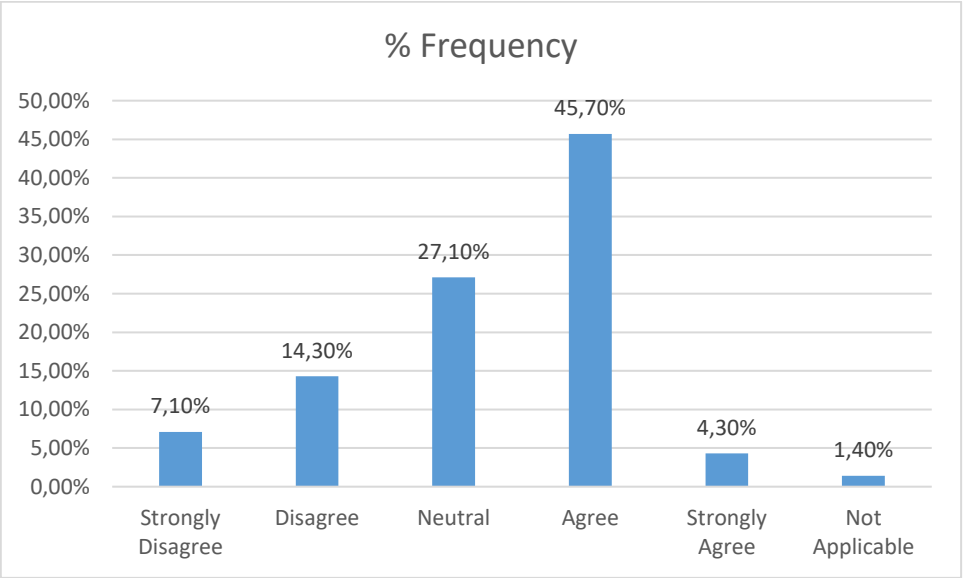

Figure 4-36: Acoustic screens are used

The respondents were asked to express their perception concerning the statement “Acoustic screens are used”. Figure 4.36 results show that 4.3% strongly agreed, 45.7% agreed, 27.10% were neutral, 14.3% disagreed, 7.1% strongly disagreed and 1.4% found the statement not applicable.

Appendix J displays an item mean statistic of 3.26; skewness is -0.73 while kurtosis is -0.15. The skewness value is negative, an indication that the distribution lies more to the right of the median, revealing that acoustic screens are used at the site. A negative kurtosis value points out that the distribution has a lighter tail than the normal distribution.

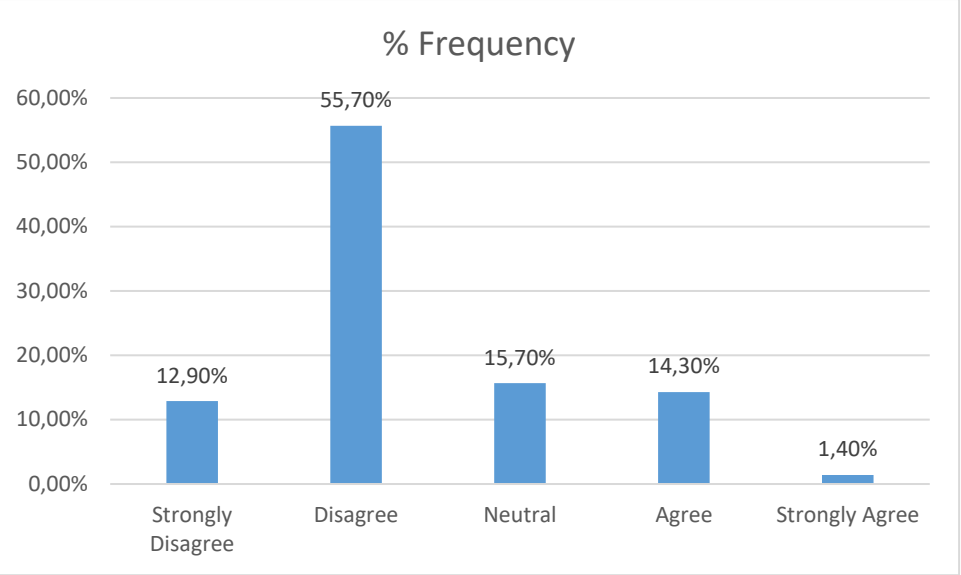

Figure 4-37: The Noise has a negative impact on my performance

The respondents were also asked to respond concerning the statement “The Noise has a negative impact on my performance”. Figure 4.37 results show that 1.4% strongly agreed, 14.3% agreed, 15.7% were neutral, 55.7% disagreed and 12.9% strongly disagreed. Appendix J displays an item mean statistic of 2.36; skewness is 0.76 while kurtosis is 0.01. The skewness value is positive, an indication that the distribution lies more to the left of the median, revealing that the noise levels at the site do not affect the workers' performance. The positive kurtosis value points out a steeper distribution.

4.4 Correlation Analysis of Ergonomic Factors

Appendix K shows the results for tests of normality using the Shapiro–Wilk test. The Kolmogorov–Smirnov test is used for n ≥50 while the Shapiro–Wilk test is proper for small sample sizes (<50 samples) (Mishra et al., 2019). The sigma values for the Shapiro–Wilk test for the variables were generally less than 0.05, at 95% confidence interval, and thus non-parametric tests were run for all the variables. Spearman's rank correlation coefficient for non-parametric measure of statistical dependence between variables was used to investigate the relationships between variables since the data were non-normal. Table 4.5 shows the results for Spearman's rho correlations at the 0.01 level (2-tailed).

The variables were abbreviated as shown below:

a. Anthropometric & Physiological Factors (APF)
b. Factors related to Posture (FP)
c. Factors Related to Design of Tasks and Jobs (FDTJ)
d. Factors Related to Information Tasks (FIT)
e. Human–Computer Interaction (HCI)
f. Illumination (I)
g. Noise and Vibration (NV)

Table 4-5: Spearman's rho Correlations for Ergonomic Factors

		APF	FP	FDTJ	FIT	HCI	I	NV
APF	Correlation Coefficient	1	.652**	.782**	.628*	.546*	.284*	.356*
	Sig. (2-tailed)		0.01	0.02	0.009	0.04	0.03	0.02
FP	Correlation Coefficient	.652**	1	.672*	.588*	.126*	.344*	.462*
	Sig. (2-tailed)	0.01		0.02	0.04	0.005	0.03	0.01
FDTJ	Correlation Coefficient	.782**	.672*	1	.274*	.111*	.254*	.372*
	Sig. (2-tailed)	0.02	0.02		0.03	0.01	0.005	0.02
FIT	Correlation Coefficient	.628*	.588*	.274*	1	.345*	.678*	.189*
	Sig. (2-tailed)	0.009	0.04	0.03		0.02	0.03	0.043
HCI	Correlation Coefficient	.546*	.126*	.111*	.345*	1	.799**	.328*
	Sig. (2-tailed)	0.04	0.005	0.01	0.02		0.02	0.009
I	Correlation Coefficient	.284*	.344*	.254*	.678*	.799**	1	.175*
	Sig. (2-tailed)	0.03	0.03	0.005	0.03	0.02		0.044
NV	Correlation Coefficient	.356*	.462*	.372*	.189*	.328*	.175*	1
	Sig. (2-tailed)	0.02	0.01	0.02	0.043	0.009	0.044	
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								

At 0.01 level (2-tailed), a strong positive correlation was noted between HCI and I, which was statistically significant, $r_S = 0.799$, $p = 0.02$. Another strong positive

correlation was noted between FDGI and APF, which was statistically significant, r_s = *0.782, p = 0.02*. Similarly, there was strong positive correlation that was noted between FP and APF, which was statistically significant, r_s = *0.652, p = 0.01*. At 0.05 level (2-tailed), a mild positive correlation was also noted between HCI and APF, which was statistically significant, r_s = *0.546, p = 0.004*.

At 0.05 level (2-tailed), weak positive correlations were noted between NV and I, and between HCI and FDTJ, which were statistically significant, r_s = *0.175, p = 0.044* and r_s = *0.111, p = 0.01* respectively. Similarly, there was a weak positive correlation that was noted between HCI and FP, which was statistically significant, r_s = *0.126, p = 0.005*.

These results highlight the interdependence of key factors that should be taken into consideration when designing scientific ergonomic programs to improve organisational performance. Any Kaizen improvements on factors related to design of tasks and jobs may also positively influence anthropometric and physiological factors indirectly.

4.6 Conclusion

After reviewing the results and findings in this study, it is clear that there is some gap in the implementation of ergonomic programs; an intervention is thus essential. The results demonstrated that the employees at the packaging sites were generally satisfied with the workstation design. Most of the employees at the packaging sites were satisfied with the force movements present in their daily activities and there was variation in movement relating to work posture and daily movement and continuous muscular effort is limited. The length of the rest breaks and the energy consumption for each manual task were satisfactory. The staff were satisfied with the worktable design and there were good seating instructions provided at work. The spacing of the items on the workstations, spacing of the items on their workstations, as well as the seating design of their work station, were all satisfactory.

