Impact of ergonomically workplace design on productivity

(Case study -Abay Bank S.C)

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ABBREVIATIONS

MSD - Musculoskeletal disorder

ERF - Ergonomics Risk Factors

SPSS - Statistical Package for Social Sciences

HR- Human Resource

ABSTRACT

This thesis is on 'Ergonomics effects and working environment design on counter cage in Abay bank S.C. Currently Abay bank S.C gives a variety of service for its customers, including saving Deposit, Demand Deposit, Fixed Time Deposit, etc.), Loan Account Services, International Banking services and other common services. And it gives special services like it serves the customers till 9:00 PM Monday to Saturday; provides fast and modern banking services; provides consultancy and financial support for entrepreneurs and others are mentioned for a sample.

Abay Bank S.C. increase its day to day services to satisfy its customers.it increases the number of branches to 156 to serve the customers. This will also increase the number of employees also. Furniture's, computers other working facilities are also related to the opening of branches. These facilities are used by the employees as well as the customers.

In order to make the customers satisfy and the employees to give the best services the work station designs have a major effect. According to different researches the best work station design can improve productivity and services.

Abay Bank S.C. is one of the service provider in Ethiopia it should implement the best work station design to the customers and also for the employees. But some of the branches miss this main issue due to several reasons. Then this research focuses on the counter cage area which has great relationship with customers and tellers. The main objective of this research is to assess impact of workplace design on the tellers and design the ergonomically workplace to increase productivity of employee. To achieve this, ergonomically factors affecting tellers are identified to improve workplace design and so productivity.

For this purpose, 49 bank branches of Abay bank in Addis Ababa were selected and studied. This study used both qualitative and quantitative data analysis. Proper sample size was calculated and questionaries' are distributed to the 49 branches. Also measurements are taken from the employees for the analysis. Different analysis tools were used like SPSS, AutoCAD, CATIA, RULA analysis, Microsoft excel, word and others etc. The conclusion from the study was derived; ergonomically factors like lighting, temperature, working furniture, bad working posture, smell and noise has effect on employee's productivity by creating fatigue specially on their shoulder, lower back and mid back. And finally; the new conceptual workplace design is proposed to address those encountered problems.

The contribution of this study is valuable for the branches of Abay Bank S.C. and other banks located all over the country.

1. CHAPTER ONE

INTRODUCTION AND PROBLEM APPROACH

1.1. Introduction

To do a work is a day to day activity for the human being in different way. Although there is different understanding with the meaning of work in researches it can be available in all of the human beings. Some works are paid others are unpaid housework and care work. Without any doubt, work is one of the most important issues for sociology to grapple with. Sociologists have long been concerned about the type of work we do, the conditions under which we perform it, the social relations that both create these conditions and arise from them, etc. (Matthews, 2004).

Work puts a person to use the energies and mentally to a proper way. Otherwise people may face dullness and boredom of life. Idleness is more pain full, disorder, physically unhealthy, mentally unhappy and to have meaning less life. Even the most unpaid, unimportant and unpleasant work is better than no work. But it is important to take the time to consider our options and to evaluate the choices so that we have time to work, time to play and time to make sure our life is as fulfilling as it can be. Working in the office, manufacturing industries, production and others should be performed with giving break and in comfortable way. Otherwise it makes the worker bored in the workplace. The workplace environment is the most critical factor in keeping an employee satisfied in today's business world (Majekodunmi, 2012).

Workplace has its own impact on the workers. It has an impact on the performance, productivity and motivation of work on the workers. Most employees spend at least fifty percent of their lives within indoor environments which influences their cognitive and emotional states, concentration, behavior, actions, abilities and by extension performance. Researches shows that better workplace can make the workers better to concentrate and connect on their work roll. Thus it makes the employees productive and achieves the organizational goals (Madu, 2017).

From the above; properly design of workplace can increase the productivity of the workers. Workplace with good temperature, light, air movement; noise, arrangements of furniture and others has an effect on the productivity. These parameters must be considered before designing the workplace and it can be achieved through the science of ergonomics.

Ergonomics is the science raised from ever present ambition of humans to optimize their efforts in achieving their objectives (Tajana LUŠETIĆ, 2018).

Ergonomic helps for workplace settings including designers, engineers, manufacturers, suppliers, health and safety professionals, employers and employees by considering body posture, movement and environmental factors such as noise, lighting, temperature and others. But the ergonomic factors are not considered while designing the workplace it may has an effect on productivity, efficiency by creating workers in stress, uncomfortable, unhealthy and unsafe condition. For example; the office design affects 58% of variability in employee's productivity in banking organization in Pakistan. (Amjad, 2009). So the impact of ergonomics is clearly seen in their study.

In developing countries, the implementation of ergonomics in the workplace is low rather than developed countries. This is because they are not aware about the benefit derived from ergonomics. Studies in Nigeria in different sector show that the level of the awareness about ergonomics is poor. This study conducted in the transportation, manufacturing educational sectors, construction, trading and banking sectors were analyzed to see the level of awareness (Ismaila, 2010). This can affect the organization as well as the person by itself. Sometimes people may not know even the safety symbols in their workplace. Putting symbols in such a way that peoples can easily understand, will decrease the injuries and illness. For example, peoples in Ghana wrongly interpreted the safety symbols in the culture of ergonomics. Meanings and representation across cultures must be used as a common database of cross-cultural interpretations which should be developed to avoid the wrong interpretation (Essuman-Johnson, 2002). The above studies show the understanding in the interpretation of ergonomics and also the impact is not well known. As ergonomics is one of the tool which can maximize the person Safety and health and for the organization and a country it makes to produce quality products which can have a standard competitor throughout the world.