The jobs were found to consist of more than one task, tasks involved problem solving, and the communication channels implemented at the site were satisfactory. Employees had the opportunity to make decisions independently and were involved in decisions made by management. It was also noted that the respondents were

generally satisfied with the information provided to control the assigned tasks and these tasks were deployed according to the staff's capabilities.

The information presented was found to be simple and easily understood and the method of displaying information selected is appropriate. Diagrams were easy to understand and the respondents did not use touch screens or computers in their daily task. The results also showed that the numerical keypad is logical for most of the employees where computer interaction is required. The light reflections, shadows, or flicker from the fluorescent tubes could be prevented and the lighting had no negative implications for the workers' sight. In summary, a small percentage of respondents did identify a gap in the ergonomic factors highlighted in the questionnaire which supports the need for an ergonomic intervention to be deployed to improve overall organisational performance. The following chapter focuses on the discussion of the results.

CHAPTER 5 : DISCUSSION OF RESULTS

5.1 The current ergonomic scenario of the packaging firms

The first objective of the study was to assess employees' perception of the current ergonomics scenario of the packaging firms. The findings on the anthropometric and physiological factors revealed that the employees at the Cape Town and Durban packaging sites were generally satisfied with the workstation design. Although there was a small percentage of employees that indicated shortcomings in factors relating to posture. This raises a concern as a study performed by Sarkar (2016) highlighted that work postures are commonly associated with the development of MSDs. The results also indicated that most of the employees at the packaging sites are satisfied with the force movements present in their daily activities and there was variation in movement relating to work posture and daily movement. The respondents were inclined to be more satisfied with the length of their break duration and the energy consumption for each manual task was limited.

The results displayed the perceptions of the workers' views on the different ergonomic factors that related to their work environment and role at work. The overall results display a positive response to the current ergonomic conditions at the site. Anthropometric data captured per sample size can be extremely useful when designing workstation and operator task layouts. It is advisable that industrial and ergonomic engineering techniques should be used to design safe and productive workstation designs that meet the needs of most users (Ahmadi *et al.,* 2017). It was noted that working posture that is adopted by an individual is a direct expression of the interaction between the individual factors, task demands, workstation design and the tools being utilised. Hence, it is imperative that the employees adopt a correct working posture to prevent any risk of injuries that could lead to musculoskeletal disorders.

It was noted from the study that highly repetitive tasks performed without the provision of sufficient rest-breaks is a concern as the residual strain would compound the muscular strain experienced. The performance of precision tasks under awkward postures would require more attention and the simultaneous effects on both individual responses and performance outcomes need to be taken into cognisance. The results also demonstrated that when human activities are performed indoors, it is essential to

have good illumination to provide a satisfactory environment for the user. If controllable lighting is used, there was a substantial increase in productivity due to improved visual performance, the various biological effects of light, and other psychological aspects.

A large percentage of the respondents were not satisfied with the lighting in the workplace which indicates a major concern. As highlighted in Chapter two a study conducted by Hu *et al.* (2018) showed how illuminance and lighting affects the reaction times under different work modes. If the illuminance and lighting is within the right range workers will perform better. It was proved from the study that moderate colour temperature and illuminance fit in with long-term reading, while high illuminance is suited for short-term reading with heavy brain fatigue. The progress of information and information interaction has been increasingly transferred from hard-copy documents to visual display terminal due to the fourth industrial revolution, making the latter the dominant form of work in modern times. It is vital to ascertain the effect of lighting condition, a key determinant of cognitive ergonomics, to ensure the working efficiency of a visual display terminal.

The presence of occupational noise in various workplaces can have serious consequences on the health of the workers in such an atmosphere and the major concern of long exposure to occupational noise is noise-induced hearing loss. Continuous, periodic and intermittent noise can lead to more errors by the workers since noise has a varied effect on tasks and performance depending on whether it is a vigilance task, inspection task, or recall task (Fernandes *et al.,* 2015).

The results also demonstrated that vibration is another factor that affects human performance, spanning from simple tasks such as reading and writing, to workers' manual control and vision. Hand-held vibrating tools lead to a condition called vibration-induced white fingers and when the job involves repetitive and forceful exertions, it might lead to serious diseases.

The major gap identified links to the use of technology, where interaction between the respondents and computers seldom occurs. While this could be due to the nature of the environment and job specifications, management should consider options of increasing the use of computers by upskilling the staff members and encouraging job rotation as job rotation helps to expand job knowledge, work experience and social

support through interaction with more co-workers (Sakthi Nagaraj and Jeyapaul, 2020).

5.2 The overall findings from the results of each ergonomic factor are discussed below.

Table 5-1: Mean values for Anthropometric and Physiological factors

Anthropometric & Physiological Factors		
Options	***μ***	***μ (%)***
Strongly Agree	10	14%
Agree	37	53%
Neutral	11	16%
Disagree	8	11%
Strongly Disagree	2	3%
Not Applicable/No response	2	3%

Table 5-1 displays the overall average results received in the anthropometric and physiological categories. From a sample size of seventy, the overall feedback is positive as the majority of the participants responded with Agree and Strongly Agree. However, feedback that fell in the neutral, disagree and strongly disagree option, will need to be addressed in the proposed solution.

Concerning factors related to work posture, the research findings revealed that majority of the staff is satisfied with the worktable design and there were good seating instructions provided at work, however a large percentage were not satisfied. The respondents were satisfied with the spacing of the items on their workstations, spacing of the items on their workstations, as well as the seating design of their workstation.

Table 5-2: Mean values of the survey results related to the working posture

Factors related to working posture		
Options	***μ***	***μ (%)***
Strongly Agree	5	7%
Agree	25	36%
Neutral	11	16%
Disagree	24	34%
Strongly Disagree	2	3%
Not Applicable/No response	3	4%

Table 5-2 displays the overall mean results received in the working posture category of the survey. From a sample size of seventy, the results display indicates a majority of the feedback received appear in the neutral and disagree option.

Concerning factors related to design of tasks and jobs, respondents' jobs consist of more than one task, tasks involved problem-solving, and the respondents were satisfied with the communication channels implemented at the site. The respondents have the opportunity to make decisions independently, are involved in decisions made by management it was also noted that the respondents were generally satisfied with the information provided to control the assigned tasks and these tasks were deployed according to the staff's capabilities.

Table 5.3: Mean values of the survey results related to Task and Job design

Factors related to the design of Tasks and Jobs		
Options	***μ***	***μ (%)***
Strongly Agree	10	14%
Agree	28	40%
Neutral	10	14%
Disagree	16	23%
Strongly Disagree	4	6%
Not Applicable/No response	2	3%

Table 5-3 displays the overall average results received in the Task and Job design category. The findings on the factors related to information tasks revealed that majority of the respondents are satisfied with the information presented and found it to be simple and easy to understand. The method of displaying information selected is appropriate. Diagrams were easy to understand and the respondents did not use touch screens or computers in their daily task. Once concern about the finding is that a large percentage of respondents did not agree that tasks were assigned to the staff with the correct skills. The results of this can lead to poor task performance and increase the chances in failure to perform.

Table 5.4: Mean values of the survey results related to Information Tasks

Factors related to Information Tasks		
Options	***μ***	***μ (%)***
Strongly Agree	5	7%
Agree	40	57%
Neutral	11	16%
Disagree	10	14.%
Strongly Disagree	4	6%

Table 5-4 displays the overall average results received in the Information Tasks category. The findings on the factors related to human-computer interaction showed that the numerical keypad is logical for most of the employees where

computer interaction is required. A majority of the respondents do not use touch screens or computers in their daily tasks and thus there were concerns relating to computer interaction that affected their jobs.

Table 5-3: Mean values for results related to Human-Computer Interaction

Human-Computer Interaction		
Options	***μ***	***μ (%)***
Strongly Agree	2	3%
Agree	10	14%
Neutral	5	7%
Disagree	5	7%
Strongly Disagree	2	3%
Not Applicable/No response	46	66%

Table 5-5 displays the overall average results received in the Human-Computer Interaction category. Since a large percentage of the respondents do not use computers in their daily operations the overall response rate in the Human and Computer Interaction factor is poor. Most of the tasks for staff members require a hands-on intervention rather than the application of computers. While this is acceptable for both sites, it is definitely something that should be addressed in the proposed solution as technology can help with productivity.

Table 5-4: Mean values of the survey results related to illumination

Factors related to illumination		
Options	***μ***	***μ (%)***
Strongly Agree	5	7.1%
Agree	31	44.2%
Neutral	12	17.1%
Disagree	18	26%
Strongly Disagree	3	4.2%
Not Applicable/No response	1	1.4%

Table 5-6 displays the overall average results received in the lighting and illumination category. The results obtained in this category indicate that majority of the participants approve of the current lighting conditions at the site, while a high percentage also disapproved of the current lighting conditions which need to be addressed to prevent any risk of injury or poor performance related to lighting and illumination. The light intensity for normal activities was found to be in the range of 200–800 lux while ambient lighting was found to be not combined with localized lighting, and the light sources at the site were screened as per requirements. The findings on the factors related to illumination also revealed that the light reflections, shadows, or flicker from the fluorescent tubes could be prevented. Although there were gaps identified in this category a low percentage of respondents indicated that the lighting had negative implications for their sight.