Countries such as Ethiopia the ergonomics influence didn't give full attention like the above countries. Surveys and researches shows on the ergonomics of Ethiopia stated that the ergonomics should be implemented widely. Even if the awareness is created; the implementation is low. Study in Gondor shows 51.9 % has known about economics and its impact but only 48.1% implementing office ergonomics (TAFESE, 2016). These means the level of understanding ergonomics is not enough and implementing of ergonomics is neglected. Although the impact is through time it can affect the person and the organization as well. Employees will be sick, faced to illness and injuries due to improper workplace design and neglecting the implementation of ergonomics. This will make the employees to resign their work when the worst comes and not capable to do the specific work. For instant research in Diredawa long hour shift and temperature causes the employees work in pain and stress (Balasundaram,

2017). These ergonomic factors consequences the organization to become inefficient in their output. Ergonomics adjustments may not need higher cost but it can put the person in series injuries. Simple arrangements and attention to ergonomics may fix the problems. But identify and analyses the existing arrangement with related to the impact of the ergonomics workplace design should be done.

This research; so that; will show the existing workplace design of the bank in the counter cage area and identifies the ergonomically factors for the existing arrangement. Here by to attain and improve comfortable and satisfactory working area for the tellers. In order to address this; physical observation, questionnaire, measurements and photos will be taken from employees and will be analysis using the SPSS (Statistical Package for Social Sciences).

1.2. Back ground the study

Abay bank is namely by the great Ethiopia's mighty river which has about 4,000 shareholders all over the country. It was licensed by the Central Bank in July 14, 2010 and started the operation November 4, 2010.

It was registering with 157.8 million Br in paid up capital, mobilized from 823 founding shareholders. The major shareholders are Dashen Brewery SC (7.5 million Br), Amhara Water Works Construction Enterprise (7.5 million Br), the Housing Development Agency of the Amhara Regional State (7.5 million Br), the Amhara Design & Supervision Works Enterprise (7.5 million Br), the Amhara Region Urban Development & Construction SC (7.5 million Br), the Gozamen Farmers' Cooperative (2.5 million Br), the Amhara Development Association (4.5 million Br), the Tikur Abay Transport SC (4.5 million Br) and Sebhatu & Sons Property Administration & Security PLC (one million Birr) (ALEMAYEHU, 2013).

The main branch of the bank is located in Addis Ababa around Jomo Kenyata Avenue, around Bambis, in front of NOC Gas Station, Zequala Complex (ALEMAYEHU, 2013). Capital adequacy ratio stands at 37pc, indicating that it is a well-capitalized bank.

It increases day to day services, some of this are; Customer Account Services (Saving, Demand, Fixed Time Deposit, etc.), Loan Account Services, International Banking services, Foreign Exchange Services, Local and international Money transfer services, interest Free Banking Services, Abay Bedeje - Agent Banking Service, Abay Card Banking Services, Abay Mobile Banking Services, Abay Online - Internet Banking Services etc…

But the above services are common in all other banks and what makes special Abay Bank S.C. is; it serves till 9:00 PM Monday to Saturday. It provides consultancy and financial support for entrepreneurs; provides professional advice for clients in order they become successful in their business; Works in partnership with clients on viability of projects and others (ALEMAYEHU, 2013).

Currently the bank increases the number of branches to 183 in different region and places. This makes the number of employees to increase which has a greater impact on reducing the number of non-workers in Ethiopia. As the number of stations increased the working station, equipment's, computers, tables and other equipment's also purchased to support the service. These facilities should be comfortable for both the customers and the workers who really have spent more time in their work. This comfortable working station helps to increase productivity, customer satisfaction, to reduce worker's absenteeism, to minimize stress and at the end it all have a great view for the outside customers and to shine on their quick services by the employees.

1.3. Problem statement

Different researches are identified the ergonomically workplace design has effects on the productivity of the company, on the customer satisfaction, worker's absenteeism and others. For instant; unsafe and poor workplace environment results in significant losses for workers, their families, and national economy (Majekodunmi, 2012). Other researches showed the stress can be occurred due to improper workplace design (Talib, 2011) . In their studies 47.2% of the changes in stress outcomes occurred due to its relationship with body postures and health factors. Also the Labor Department stated that the Hong Kong bank employees are exposed to some significant risk of body injury and ill-health because of different types of workplace design (Department, 2001).

In similar fashion in Ethiopian the branch of banks is increased time to time. Among them Abay Bank S.C is one of the famous banks in Ethiopian which gives different type of service for the customers until 3:00PM. The branch of Abay bank S.C. is also increased to 183 and opened on Addis Ababa and outline regions. While opening one branch; hiring employees is a must to serve peoples on the counter front window. This counter window has to be designed ergonomically to fit the working posture of the employees and customers getting service from the banks. However, the ergonomic consideration has not been considered for bank workplace design as the organizations are looking to the functionality of the bank only. When ergonomics design is considered, the bank obtains more employee satisfaction there by customers. This ergonomically effects impose problems mostly on the workers than the customers'.