Table 5-5: Mean values related to Noise and Vibration

Factors related to Noise and Vibration		
Options	***μ***	***μ (%)***
Strongly Agree	4	5.7%
Agree	27	38.6%
Neutral	14	20%
Disagree	18	25.7%
Strongly Disagree	5	7.1%
Not Applicable/No response	2	2.9%

The findings on the factors related to noise and vibration revealed that majority of the respondents are satisfied with the spacing between the worker's workplace and the source of the noise. It was also found that the respondents were able to recognize any harmful vibrations at the site and acoustic screens were used at the site. Table 5-7 displays the overall average results received in the Noise and Vibration category. The results obtained in this category also indicate the need for an improvement plan, as a high percentage responded in the neutral, disagree and strongly disagree option.

5.3 Conclusion

In this chapter the results and findings relating to the feedback provided by the respondents at both sites were discussed. Our results demonstrated that majority of the response in most areas pertaining to the ergonomic elements are satisfactory, however there are gaps in areas that remain a concern. The correlation analysis in Chapter 4, highlighted the interdependence of key factors that should be taken into consideration when designing a scientific ergonomic program to improve organisational performance. Due to this finding the proposed program will need to apply a systematic approach that takes all ergonomic factors into account. The following chapter focuses on the conclusions and recommendations on current ergonomics gaps and development of an effective ergonomic program.

CHAPTER 6 : RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

An ergonomic intervention is defined as a well-planned, structured process for thinking and action at three levels in an organisation, individual, group, and organisational, to instigate change, that is suitable for the work systems in question. The ergonomist must receive a professional evaluation and improvement of the work system through the participation of the workers in action. The benefits of ergonomic interventions are not yet well-known to most people in industrial developing countries. The most common reason is the general lack of knowledge and awareness about ergonomics and its positive contribution to health, safety, productivity, and quality of work (Helali, 2008).

In this case, it was vital to propose recommendations for developing an effective ergonomic program for the current working processes that would contribute to organisational improvement. After identifying the gaps relating to the lack of knowledge and ignorance about ergonomics programs, it was evident that an intervention was needed. Due to time constraints, the proposed solution to monitor the overall improvement were yet to be implemented; however, the proposed intervention was deemed valuable.

Systems engineering establishes the technical framework for delivering and providing the foundation on which everything is built, and it supports program success. It ensures the effective development and delivery of capability through the implementation of a balanced approach aligned to cost, schedule, performance, and risk, using integrated, disciplined, and consistent activities and processes regardless of when a program enters the acquisition life cycle (Vesonder *et al*., 2018). Integrating methodologies and processes adopted from systems engineering with ergonomic best practices will ensure that the ergonomic intervention is sustainable and addresses the identified gaps in the business.

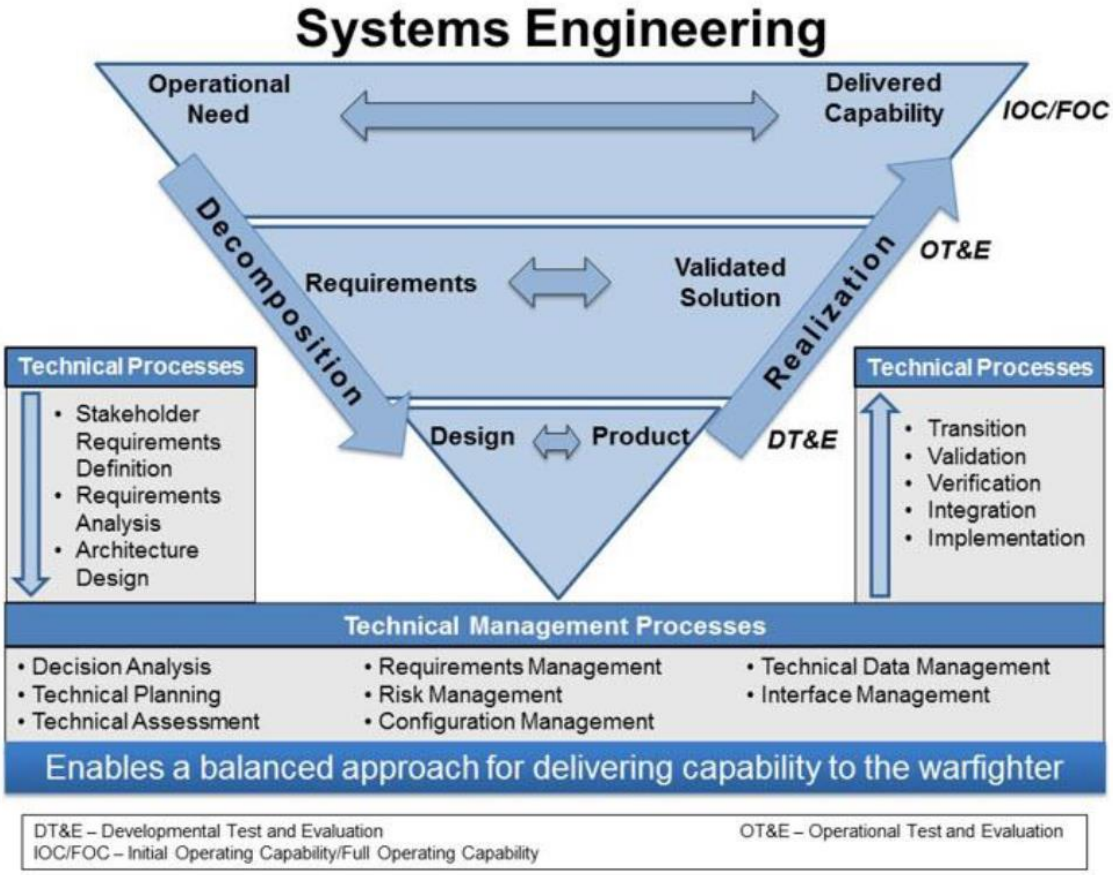

Figure 6-1: Systems Engineering Process

Source: DAG *et al.* (2000)

Figure 6-1 illustrates the technical management processes applied in systems engineering, this approach is taken from the Defense Acquisition Guidebook provides a consistent approach to managing the program's activities and controlling information and events that are vital to the success of the program (DAG et al., 2000). These 16 processes are a systematic approach focused on providing operational capability that can be applied and incorporated with various systems and business processes to ensure a successful program implementation.

6.2 Determining ergonomics gaps of the packaging firms

The second objective of the study was to determine the current ergonomics gaps and conditions of the packaging firms. After reviewing the results and findings in this study, it is clear that a huge gap lies in the implementation of ergonomic programs, thus the need for an intervention to occur is essential. The common error of management in

manufacturing industries frequently associating ergonomics with the occupational health and safety delays the success and possibility of opportunities that ergonomic programs can have within an organisation. Although recent literature has shown that management in the manufacturing and packaging sector is beginning to understand and value the benefits such programs can have for employee performance, quality, productivity, and lead-time, the current literature shows that research conducted in the packaging industry relating to ergonomics is limited.

It was also found from this study that there is a huge gap in knowledge about the basic principles and fundamentals of ergonomics. While most workers understood their purpose and job expectation, none of them understood how factors such as safety procedures, operational performance, and employee best practices fitted into the bigger picture of the organisation.

Departments working in isolation can also be a major barrier to organisational effectiveness. Another finding was that the older members of the work force, those older than thirty-six years, had little knowledge of ergonomic interventions. It was also found that the use of computers was restricted to a few employees. The idea of automating processes to make job tasks much easier would not be an easy fix, as the gap between technology and business operations in industrial developing countries is still a major problem that needs to be addressed.

The correlation analysis of ergonomic factors highlighted the interdependence of key factors that should be taken into consideration when designing scientific ergonomic programs to improve organisational performance. Kaizen improvements on factors related to design of tasks and jobs may also positively influence anthropometric and physiological factors indirectly. Additionally, any efforts in improving illumination would also positively influence human–computer interaction. Given that weak positive correlations were noted between illumination, noise, and vibration, as well as between the factors related to design of jobs and human–computer interaction, it was also concluded that these factors could be treated independently when designing scientific ergonomic programs.

6.3 Recommendations

6.3.1 Development of an effective ergonomic program

The third objective of the study was to develop and integrate an effective ergonomic program with the current working processes that will contribute to organisational improvement. The implementation of the risk assessment is a vital process that characterised the technical planning process of systems engineering. Risk assessment is described as process of determining the measure and value of risk that is related to a prevailing circumstance and a known threat, which forms a crucial part of known programs (Akinsolu, 2013). The approach of integrating risk assessment with ergonomic programs addresses the existing gaps that were identified in the results and aids to build a sustainable program that is aligned with the needs of the organisation.

To develop an effective ergonomic program that is incorporated with the systems engineering Risk Assessment methodology, several steps had to be completed, a probability of occurrence matrix, ratings of criticality and rating of consequences. The results of these activities will assist in determining the criticality of the ergonomic factors. The problem-solving methods selected to address these factors will be dependent on the criticality rating.