While conducting field observation in different branches; it has shown that the chairs for the backrest height is not adjustable to fit the size of the employees, the work surface is not accessible to get components such as printer and money counting machine, there is no proper foot rest to rest their foot when they rise up their chair to fit with the table height; the working light for the branches are too dim and there is reflection from outside and awkward postures. Awkward posture is occurred when any joint of your body bends or twists excessively, outside a comfortable range of motion which is resulting from bending down to work at low level to get printed papers, bending the wrist when keyboarding, reaching overhead to get the information from customer are some of the awkward posture the tellers faced. All of the above issues concern themselves with the reduction or elimination of a class of physical disorders associated with poor ergonomic design known as Musculoskeletal Stress Disorders (MSD's).

Due to the above reasons the employees as well as the company has faced different problems. For example; Customer complaining is increasing because employees are taking too much time to serve, Employees are boring to work in uncomfortable condition, most of the time the employees stand to have rest for more than the needed time so that the effective working hour is minimum (Turnaround time) and absenteeism due to sick leave is increasing. According to the bank; beyond serving the customers, the employees are expected to go to find new customer like building owner, exporters, importers, etc… and discuss with them to work with the bank to increase the financial deposit of the bank as well as productivity. But the yearly company report showed that, the incremental deposit mobilization performance is low and below the planned target calculated as of 31-March-2019 from financial perspective even if the overall performance of the company has increased from the last year from different perspective.

Studies shows that the Sickness absenteeism is a direct impact on the productivity (Rycx, 2018).According to the research it is importance that productivity growth is a well-known major source of sustained and sustainable economic growth. Firms should invest more in developing employee-friendly work environments, since absences due to stress and mental health problems related to work are known to be a major determinant of sickness absenteeism, too.

Therefore; this study will analyses the impact of workplace environment on counter cage areas in Abbey Bank S.C. To address those encountered problems the below research questions are mainly raised to assist this research

1. What is the current state of art of the ergonomics workplace design?
2. What are the Ergonomics Risk Factors (ERF) affecting tellers?
3. How to develop and make bank workplace comfortable?

1.4. Objective of the study

1.4.1 General objective

The general objective of this research is to assess impact of workplace design on the tellers and improve the ergonomical workplace to increase productivity of employee.

1.4.2 Specific objective

The specific objectives of the project are:

- To identify the current state of art of the ergonomics workplace design
- To identify the ergonomically factors that are affecting the tellers
- To develop workplace design so as to improve those problems encountered

1.5. Scope of the study

The study is to be conducted Abay Bank S.C. as a target in different branches located in Addis Ababa. The research focuses on improving to identify the ergonomically effect of work station areas and design a proper work station.

This research only focuses on faster services and thus on reducing the turnaround time of the services. When identifying the ergonomically effects on the work stations it can be performed in different branches which are found in Addis Ababa. It will have a more in- depth insight could be made to include the most of branches that has a great attention by the managements.

1.6. Significance of the research

This research aims to explain to identify the ergonomically factors affecting tellers, to identify the factors to improve workplace design, design proper work station which is compatible for both the tellers and the customers in order to get more satisfaction. This is done by identifying the factors that influence on the ergonomically factors which leads to MSD's. These factors provide a framework for improvement projects within the Abay Bank S.C. The recommendations and work station design are alternatives based on the factors that form the scientific relevance and aim to eliminate or minimize the MSD's effects on the employees. Reducing MSD's means increase productivity, reduce worker's absenteeism, enhance safety and more customer satisfaction.

Generally, this research study could benefit all employees who are working in the position of tellers in Ethiopia on different branches of Abay Bank S.C.

1.7. Limitation of the study

The main limitation of this research is unavailability of literatures related to the existing workplace design of the bank. The literatures in the banks are mostly has different arrangement and workplace, it is difficult to develop and identify the existing ERF with related to other literatures and also to set as a benchmark. Therefore, the research develops its new design by using only the existing workplace effect.

1.8. Organization of the study

The study is organized in 6 different chapters. The first chapter includes background of the study, states the problem, set out objectives, reveals its limitation, defines the scope, and outlines the organization. The second chapter includes reviewing different articles written on the subject matter. In this chapter various issues that support the study are selected and used. The third chapter includes the methodology of the research. In this section the research design, type of data used and collecting, the analysis mechanism and the population size and reliability of the data are explained. In chapter four, the collected data is presented and analyzed to come up with the factors, affected body parts and awareness level. Also this chapters analyzed the anthropometric data of the tellers for the new work place design. the new proposed workplace design to alleviate the problems is presented in chapter five. This chapter includes the new design pictures and tested on the software. The last chapter, the conclusions, recommendation and future research direction have been presented.

2. CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction of ergonomics effect

Most of the time peoples are spent their time in working area than other places. This working area should be more comfortable, stress free and healthier for the workers. However, if this is not happened it has a great impact on the workers as well as for the organization that employed them. Poor and unsafe workplace environment, result in significant losses for workers, their families, and national economy. (Majekodunmi, 2012) .According to him conductive workplace environment can improve productivity, enhance safety, fewer rejection, lower insurance, increase workers moral and customer satisfaction.

Rather than the above effects unsafe working environment can lead to stress to the employees. Study in the workplace design and stress shows that 47.2% of the changes in stress outcomes at the Workplaces were occurred due to its relationship with body postures and health factors. (Talib, 2011) This study also indicted that working for long hours and the ergonomic work station factors related to body postures lead the employees to depression and stress.

Researches founds in the Hong Kong Association of Banks (Department, 2001) that the employees are exposed to some significant risk of body injury and ill-health. Among their visualization, they found that poor and wandering cable arrangement, position of firefighting equipment's, teller work station arrangement, use of computers and others work environment problems are reviewed., based on the problems they recommended different working measurements, manual handling methods working postures and others.

Based on the above researches the work station environment has a great influence in productivity, safety, customer satisfaction, interest to work, worker's absenteeism, stress and other factors.

Implementing ergonomics is not for a person or the employee only it has the great impact on the companies as well us for the countries. Injuries and illness may happen with different cause but identifying the main cause is the main thing. Especially in the company's, managements and employees should be sitting together and discuss with the factors which can reduce their productivity, comfort, safety, and security. These factors may not be difficult to adjust but low attention and awareness about the ergonomics effect causes the people staying in the pain.

2.2 Definition and terms

Ergonomics has a wide meaning and definition depend on different writers. Below are some of them.

- Ergonomics is a wide-ranging field that seeks to design tools, equipment and tasks to optimize human capabilities (Bashir, 2014).
- Ergonomics is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job. (Zafir Mohamed Makhbul, 2007).
- Ergonomics defined by Fernandez (1995), is the design of the workplace, equipment, machine, tool, product, environment, and system, taking into consideration the human's physical, psychological, biomechanical, and psychological capabilities, and optimizing the effectiveness and productivity of work systems while assuring the safety, health, and well-being of the workers (Zafir Mohamed Makhbul, 2007).
- Ergonomics is an interdisciplinary field of study that seeks to design tools, equipment and tasks to optimize human capabilities. Ergonomics seeks to improve the interrelationship between the human and a system, whether a simple hand tool or an entire production line (MacLeod, 2000).
- Ergonomics mainly can be defined as the relationship between humans, machine systems, job design and the work environment. Generally, the aim of ergonomics is to fit the task to the individual and not the individual to the task (Jaffa, 2011).

From the above meanings Ergonomics is the relationship between the human and its environment which aims to minimize injuries and illness for the person and increase productivity and efficiency by assuring healthy and safety.

Other definitions: -

- **Musculoskeletal disorder (MSD)** is a condition or disorder that involves the muscles, nerves, tendons, ligaments, joints, cartilage, or spinal discs (Jaffa, 2011).
- **Ergonomics Risk Factors (ERF)** is situations that exist or created intentionally or unintentionally that could or might contribute to results contravene or against the principles or philosophy of ergonomics that could or might harmful to the health and well-being of workers or users at work or after work. (Jaffa, 2011).
- **Work stress** is a negative emotional and physiological state that employees suffer from when faced with adverse work conditions beyond their control. (Senik, 2013).
- **Static load: -** static means "not moving," as in stationary which is holding the same position for a period of time (MacLeod, 2000).

- **Anthropometry: -** Anthropometry is the study of the measurement of the human body in terms of the dimensions of bone, muscle, and adipose (fat) tissue (Rockville, 1988).

2.3 Global concern on ergonomics

2.3.1 Ergonomics in the world

Ergonomics should be implemented in every sector, industries and companies as it is the direct relationship with the human. Humans perform their day to day activities with the interaction of human, machines, tools and fixtures. This can affect the health of the humans in a short or long period of time if it is not protected. This can be minimized by implementing the ergonomic work station, proper workplace design and aware peoples to have proper working posture when they are sitting, standing, holding, carrying and other different working activities. Even if most peoples are spending most of their time in their workplaces, ergonomics activities should be applied and considered in their home. While sleeping, cooking, shopping and doing day to day activities proper and recommended movements should give a great attention. Aware peoples about the effect of the ergonomics and its consequence either in home or in the workplace should also teach other peoples. This way can minimize people ill ness, maximize productivity and increase job satisfaction.

A large number of studies are studied on the impact of the ergonomics effect in the productivity, satisfaction, organizational performance and other factors. Every organization which has the proper workplace design can have better productivity. An ergonomically designed working environment can reduce human resource problems, including fatigue, job dissatisfaction and intention to quit (Senik, 2013). This research also implies that 38% of the change in the work stress out comes are due to the factors of ergonomic work station components like human, machine, work area, environmental factors. This indicates that factor of the workplace design has a direct relation to the stress.

Proper work design in the organization can minimize the work stress. The independent variable in the workplace like chair, lightning, humidity and others can affect the work stress in the employees. Research in one of multinational electronic company in Malaysia shows that 62.9% stress outcomes is accounted by the above independent variables (Zafir Mohamed Makhbul, 2007).