Table 6-1: Risk assessment consequence rating table

Level	Likelihood	Probability of Occurrence
5	Near Certainty	80%< to ≤ 100%
4	Highly Likely	60%< to ≤ 80%
3	Likely	40%< to ≤ 60%
2	Low likelihood	20%< to ≤ 40%
1	Not likely	0% ≤ to ≤ 20%

Table 6-2: Rating of Criticality Table

Rating of Criticality	Levels
Anthropometry Physiological Factors	
Work station design	
Worker postures and movements	
Continuous muscular effort	
Energy consumption for each manual task is limited.	
Factors related to posture	
Height of the work table	
Good seating instructions provided at work	
Accessibility of work station items	
Factors related to the design of tasks and jobs	
The job consists of more than one task	
Communication between workers	
Skill level of people.	
Factors related to Information tasks	
Information presentation	
Information is easy to interpret	
Diagrams are easy to understand.	
Human-computer interaction	
Touch screens are used to facilitate operation	
There are concerns relating to computer interaction that	
Illumination	
The light sources are properly screened.	
The lighting has negative implications for my sight.	
Noise and vibration	
The sources of uncomfortable and damaging body vibration are recognised.	
The Noise has a negative impact on my performance.	

Table 6-1 displays a risk assessment consequence rating table. Each level had to be categorised with the range of probability. Level 1 is not likely to occur and falls in the probability of occurrence range between 1% and 20%, and Level 2 indicates a low likelihood and falls in the probability of occurrence range between 20% and 40%. Level 3 is likely to occur and falls in the probability of occurrence range between 40% and 60%, Level 4 is highly likely to occur and falls in the probability of occurrence range between 60% and 80% and Level 5 has a high probability of occurring and falls in the probability of occurrence range of 80% to 100%.

Table 6-3 displays the rating of criticality that is completed using the ratings from the risk assessment consequence rating table in Table 6-1.

Table 6-3: Rating of Consequence Table

Rating of consequences	Performance	Cost	Quality
1	no effect	no effect	no effect
2	moderate effect	moderate effect	moderate effect
3	effects displayed	effects displayed	effects displayed
4	significant effect	significant effect	significant effect
5	extreme effects	extreme effects	extreme effects

Table 6.3 displays the rating of the consequences table. A risk consequence is known to be measured as a deviation against the program's performance, schedule, or cost (Vesonder *et al.,* 2018).

Figure 6-2 indicates the severity and urgency of the outcome deduced from the criticality and consequence tables. The results from the risk management consequence criteria must be reviewed and addressed according to the priority. High factors must be addressed with urgency, medium factors can be addressed with medium priority and low factors can be addressed with a lower priority.

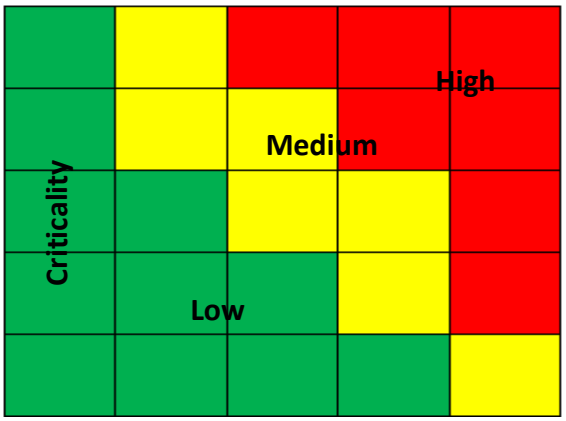

Figure 6-2: Criticality Matrix

The combination of all activities forms a program that will entail a criticality analysis related to ergonomic factors, such as the example below:

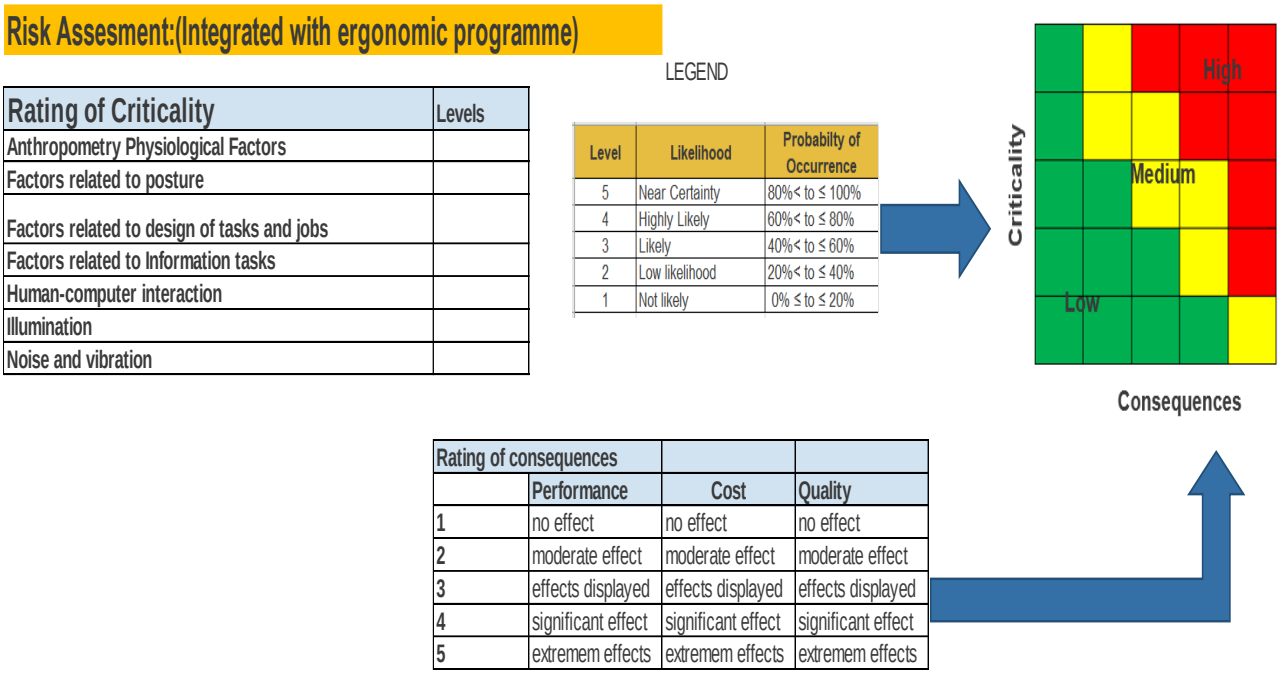

Figure 6-3: Risk Assessment integrated with ergonomic program

Figure 6-3 illustrates how both processes can be integrated as an intervention to identify current gaps that impede performance and growth opportunities. Risk assessment tools highlight ways of working preventively and improve the work environment (Nord Nilsson and Vänje, 2018). The procedure of the program will entail a criticality analysis related to ergonomic factors. The levels of criticality will be scored by a matrix and the 'rating of consequences' table. The result of the assessment will

then identify the priority of the ergonomic factors. Based on the priority scale (low, medium, high), action plans can be developed to resolve the current pain points that impede organisational performance. The action plans can vary from the implementation of ergonomic checkpoints to failure mode analysis tools. The problem factors identified in the adopted ergonomic program in Figure 6-3 must be resolved using effective problem-solving techniques in order to prevent consequential events. Some mitigation options for problem areas identified in the ergonomic program in Figure 6-3 can include ignoring the issue of accepting the consequences without further action if deduced as a low severity on the risk management criteria. However, outcomes that are classified in the medium and high scale of the risk management criteria must be addressed using problem-solving methods and addressed during the feedback meetings.

Results that are categorised in the medium severity on the ergonomic program in Figure 6-3, will be addressed using ergonomic checkpoints (Appendix I) adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association. These templates were selected for the study as they displayed practical and low-cost solutions to ergonomic problems and addressed all relevant factors in the packaging plant.

The ergonomic manual checkpoints address materials storage and handling, hand tools, workstation design, participatory training, workplace safety and premises. These checklists (Appendix I) can be used as a guideline when resolving medium severity problem areas. Results that were categorised in the high severity scale of the risk management criteria should be addressed with urgency using effective problem-solving tools.

6.4 Limitations of the Research

Due to the tight time constraints and the effect of the Covid pandemic the outcome of the Scientific Ergonomic Program implemented could not be studied to draw conclusions on its effectiveness. The complexity of the topic was evident due to the background knowledge in ergonomics and the nature of the participants job title. If timing had not been a challenge the questionnaire would have also been rolled out to

the other departments within the organisation and not only Engineering and Production.

6.5 Future Research

Ergonomics in the manufacturing sector especially packaging will continue to evolve and expand onto other subjects. The following are a few areas for future research.

a) How can other industries apply the Ergonomic Program proposed in this study?

b) What additional tools or system engineering principles can be applied to ensure effective implementation of ergonomics programs?

c) How will the new culture of working from home influence the ergonomic elements that affect organisations performance?

6.6 Conclusion

The first objective of the study was to assess employees' perception of the current ergonomics scenario of the packaging firms. This objective was achieved, the findings on the anthropometric and physiological factors revealed that the employees at the packaging sites were generally satisfied with the workstation design. The research findings revealed that the staff is satisfied with the worktable design and there were good seating instructions provided at work. Concerning factors related to design of tasks and jobs, respondents' jobs consist of more than one task, tasks involved problem-solving, and the respondents were satisfied with the communication channels implemented at the site. The findings on the factors related to information tasks revealed that the information presented was found to simple and easily understood and the method of displaying information selected is appropriate.

The findings on the factors related to human-computer interaction showed that the numerical keypad is logical for most of the employees where computer interaction is required. However, the findings on the factors related to illumination also revealed that the light reflections, shadows, or flicker from the fluorescent tubes could be prevented and the lighting had no negative implications for the workers' sight. Additionally, a high percentage of the respondents also disapproved of the current lighting conditions which need to be addressed to prevent any risk of injury or poor performance related to lighting and illumination. The findings also demonstrated that there was a need for

an improvement plan concerning noise and vibration at the Cape Town and Durban sites.

The second objective of the study was to determine the current ergonomics gaps and condition of the packaging firms. This objective was also achieved, it was found that there is a huge gap in knowledge about the basic principles and fundamentals of ergonomics. While most workers understood their purpose and job expectation, none of them understood how factors such as safety procedures, operational performance, and employee best practices fitted into the bigger picture of the organisation.

The third objective of the study was to develop and integrate an effective ergonomic program with the current working processes that will contribute to organisational improvement. This objective was also achieved, an effective ergonomic program that incorporated systems engineering risk assessment methodology, was developed, embracing a probability of occurrence matrix, ratings of criticality and rating of consequences.

From the findings and results identified in this research, it is evident that the value of ergonomics extends beyond health and safety. Ergonomic programs help organisations to achieve high performance through holistic measures. While research in the packaging sector is limited, the existing literature highlights the value and benefits that ergonomics interventions have in the manufacturing industry. Holistically, a lot more can be done in the field of ergonomics in the packaging sector; it is thus important that organisations foster a culture that aligns their operational processes with ergonomic best practices.

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APPENDICES

Appendix A: Certificate of completion

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Riashna Roopnarain** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/25/2017.

Certification Number: 2355086.

Appendix B: Ethics clearance letter – IREC 105/17

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

28 August 2017

Ms R Roopnarain
32 Wren Street
Kharwastan
Durban
4092

Dear Ms Roopnarain

ACKNOWLEDGEMENT OF RECEIPT OF APPLICATION FOR ETHICAL APPROVAL

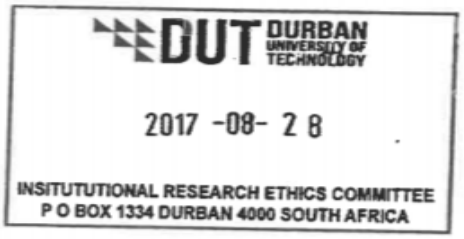
Title: Optimization of organizational performance through exploitation of scientific ergonomic programs.
Reference Number: REC 105/17

The Institutional Research Ethics Committee wish to acknowledge receipt of your research proposal received on 24 August 2017 which is to be reviewed via the expedited process.

A reference number has been assigned to your proposal. You are required to quote this number for all queries relating to the study.

Yours Sincerely

Professor J K Adam
Chairperson: IREC



Appendix C: Letter of consent by the organisation

NAMPAK RIGIDS
FULHAM HOUSE
HAMPTON OFFICE PARK
20 GEORGIAN CRESCENT EAST
BRYANSTON, SANDTON, 2191
SOUTH AFRICA
TEL: +27 (0) 11 719 6300
WEBSITE: www.nampak.com

SITE APPROVAL LETTER

Nampak Liquid

Epping

Cape Town

7460

Subject: **Letter of consent for Research to be conducted**

To whom it may concern:

This letter acknowledges that I have received and reviewed a request by Riashna Roopnarain to conduct a research project entitled "Use of scientific ergonomic programme's to improve organisational performance" at Nampak liquid and I approve of this research to be conducted at our facility.

Sincerely,

Franswyn Smith

Technical Manager

Franswyn.Smith@nampak.com

Appendix D: Editors Certificate

MKMoyoh Editing Solutions
Email: mikemoyoh@gmail.com Cell :083 680 7348

Editor's certificate

30 April 2021

REF: To whom it may concern

This letter serves to confirm that MKMoyoh Editing Solutions have edited the dissertation entitled "Use of Scientific Ergonomic Programs to Improve Organisational Performance"

By

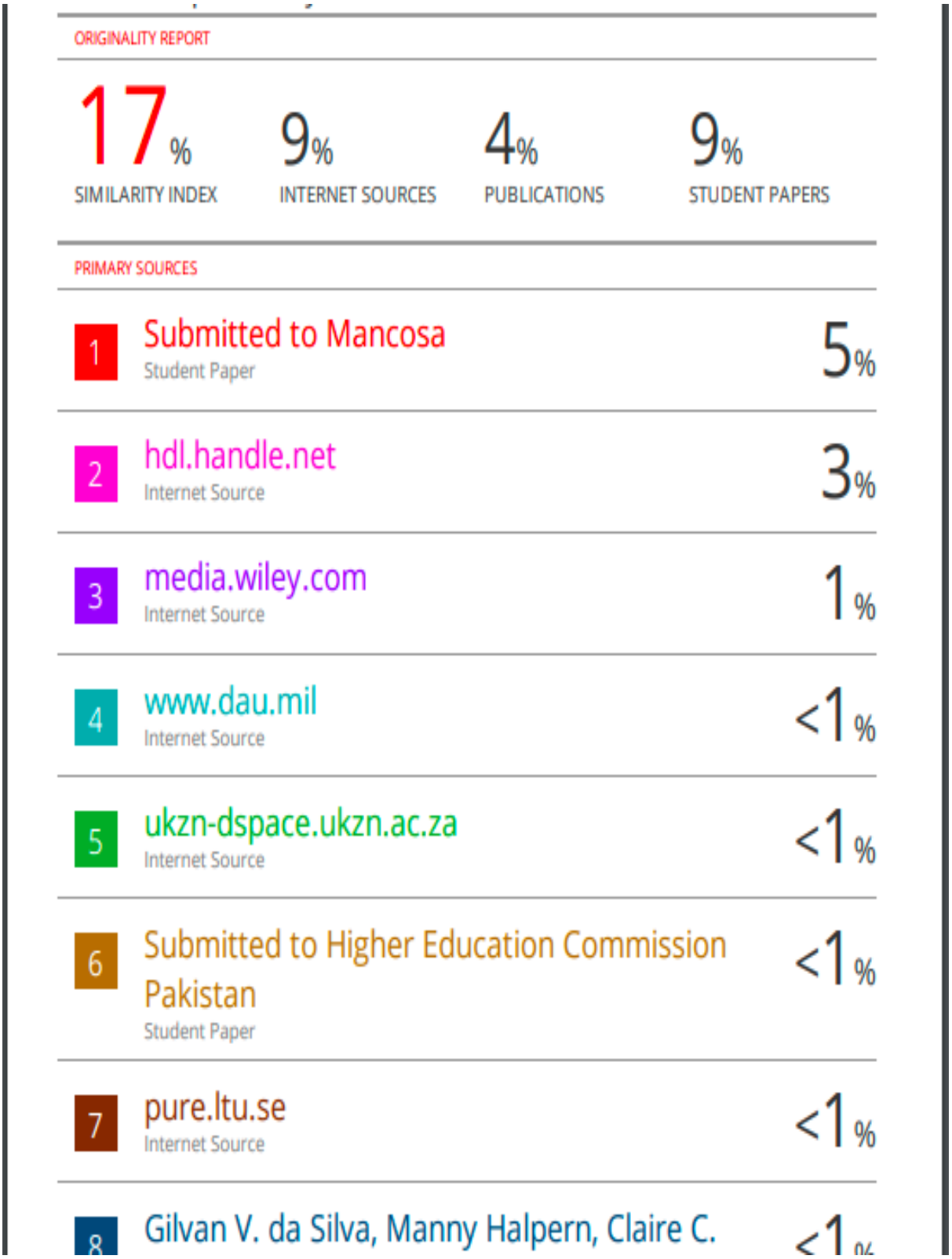
Riashna Roopnarain

We guarantee that the work has been edited to the best of our abilities and if you have any queries, please do not hesitate to contact us.

Regards

Mike Moyoh
(email: mikemoyoh@gmail.com)

Appendix E: Turnitin report for plagiarism



ORIGINALITY REPORT

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PRIMARY SOURCES

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Appendix F: Letter of Information

LETTER OF INFORMATION

Title of Research: Use Of Scientific Ergonomic Programs To Improve Organisational Performance

Principal Investigator/s/researcher: Riashna Roopnarain, (BTech) degree Industrial Engineering

Supervisor: Prof KR Ramdass (D.Phil Engineering Management)

Co-Supervisor: Mr. Mendon Dewa (MSc Manufacturing Systems and Operations Management; B.Eng. Industrial Eng.**)**

Invitation to participate in research

You are kindly invited to voluntarily participate in this research project. The purpose of this research is to investigate ergonomic programs which can be used to improve organisational performance at Nampak Liquids. The purpose of this letter is to give you the information you need to make an informed decision about whether or not you would like to participate. It is important that you understand what the research entails. Please take the time to read this carefully and ask questions if anything is unclear. You will be given a copy of this Letter of Information and Consent Form once it has been signed

Brief Introduction and Purpose of the Study:

The aim of the study is to determine the effect scientific ergonomic programs have on Nampak's Liquid overall performance by incorporating and aligning these programs with an organisations business strategy.