2.3.2 Ergonomics in Africa

Even if ergonomics is involved in different sectors in the world; countries in Africa, it is not widely used and aware to use ergonomically design of work station. The awareness about the ergonomics is not developing well in different sectors. For instant; Study in Ghana was done by interpretation of traditional symbols which can relate to the ergonomics. The participants are from police officer,

manufacturing industries, farming implements company and trade workers. In this study, most of the peoples have wrongly interpretation with the cultural ergonomics symbols. This implies that quantitatively and qualitatively capture meanings and representations across cultures must be used. A common database of cross-cultural interpretations should be developed to avoid the wrong interpretation. This study in Ghana shows that most peoples are not aware about ergonomics (Essuman-Johnson, 2002).

A Study on Ergonomics Awareness in Nigeria where studied to know the awareness level of the employees in different areas like transportation business, manufacturing, educational sector, medical profession, construction companies, banking sector and petty trading and other sectors. From the research output, it concludes that awareness about the ergonomics is poor. This is because most of the people don't know about the benefit of derivable from ergonomics (Ismaila, 2010) .

Therefore, it should be improved the view of the ergonomics in Africa. Teaching the peoples about the benefit of using ergonomics and showing them the consequence and effects if not used; can improve the awareness. Researches, studies, case studies should be encouraged to show the effect. Designing the work station by considering the ergonomics factors can improve employee's satisfaction, customer satisfaction as well as the people in the country.

When designing an organization; suitable work station and equipment design must be considered. This design contributes to the employee's satisfaction. Better lighting, easy to access working tools, temperature and other factors can affect the working posture of the employees. The study in the Federal and State University Libraries in Southern Nigeria has found the work station and equipment design is affect the job satisfaction which is directly affects organizational behavior and achievement of organizational goal (Ikonne, 2014).

2.3.3 Ethiopian ergonomics concern

Different type of ergonomic researches has been done in Ethiopia on different sectors. Among them on the rail, on the buses, textile Company, in several working areas to identify the effect of ergonomics with related to identify the improvement, culture, level of knowhow, productivity, stress and others.

Most researches show that the culture using ergonomics is not widely used and has a negative consequence. Using reliable machine, adjusting temperature, controlling light, proper sitting chair, working table, and other working tool and atmosphere must be considered in a working area. Some times with simple adjustments of working tool it may prevent the effect of MSDs. For example, keeping the distance of objects that are placed above our head, adjusting the height of our chair to fit to the tool

that we used, keeping near to us for the objects that are frequently used, and other can be a solution for preventing MSDs.

Ergonomics has a relation with comfort, safety and security of people. Since our day to day life safety and security to our life must be stands in the first place. But this can be affected with our unprotected movement and ergonomics design of buses, taxis, cars and others. Especially in the public buses which are modified locally, the safety and security concern is low. The locally modified buses did not consider the standard required for passenger's safety and comfort. The modified buses in Ethiopia generate heats, didn't fit for the passengers, haven't enough space, with hazards like sharp edges. Additionally, 60% the seats are not comfortable and 65% are not standard (Dengiso, 2017) .Beyond that it is not comprehends all segments of the population like aged, children, disabled and people with limited mobility. One of the ergonomics goal is to reduce injuries and illness that are caused by over use of muscle and bad posture this kind of public usage buses must be deigned integrated with the user, the bus interior and the bus to full fill at least minimum standard of ergonomics like comfort, safety, ease of use.

Other studies recommended adjusting machineries and temperature if there is an effect in the employees. For example, study in Dire Dawa textile factory which has target to find out the ergonomic problems that affect employees. This research will conduct questionnaire for employees and it founds that Long hour shift will cause back pain and other health issues. The main cause for the healthy issue is temperature and heat in the company which has consequence of stress in the employees. So, this research recommends using reliable machine and controlling the temperature so that it can reduce the pain on the employees (Balasundaram, 2017).

Sometimes awareness only has no effect to change the cause of ergonomics, implementing ergonomics must be considered. Case study on secretaries and data processing workers in Gondor University, Northwest of Ethiopia shows that the means of knowledge and implementing office ergonomics has 51.9% and 48.1% respectively (TAFESE, 2016). This research describes that the knowledge in the computer ergonomics is good but the implementation is poor. It recommends improving the knowledge with different Medias and university should design the ergonomics work station. Additionally, it recommends to improve the ergonomics knowledge with update technologies and to practice it.

So, ergonomics awareness in Ethiopia should be increase and implementing ergonomics is the main thing to reduce the caused by poor ergonomics. Using Medias, different technologies, studied in the college and universities can increase the awareness of ergonomics. Thus, by implementing it minimizing the effects and keep in health. As seen before productivity of the company, quality, cost

and also employee satisfaction has relation with the ergonomics, it should be encouraged to aware all the employees and managements and also implement to use ergonomics in every sector to increase the company's market share as well as to increase the country economy.

2.4 Principles of ergonomics

There are 10 basis principles of ergonomics according to the ergonomics manual. (MacLeod, 2000)

No 1 Principle - Work in Neutral Postures

Working in neutral postures means that keeping the muscle joints in equally balanced way. This way can minimize the stress on the joints and tissues, keep with the most strength and best controlled movement. Whether we stand or sitting keeping our body in the neutral posture, like maintain the S-curve, keep the neck aligned, the wrists in neutral and others. Moving the tools and equipment's we used towards the body to keep in the neutral posture than moving to the objects.

No 2 Principle - Reduce Excessive Force.

Excessive force can make the injuries on the workers due to excessive load in the muscle and by creating fatigue. This can be minimizing by using tools, machines and by using mechanisms. For example, to using tools to tight bolts rather than tight by hands, lifting and moving heavy objects with conveyers rather than by hands, using the skids to hold the objects can minimize the fatigue on the muscles.

No 3 Principle - Keep Things in Easy Reach

Bend, twist and tension can be caused by placing the objects in the long reached. Keeping the objects near when we using them frequently and far if not used repeatedly. By making our bodies to bend, twist and stretch our work will be more difficult so this principle should be coincided with principle No 1; working in neutral position. Rearranging our tools and equipment's may help us to follow both principles.

No 4 Principle - Work at Proper Heights

Mostly workplaces are designed to fit the medium height and size of the peoples. So, there might be mismatch with the workers and working height. Working in improper height can lead to work in discomfort, fatigue to the muscles, some damages in the soft issues, work on unnecessary force, so that it reduces the ability to perform the job.

No 5 Principle - Reduce Excessive Motions

Repetitive motions can cause tear and wear on the body and also to do unproductive work. Using tools instead of hands can minimize motion. Moving objects as a set or bulk has great advantage than t moving one by one. Because; moving objects as a bulk, reduced excessive motion in our body, minimum production time so that minimum production cost and efficient work.

No 6 Principle - Minimize Fatigue and Static Load

One of the common sources of fatigue called Static load is occurred by holding things in one position without moving for certain time. This can be caused by holding excessive load in one position for long time and even the object is not heavy excessive amount of the time can cause fatigue and pain on the muscles. Resting arms, hand and foots can minimize the fatigue. Reduce force and duration of the task can minimize the load on physical and mental capability of peoples.

No 7 Principle - Minimize Pressure Points

Direct pressure to the body causes contact stress in the body which has an effect on nerve function and blood flow. Contact stresses are defined as impingement or injury by hard, sharp objects, equipment or instruments when grasping, balancing or manipulating. (Jaffa, 2011)To reduce this effect worker who works by standing in the hard floor can use comfortable Anti-fatigue mat or using cushioned insoles or heels cups to reduce the fatigue and tissue damaged on their leg. Contacting body in sharp edges can increase the stress so providing curve edge with cushion can minimize this stress.

No 8 Principle - Provide Clearance

Giving enough clearance in the workplace and easy access to get the objects can reduce accidents in the body. While designing workplace it should be consider the lowest and the highest length, the minimum and maximum size of bodies to fit the work station for all peoples.

No 9 Principle - Move, Exercise and Stretch

Movement, exercise and aerobic activities should be encouraged in every work. Stretching our body on some time interval, changing chair position and using alternate posture prevent fatigue and injuries on workers.

No 10 Principle - Maintain A Comfortable Environment

To perform effective work, we humans should place in the comfortable environment.

Providing appropriate light: - protecting our eyes from reflected light with our working objects.

Eliminate or minimize vibration: - vibration or shocks can cause injuries to person by damaging body organs and sensitive tissues. So, using cushion and vibration dampening can minimize this effect.

Work on medium temperature: - extreme heat and humidity slow the person to perform their work and excessive cold minimize to do effective work.so keeping good temperature in the workplace can reduce discomfort as well as health problems. Using ventilation diffusers or deflectors to circulate the air and add heat shields around heat sources and furnaces to damp the hot temperature are examples to work in good temperature.

Avoiding extreme noise: - to protect the ears from damaged caused by extreme noise. Using mufflers on noisy environment can minimize this kind of damage.

Other effects like colors, toxic chemicals and other factors have to give attention while designing workplace.

2.5 Benefit of ergonomics

Several researches study on ergonomics effect and its benefit by their case study and researches. In this study let's classify the benefits of ergonomics step by step in short.

2.5.1 Ergonomics benefit on person/workers

Ergonomics is available on any movements and activities of human. When we sit, stand, walk, work, and sleep we have to be careful to not injure our bodies. Injuries can happen in any activities and movements if is not protected. Sometimes human bodies are tolerated for some pains but it doesn't mean that they are not affect with series pain after some period of time.

Ergonomics risk factors include working in awkward posture, vibration and force which may come from gripping, lifting, pushing or pulling. The main risk factors such as doing tasks repeatedly with the same muscle, working on extreme hot and cold temperature and in uncomfortable static position or contact stress of muscle will increase the occurrence of injury (Jaffa, 2011).

Sitting and standing with the right position and with right chair can minimize the effect on a body. Keeping the S-curve instead of C-curve can minimize injuries on the west (MacLeod, 2000).

Figure 2.1 Picture of s-curve and c-curve

Walking in the erect position, sleeping with the right pillow which fits with our neck can prevent our body from pain. Holding things from the floor specially twisting motions have a series injury. Tilting our body in some angle is better than creating V-curve. Refer Fig 2.