Research Objectives:

- To determining the impact scientific ergonomic programs, have on business employee performance.
- To identify and measure improvements through the implementation of ergonomic programs
- To ensure sustainability in the organisation's performance

Number of subjects participating:

The study will involve 100 people from the Nampak Liquid sites based in Cape Town, Port Elizabeth and Johannesburg.

Eligibility

The study is an option for all employees of Nampak Liquids that belong in the engineering and production department.

Procedure

All participants will be required to complete a questionnaire which will be handed out on site. Each questionnaire will take approximately 15minutes to complete. Participants will also be required to partake in an interview which will be based on random selection. All interviews will be conducted on site and will take a total of 30 minutes. If you are participating in this research, a copy of the Letter of Information and Consent will be given to you once you have signed it.

Risks or Discomforts to the Participant: The procedures and methods followed in conducting this research aims to have minimum risks to participants. Should you feel uncomfortable in answering certain questions in the questionnaire or interview you are free to not answer the questions you do not like during the interview, and to give only as much information as you are comfortable giving during the study interview.

Benefits: Your participation in this research will lead to improvements on site that will improve the current working conditions which will help employees to work at their optimum.

Right to withdraw from the Study: Participation in this study is voluntary. You may refuse to participate or answer any questions or withdraw from the study at any given time with no adverse consequences. You do not waive any legal rights by signing the consent form.

Remuneration: There will be no type of monetary remuneration should you participate in the questionnaire. Your input in this research will contribute to creating a working environment that is productive, efficient and comfortable for employees working in the production and engineering department of Nampak Liquids.

Costs of the Study: Participants will not be subjected to any costs related to this study.

Confidentiality: Any information that is collected about you during the study will be kept strictly confidential. If the results of the study are published, your name will not be used and no information that identifies you will be released. Your research records will be stored in a locked filing cabinet in a secure office and will be saved digitally with encryption.

Research-related Injury: In the unlikely event that you suffer an injury during participation in this study, appropriate care will be arranged for you by the researcher.

Persons to Contact in the Event of Any Problems or Queries:

Please contact the researcher Riashna Roopnarain on 0721969537, my supervisor Dr KR Ramdass (0824173545.) or Co-supervisor Mr. Mendon Dewa on 0716242785. T

The Institutional Research Ethics Administrator on 031 373 2375.

Complaints can be reported to the Director: Research and Postgraduate Support, Prof S Moyo on 031 373 2577 or moyos@dut.ac.za

Appendix G: Letter of Consent

Statement of Agreement to Participate in the Research Study:

(name of hereby confirm that I have been informed by the researcher, _____ about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,

- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature/Right Thumbprint**

I, _____ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.
informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**
_____	_____	_____

Durban University of Technology

5tH February 2019

Dear Sir/Madam

I trust you are keeping well.

I am a student of the Durban University of Technology pursuing a Master's degree in Industrial Engineering.

I am writing to you requesting your participation in a research survey. The aim of the research is to investigate ergonomic programs which can be used to improve organisational performance.

I humbly request your participation in the research as your current position in the company meets the criteria for the research survey. All that is required is for you to fill in the attached questionnaire and which should take approximately 15 minutes of your time.

If you agree to participate in this survey, please fill in the questionnaire and return to the Technical Manager. All information will remain strictly confidential.

If you require additional information or have further questions, please feel free to contact me.

Yours sincerely,

Riashna Roopnarain

[Cell: 0721969537 / email: riashna.r@gmail.com]

Supervisor: Prof Kemlall Ramdass

[Cell: 0824173545 / email: ramdakr@unisa.ac.za]

Appendix H: Questionnaire

SECTION A: DEMOGRAPHICS

OCCUPATION				
HEIGHT				
AGE (mark with an X)	20-25 years	26-35years	36-45years	>46years
WORKING PERIOD (mark with an X)	< 1-2 years	2-5 years	6-10years	>10 years
GENDER	**Female**		**Male**	

SECTION B: ERGONOMICAL FACTORS

This section aims to determine the current ergonomic conditions of the working environment and how it affects organisational overall performance. Please respond to the following statements by marking your preferred option with an ***X.***

	QUESTIONS	Strongly	Agree	Neutral	Disagree	Strongly	Comments
Anthropometric & Physiological Factors							
1	The work stations are designed in a way that allows you to work effectively.						
2	There are sudden movements and force exertion present in my daily task activities.						
3	There is a variation in worker postures and movements.						

4	The duration of any continuous muscular effort is limited.						
5	The breaks are of sufficient length and spread over the duration of the task.						
6	The energy consumption for each manual task is limited.						
Factors related to Posture							
7	The height of the work table is adjustable.						
8	There are good seating instructions provided at work.						
9	I often find it difficult to reach items around my work station.						
10	Sitting/Standing is often alternated with Standing/Sitting and walking.						
11	The current seating design prevents me from working effectively.						
12	The job consists of more than one task.						
13	The tasks performed contribute to problem solving.						
14	There are sufficient possibilities for communication between workers.						
15	Workers can decide independently on how the tasks are carried out.						

16	My job allows me to take part in management decisions.						
17	There is sufficient information provided to control the assigned tasks.						
18	Tasks are deployed to the correct skill level of people.						
Factors Related to Information Tasks							
19	The information presentation is as simple as possible and easily understood.						
20	Information is easy to interpret.						
21	The method of displaying information selected is appropriate.						
22	Diagrams are easy to understand.						
Human–Computer Interaction							
24	Touch screens are used to facilitate operation by inexperienced users.						
25	The numerical keypad layout is logical.						
26	The QWERTY layout selected for the keyboard is used.						
28	There are concerns relating to computer interaction that affects my job.						

Illumination							
29	The light intensity for normal activities is in the range of 200–800 lux.						
31	Information is easily legible.						
32	Ambient lighting is combined with localized lighting.						
33	The light sources are properly screened.						
34	The light reflections, shadows, or flicker from the fluorescent tubes can be prevented.						
35	The lighting has negative implications to my sight.						
36	My vision has deteriorated since the start of my job.						
Noise and Vibration							
37	There is an adequate separation between workers and source of noise.						
38	The sources of uncomfortable and damaging body vibration is recognised.						
40	Acoustic screens are used.						
41	The Noise has a negative impact on my performance.						

Additional Comments:

Appendix I: Ergonomic Checkpoints

ERGONOMIC CHECKPOINTS

Adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association.

1. Materials storage and handling

1. Clear and mark transport routes. Do you propose action?					
NO		YES		PRIORITY	
Comments					

2. Keep aisles and corridors wide enough to allow two-way transport. Do you propose action?					
NO		YES		PRIORITY	
Comments					

3. Make the surface of transport routes even, not slippery, and without obstacles. Do you propose action?					
NO		YES		PRIORITY	
Comments					

4. Provide ramps with a small inclination instead of small stairways or sudden height differences within the workplace. Do you propose action?					
NO		YES		PRIORITY	
Comments					

5. Improve the layout of the work area so that the need to move materials is minimized. Do you propose action?					
NO		YES		PRIORITY	
Comments					

6. Use carts, hand-trucks and other wheeled devices, or rollers, when moving materials. Do you propose action?					
NO		YES		PRIORITY	
Comments					

7. Use mobile storage racks to avoid unnecessary loading and unloading. Do you propose action?						
NO		YES		PRIORITY		
Comments						

8. Use multi-level shelves or racks near the work area in order to minimize manual transport of materials. Do you propose action?						
NO		YES		PRIORITY		
Comments						

9. Use mechanical devices for lifting, lowering and moving heavy materials. Do you propose action?						
NO		YES		PRIORITY		
Comments						

10. Reduce manual handling of materials by using conveyers, hoists and other mechanical means of transport. Do you propose action?						
NO		YES		PRIORITY		
Comments						

11. Instead of carrying heavy weights, divide them into smaller lightweight packages, containers or trays. Do you propose action?						
NO		YES		PRIORITY		
Comments						

12. Provide handholds, grips or good holding points for all packages and containers. Do you propose action?						
NO		YES		PRIORITY		
Comments						

13. Move materials horizontally at the same working height. Do you propose action?						
NO		YES		PRIORITY		
Comments						

14. Eliminate tasks that require bending or twisting while handling materials. Do you propose action?						
NO		YES		PRIORITY		
Comments						

15. Keep objects close to the body when manually handling materials. Do you propose action?						
NO		YES		PRIORITY		
Comments						

ERGONOMIC CHECKPOINTS

Adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association.