Doing our day to day activities with the recommended position and fixture can minimize the injuries on a body.

Injury and related problems including the tendons, muscles or nerves which most of the problems may develop to Musculosketal disorders (MSDs).

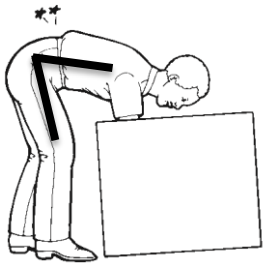


Figure 2.2 Picture of v-curve

Protecting our body from illness indirectly can minimize the cost which can offer for hospital and clinic. A person who can have damaged in a body should go to hospitals in order to relief the pain. This can happen with money. This can increase the cost for a person. But if ergonomics was aware and implemented this will not have happened.

MSDs, or musculoskeletal disorders, are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nervous system. They can affect nearly all tissues, including the nerves and tendon sheaths, and most frequently involve the arms and back. 90% of disabled older workers had MSDs. The treatment of the MSDs problems will cost tens of billions of dollars (Jaffa, 2011)

Therefore; the best prevention method of the MSDs which can benefits the employer and also their workers.

Generally; ergonomics has a great benefit for a person/worker by;

a. Protecting our bodies from injuries and Musculosketal disorders (MSDs).
b. Minimizing the costs for medical treatment

The above are main common advantages of ergonomics listed from the most. This kind of injuries and stress can be minimized and also can make comfortable working environment with the help of ergonomics in such a manner those simple adjustments of tools like tables, chairs, machines and other equipment's are introduces (Senik, 2013).

2.5.2 Ergonomics benefit for the company/ organization

The implementation of ergonomics removes barriers to quality, productivity and safe human performance by fitting products, tasks, and environments to people instead of forcing the person to adapt to the work (Jaffa, 2011).

I. **Productivity: -**Ergonomics and productivity has a direct relationship. Ergonomics risk factors like proper lighting, noise, proper work station design, air quality, temperature and others can affect the productivity of the employees. The more quality production in the company is the more income to the company. The workplace in environment with the workplace ergonomics will improve health and performance of workers and leads to higher organizational productivity (Zafir Mohamed Makhbul, 2007).

   The relationship between the production and ergonomics is revised in the below section widely.

II. **Quality: -**

   a. **Quality life of employees: -** Healthy employees can fully engage in their job. This can give full attention in their job. Attention in their work can give them to do the job in the proper quality by minimizing work mistakes. This can be done when the working environment is free from the risk factors. Long-term exposure to risk factors will reduce the quality of life. Even if any work has its own risks the main issue is to minimize these risks by minimizing MSD and implementing ergonomically design workplace (Jaffa, 2011).

      Employees' quality of life can be made by the workspace in the workplace. The physical environment at work should be such that will better the employees' health. It would come in form of quality of indoor aim (open office place), ergonomic furniture and lighting (Majekodunmi, 2012).

b. Quality product of the company: - Workers who work in poor workstation design expose in stress, strain and overexertion which leads to MSD injuries. These conditions lead to workplace hazards, poor workers' health, disabilities, and reduction of workers' productivity and products' quality (Zafir Mohamed Makhbul, 2007)**.**

Working in improper temperature, vibration and noisy environment too dim or to shine lighting, repetitive motion, adequate ventilation, work on static load and other risk factors increases workers stress and so that the quality in the company product is minimize.so giving better attention while designing these factors has a direct effect on the company product with respect to quality.

III. Cost: - Cost is one of the major requirements for company development. By any means reasonable cost minimization is encouraged in the company because it can affect the profit of the company product. This cost can be increased and decreased with respect to the production of the company. As shown previously and below productivity and ergonomics has a relationship. With comfortable ergonomic workplace environment, the productivity of the company will increase; it means that it has an effect on the company cost. If the Production of the company is decline the cost is increased, it is therefore deterioration in the competitive position of an organization. On the other hand, an improvement in productivity can lead to a decrease in cost and duration of production, an improvement in quality, and therefore a growth in the market share (Bashir, 2014).

With regards to employees; ergonomics has a great roll on the employee's absenteeism and turnover. To minimize this absenteeism and turnover managements should trace the reason behind these factors. Starting from their workplace environment employees may have several factors and reasons. Employees exposed to stress, awkward body posture, too hot or too cold temperature, sitting or standing for long period of time, work on pressure, and work on static load can get into a series injuries and illness which is impossible to do a job. Healthy workers can perform the job properly so that the time cost to perform the given task will be minimized. Here by minimized the overall time cost for the production in the organization.

Beyond that ergonomic workplace environment prevents work related illness, absenteeism and turnover. A well-designed and efficient ventilation system reduces exposure to airborne hazardous substances thereby preventing work-related illness, absenteeism and turnover (Majekodunmi, 2012).

If experienced employees exposed in such kind of series illness it may has a consequence for the absenteeism and forced to resign their work. To replace these experienced workers hiring the new employees will be a must in order to fill the gap. Hiring the new employees will have to be selected, recruited, oriented and trained. In fact, it is estimated that it costs an organization approximately 1½ times the salary of the vacated position to replace an employee (Bashir, 2014) . So, hiring new employees will have additional cost for the organization.