2. Hand Tools

1. Select tools designed for the specific task requirements. Do you propose action?					
NO		YES		PRIORITY	
Comments					

2. Provide safe power tools and make sure that safety guards are used. Do you propose action?					
NO		YES		PRIORITY	
Comments					

3. Use hanging tools for operations repeated in the same place. Do you propose action?					
NO		YES		PRIORITY	
Comments					

4. Use vices and clamps to hold materials or work items. Do you propose action? Do you propose action?					
NO		YES		PRIORITY	
Comments					

5. Provide hand support when using precision tools. Do you propose action? Do you propose action?					
NO		YES		PRIORITY	
Comments					

6. Minimize the weight of tools (except for striking tools). Do you propose action?					
NO		YES		PRIORITY	
Comments					

7. For hand tools, provide the tool with a grip of the proper thickness, length, shape and size for easy handling. Do you propose action?					
NO		YES		PRIORITY	
Comments					

8. Provide hand tools with grips that have adequate friction or with guards or stoppers to avoid slips and pinches. Do you propose action?					
NO		YES		PRIORITY	
Comments					

9. Provide tools with proper insulation to avoid burns and electric shocks. Do you propose action? Do you propose action?					
NO		YES		PRIORITY	
Comments					

10. Minimize vibration and noise of hand tools. Do you propose action?					
NO		YES		PRIORITY	
Comments					

11. Inspect and maintain hand tools regularly. Do you propose action?					
NO		YES		PRIORITY	
Comments					

12. Train workers before allowing them to use power tools. Do you propose action?					
NO		YES		PRIORITY	
Comments					

13. Provide enough space for stable postures and stable footing during power tool operation Do you propose action?					
NO		YES		PRIORITY	
Comments					

ERGONOMIC CHECKPOINTS

Adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association.

3. Machine Safety

1. Design controls to prevent unintentional operation. Do you propose action?					
NO		YES		PRIORITY	
Comments					

2. Make emergency controls clearly visible and easily accessible from the natural position of the operator. Do you propose action?					
NO		YES		PRIORITY	
Comments					

3. Make different controls easy to distinguish from each other.

Do you propose action?

NO		YES		PRIORITY	

Comments

4. Make sure that the worker can see and reach all controls comfortably.
Do you propose action?

Do you propose action?

NO		YES		PRIORITY	

Comments

5. Locate controls in sequence of operation.

Do you propose action?

NO		YES		PRIORITY	

Comments

6. Use natural expectations for control movements.
Do you propose action?

NO		YES		PRIORITY	

Comments

7. Limit the number of foot pedals and, if used, make them easy to operate.
Do you propose action?

NO		YES		PRIORITY	

Comments

8. Make displays and signals easy to distinguish from each other and easy to read.

Do you propose action?

NO		YES		PRIORITY	

Comments

9. Use symbols only if they are easily understood by local people.

Do you propose action?

NO		YES		PRIORITY	

Comments

10. Make labels and signs easy to see, easy to read and easy to understand.

Do you propose action?

NO		YES		PRIORITY	

Comments

11. Use warning signs that workers understand easily and correctly.

Do you propose action?

NO		YES		PRIORITY	

Comments

12. Use jigs and fixtures to make machine operation stable, safe and efficient.
Do you propose action?

NO		YES		PRIORITY	

Comments

13. Purchase machines that meet safety criteria. Do you propose action?					
NO		YES		PRIORITY	
Comments					

14. Use feeding and ejection devices to keep the hands away from dangerous parts of machinery. Do you propose action?					
NO		YES		PRIORITY	
Comments					

ERGONOMIC CHECKPOINTS

Adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association.

4. Workstation Design

1. Adjust the working height for each worker at elbow level or slightly below it. Do you propose action?					
NO		YES		PRIORITY	
Comments					

2. Make sure that the workplace accommodates the needs of smaller workers. Do you propose action?					
NO		YES		PRIORITY	
Comments					

3. Make sure that the workplace accommodates the needs of taller workers. Do you propose action?					
NO		YES		PRIORITY	
Comments					

4. Place frequently used materials, tools and controls within easy reach. Do you propose action?					
NO		YES		PRIORITY	
Comments					

5. Provide a stable multi-purpose work surface at each workstation. Do you propose action?					
NO		YES		PRIORITY	
Comments					

6. Allow workers to alternate standing and sitting at work as much as possible. Do you propose action?					
NO		YES		PRIORITY	
Comments					

7. Provide standing workers with chairs or stools for occasional sitting. Do you propose action?					
NO		YES		PRIORITY	
Comments					

8. Provide sitting workers with good adjustable chairs with a backrest. Do you propose action?					
NO		YES		PRIORITY	
Comments					

9. Use height-adjusted computer workstations and arrange related computer peripherals within easy reach. Do you propose action?					
NO		YES		PRIORITY	
Comments					

10. Provide eye examinations and proper glasses for workers using a visual display unit (VDU) regularly. Do you propose action?					
NO		YES		PRIORITY	
Comments					

11. Provide a sound and stable footing and sufficient guarding arrangements for work in high places. Do you propose action?					
NO		YES		PRIORITY	
Comments					

12. Increase safety and comfort of driving cabins and seats of vehicles used at the workplace. Do you propose action?					
NO		YES		PRIORITY	
Comments					

ERGONOMIC CHECKPOINTS

Adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association.

5. Lighting

1. Increase the use of daylight and provide an outside view. Do you propose action?					
NO		YES		PRIORITY	
Comments					

2. Use light colours for walls and ceilings when more light is needed. Do you propose action?					
NO		YES		PRIORITY	
Comments					

3. Light up corridors, staircases, ramps and other areas where people may walk or work Do you propose action?						
NO		YES		PRIORITY		
Comments						

4. Light up the work area evenly to minimize changes in Brightness. Do you propose action?						
NO		YES		PRIORITY		
Comments						

5. Provide sufficient lighting for workers so that they can work efficiently and comfortably at all times. Do you propose action?						
NO		YES		PRIORITY		
Comments						

6. Provide local lights for precision or inspection work. Do you propose action?						
NO		YES		PRIORITY		
Comments						

7. Relocate light sources or provide shields to eliminate direct and indirect glare. Do you propose action?						
NO		YES		PRIORITY		
Comments						

8. Choose an appropriate visual task background for tasks requiring close, continuous attention. Do you propose action?						
NO		YES		PRIORITY		
Comments						

9. Clean windows and maintain light sources. Do you propose action?						
NO		YES		PRIORITY		
Comments						

10. Provide sufficient lighting for workers so that they can work efficiently and comfortably at all times. Do you propose action?						
NO		YES		PRIORITY		
Comments						

ERGONOMIC CHECKPOINTS

Adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association.

6. Premises

1.Protect workers from excessive heat.
Do you propose action?

NO		YES		PRIORITY	

Comments

2. Protect workers from cold work environments.

Do you propose action?

NO		YES		PRIORITY	

Comments

3. Isolate or insulate sources of heat or cold.

Do you propose action?

NO		YES		PRIORITY	

Comments

4. Install effective local exhaust systems that allow efficient and safe work.

Do you propose action?

NO		YES		PRIORITY	

Comments

5. Increase the use of natural ventilation when needed to improve the indoor climate

Do you propose action?

NO		YES		PRIORITY	

Comments

6. Use air-conditioning systems to provide an indoor climate conducive to the health and comfort of people.

Do you propose action?

NO		YES		PRIORITY	

Comments

7. Improve and maintain ventilation systems to ensure good workplace air quality.

Do you propose action?

NO		YES		PRIORITY	

Comments

8. Keep the office work area in good order to increase the efficiency and comfort of people using the area.

Do you propose action?

NO		YES		PRIORITY	

Comments

9. Provide enough fire extinguishers within easy reach and be sure that workers know how to use them.

Do you propose action?

NO		YES		PRIORITY	

Comments

10. Recycle wastes to make better use of resources and protect the environment.

Do you propose action?

NO		YES		PRIORITY	

Comments

11. Mark escape routes and keep them clear of obstacles. Do you propose action?					
NO		YES		PRIORITY	
Comments					

12. Establish evacuation plans to ensure safe and rapid egress from the worksite. Do you propose action?					
NO		YES		PRIORITY	
Comments					

ERGONOMIC CHECKPOINTS

Adapted from Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions published by the International Labour Office that is in collaboration with the International Ergonomic Association.

7. Hazardous substances and agents

1. Isolate or cover noisy machines or parts of machines. Do you propose action?					
NO		YES		PRIORITY	
Comments					

2. Maintain tools and machines regularly in order to reduce noise. Do you propose action?					
NO		YES		PRIORITY	
Comments					

3. Make sure that noise does not interfere with verbal communication and auditory signals. Do you propose action?					
NO		YES		PRIORITY	
Comments					

4. Reduce vibration affecting workers in order to improve safety, health and work efficiency. Do you propose action?					
NO		YES		PRIORITY	
Comments					

5. Choose electric hand-held equipment that is well insulated against electric shock and heat. Do you propose action?					
NO		YES		PRIORITY	
Comments					

6. Ensure safe wiring connections for equipment and lights. Do you propose action?					
NO		YES		PRIORITY	
Comments					

7. Label and store properly containers of hazardous chemicals to communicate warnings and to ensure safe handling.

Do you propose action?

NO		YES		PRIORITY	

Comments

8. Protect workers from chemical risks so that they can perform their work safely and efficiently.

Do you propose action?

NO		YES		PRIORITY	

Comments

9. Identify confined spaces requiring entry permits and take adequate control measures to render the space safe for entry and work.

Do you propose action?

NO		YES		PRIORITY	

Comments

10. Protect workers from biological risks by minimizing exposure to biological agents and isolating potentially contaminated areas.

Do you propose action?

NO		YES		PRIORITY	

Comments

Appendix J: Descriptive Statistics

	N		Mean	Median	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
	Valid	Missing							
Occupation	70	0	2.66	2.00	2.327	1.466	0.287	1.077	0.566
Gender	70	0	1.04	1.00	0.204	4.614	0.287	19.853	0.566
Age	69	1	2.88	3.00	0.850	0.078	0.289	-1.302	0.570
Work Experience	70	0	2.86	3.00	0.997	-0.337	0.287	-1.010	0.566
The work stations are designed in a way that allows you to work effectively.	68	2	3.66	4.00	0.956	-1.061	0.291	1.173	0.574
There are sudden movements and force exertion present in my daily task activities.	69	1	3.51	4.00	1.024	-0.486	0.289	-0.733	0.570
There is a variation in worker postures and movements.	69	1	4.04	4.00	0.756	-0.914	0.289	1.341	0.570
The duration of any continuous muscular effort is limited.	70	0	3.67	4.00	0.912	-0.705	0.287	0.237	0.566
The breaks are of sufficient length and spread over the duration of the task.	69	1	Mean:3.62	4.00	1.016	0.736	0.289	0.032	0.570
The energy consumption for each manual task is limited.	67	3	3.52	4.00	0.911	-0.999	0.293	1.092	0.578
The height of the work table is adjustable.	64	6	3.69	4.00	0.852	-0.931	0.299	0.978	0.590
There are good seating instructions provided at work.	68	2	3.21	4.00	1.140	-0.170	0.291	-1.196	0.574

I often find it difficult to reach items around my work station.	69	1	2.94	3.00	1.013	0.294	0.289	-0.920	0.570
Sitting/Standing is often alternated with Standing/Sitting and walking.	70	0	2.89	2.50	1.123	0.294	0.287	-1.131	0.566
The current seating design prevents me from working effectively.	68	2	2.87	2.00	1.064	0.425	0.291	-1.117	0.574
The job consists of more than one task.	69	1	3.93	4.00	1.019	-0.967	0.289	0.274	0.570
The tasks performed contribute to problem solving.	70	0	3.79	4.00	0.991	-1.022	0.287	0.714	0.566
There are sufficient possibilities for communication between workers.	69	1	3.54	4.00	1.051	-0.528	0.289	-0.473	0.570
Workers can decide independently on how the tasks are carried out.	69	1	3.06	3.00	1.162	-0.058	0.289	-0.954	0.570
My job allows me to take part in management decisions.	67	3	2.54	2.00	1.198	0.700	0.293	-0.665	0.578
There is sufficient information provided to control the assigned tasks.	69	1	3.07	3.00	1.048	-0.069	0.289	-1.028	0.570
Tasks are deployed to the correct skill level of people.	69	1	3.36	4.00	1.124	-0.700	0.289	-0.348	0.570
The information presentation is as simple as possible and easily understood.	70	0	3.59	4.00	0.893	-1.210	0.287	0.966	0.566
Information is easy to interpret.	69	1	3.67	4.00	0.816	-0.977	0.289	1.168	0.570
The method of displaying information selected is appropriate.	69	1	3.39	4.00	1.003	-1.132	0.289	0.299	0.570

Diagrams are easy to understand.	69	1	3.23	4.00	1.152	-0.472	0.289	-0.833	0.570
Touch screens are used to facilitate operation by inexperienced users.	23	47	3.30	4.00	0.926	-0.682	0.481	-1.544	0.935
The numerical keypad layout is logical.	22	48	3.55	4.00	0.800	-0.162	0.491	-0.161	0.953
The QWERTY layout selected for the keyboard is used.	18	52	3.50	4.00	0.857	-0.630	0.536	-0.337	1.038
There are concerns relating to computer interaction that affects my job.	21	49	2.76	3.00	0.995	-0.144	0.501	-1.047	0.972
The light intensity for normal activities is in the range of 200–800 lux.	67	3	3.37	4.00	1.099	-0.444	0.293	-0.757	0.578
Information is easily legible.	70	0	3.66	4.00	0.946	-1.050	0.287	1.198	0.566
Ambient lighting is combined with localized lighting.	69	1	3.45	4.00	1.008	-0.567	0.289	-0.063	0.570
The light sources are properly screened.	68	2	3.56	4.00	0.799	-1.193	0.291	0.935	0.574
The light reflections, shadows, or flicker from the fluorescent tubes can be prevented.	69	1	3.61	4.00	0.790	-1.015	0.289	0.190	0.570
The lighting has negative implications to my sight.	70	0	2.59	2.00	0.970	0.730	0.287	-0.387	0.566
My vision has deteriorated since the start of my job.	68	2	2.49	2.00	1.015	0.836	0.291	-0.283	0.574
There is an adequate separation between workers and source of noise.	70	0	3.49	4.00	1.046	-0.704	0.287	-0.253	0.566

The sources of uncomfortable and damaging body vibration is recognised.	62	8	3.31	4.00	1.001	-0.658	0.304	-0.423	0.599
Acoustic screens are used.	69	1	3.26	4.00	1.010	-0.728	0.289	-0.153	0.570
The Noise has a negative impact on my performance.	70	0	2.36	2.00	0.933	0.761	0.287	0.091	0.566

Appendix K: Tests of Normality

	Gender	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
The work stations are designed in a way that allows you to work effectively.	Male	.385	3	.	.750	3	.000
There are sudden movements and force exertion present in my daily task activities.	Male	.385	3	.	.750	3	.000
There is a variation in worker postures and movements.	Male	.	3	.	.	3	.
The duration of any continuous muscular effort is limited.	Male	.385	3	.	.750	3	.000
The breaks are of sufficient length and spread over the duration of the task.	Male	.385	3	.	.750	3	.000
The energy consumption for each manual task is limited.	Male	.385	3	.	.750	3	.000
The height of the work table is adjustable.	Male	.385	3	.	.750	3	.000
There are good seating instructions provided at work.	Male	.253	3	.	.964	3	.637
I often find it difficult to reach items around my work station.	Male	.175	3	.	1.000	3	1.000
Sitting/Standing is often alternated with Standing/Sitting and walking.	Male	.385	3	.	.750	3	.000
The current seating design prevents me from working effectively.	Male	.253	3	.	.964	3	.637
The job consists of more than one task.	Male	.385	3	.	.750	3	.000
The tasks performed contribute to problem solving.	Male	.385	3	.	.750	3	.000
There are sufficient possibilities for communication between workers.	Male	.175	3	.	1.000	3	1.000
Workers can decide independently on how the tasks are carried out.	Male	.385	3	.	.750	3	.000
My job allows me to take part in management decisions.	Male	.253	3	.	.964	3	.637
There is sufficient information provided to control the assigned tasks.	Male	.385	3	.	.750	3	.000
Tasks are deployed to the correct skill level of people.	Male	.385	3	.	.750	3	.000
The information presentation is as simple as possible and easily understood.	Male	.385	3	.	.750	3	.000
Information is easy to interpret.	Male	.385	3	.	.750	3	.000

The method of displaying information selected is appropriate.	Male	.175	3	.	1.000	3	1.000
Diagrams are easy to understand.	Male	.385	3	.	.750	3	.000
Touch screens are used to facilitate operation by inexperienced users.	Male	.385	3	.	.750	3	.000
The numerical keypad layout is logical.	Male	.385	3	.	.750	3	.000
The QWERTY layout selected for the keyboard is used.	Male	.385	3	.	.750	3	.000
There are concerns relating to computer interaction that affects my job.	Male	.385	3	.	.750	3	.000
The light intensity for normal activities is in the range of 200–800 lux.	Male	.175	3	.	1.000	3	1.000
Information is easily legible.	Male	.385	3	.	.750	3	.000
Ambient lighting is combined with localized lighting.	Male	.385	3	.	.750	3	.000
The light sources are properly screened.	Male	.385	3	.	.750	3	.000
The light reflections, shadows, or flicker from the fluorescent tubes can be prevented.	Male	.385	3	.	.750	3	.000
The lighting has negative implications to my sight.	Male	.385	3	.	.750	3	.000
My vision has deteriorated since the start of my job.	Male	.253	3	.	.964	3	.637
There is an adequate separation between workers and source of noise.	Male	.385	3	.	.750	3	.000
The sources of uncomfortable and damaging body vibration is recognized.	Male	.385	3	.	.750	3	.000
Acoustic screens are used.	Male	.385	3	.	.750	3	.000
The Noise has a negative impact on my performance.	Male	.	3	.	.	3	.
a. Lilliefors Significance Correction							