From the above ergonomics workplace design has a great roll in the cost minimization of the organization. Hence managements in the companies should discuss with the employees how to minimize the cost by implementing ergonomically design workplace and also to minimize the MSDS on the workers.

IV. **Employ satisfaction: -**Repetitive illness and series injuries that are caused by awkward motion, fatigue, static load, excessive motion, excessive force and other MSDs effects may happen on the workers. These workers may work with pain which forced them to not engage in their work and much tired to perform their job. This has a consequence on the workers to hate their job and to reduce their interest of work. Beyond that it may lead them to resign the job. An ergonomically designed working environment can reduce human resource problems, including fatigue, job dissatisfaction and intention to quit (Senik, 2013).

Companies having satisfied workers will increase their productivity and cost minimization. Employees with full health can perform their job in best way. Ergonomically design workplace will encourage performing the job in best way which can increase the interest to do the work. These increase the employee's satisfaction. Satisfied employee performs the work with interest so that it can produce the company product with best quality and to use the production time perfectly. Quality and less productive time has a greater role for the company to increase the market share.

2.5.3 Ergonomics benefit for a country

As stated in the above implementing ergonomically design workplace has a benefit for a person and for the company in different ways. Employees working in the ergonomically design workplace reduces injuries and MSDs so that they can work in a very effective way. This will help the company to increase the productivity, quality, employee satisfaction and to minimize the cost of the company. If the company product is increase the market share in the country will also increase. This way companies will have a great competition to produce their product with quality. Competition with the companies in the country helps them to produce their products with a great quality which is in the standard with the global market.

Products produced with standard may have a chance to export to other countries. Export products have benefits like an income for foreign currency, introduction of the country, etc…. for the country.

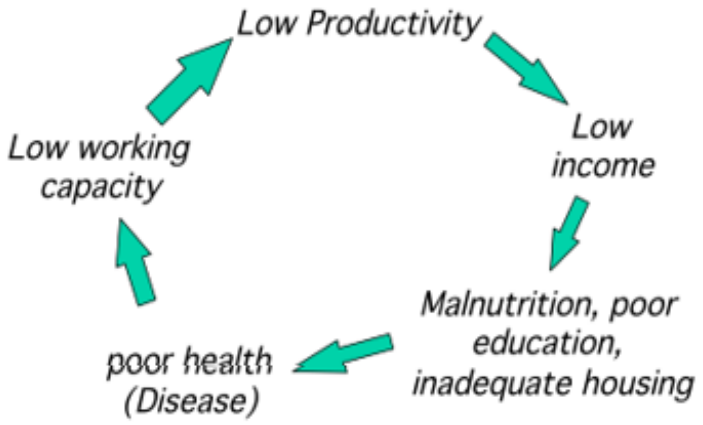


Figure 2.3 Economic cycle of diseases (McNeill, 2008)

2.6 Ergonomic impact on productivity of banks

Productivity is one of the widely-used measuring tools for evaluating and monitoring the performance of the industry as well as the economy of the country (Bashir, 2014) .Most research shows that the increment and decrement of productivity can vary the company performance. Which means the highest productivity can lead to increase the quality, minimize the production time cost and growth in the organization.

Productivity of the company can be affected by different parameters. One of them is the office design in the workplace. Factors like Acoustic, office furniture, humidity, working hour and other factors can reduce the productivity of employees. The office design affects 58% of variability in employee's productivity in banking organization in Pakistan (Amjad, 2009).

Islamic Banks of Karachi; studied on selected variables such as lightening, noise, upshot of color, effect of office equipment, check office furniture & air quality. Up on the finding Office Furniture, Office Equipment and Communication has the negative impact on the employees productivity but all the other variables associated with the office design are not creating any impact on the employees productivity.so this research recommends to work on the above negative factors in this bank (Muhammad Faisal Sultan, 2016) .From this, not all the factors can affect the productivity of the organization. Researches should

be done to identify the exact factors that minimize productivity, job satisfaction and increase the work stress on the employees. Otherwise companies will encounter for additional cost, time and labor.

Workers who work with stress or too high and too cold temperature as well as work on improper work station area can lead them to unable to perform their work. Work stations designs which is not ergonomically fit with the workers can cause different kind of body posture movements such as to extreme extend their hands, awkward postures too short to get the tools and others. These may lead work on the stress, discomfort and finally to minimize their productivity. Especially in the bank sector it should be given more attention because work on this kind of situation has a problem like fatigue, burnout, job dissatisfaction, and intention to quit could be reached. This kind of problems can be corrected by improving the work flow by the managements. Suitable and comfortable arrangements of workstation, sharing long standing hour work can minimize the work stress on the employees.47.2% the change in stress outcome is due to the relationship with body postures and health factors. This especially when the employees are working for long hours other than the normal working hour to complete the given asks (Talib, 2011).

Ergonomics had a sign significant influence on stress due to long working hour, workplace design and the work flow of the company as previously seen. Studies on the Banking Sector in Gujarat founds the stress factor of the employees might result in fatigue and decrease productivity. This negative effect can be minimized by stretching exercise, taking regular breaks, leaving the work station every hour, working foot and body exercise (Revati, 2013).

Proper Lightening also has an effect in productivity. Using proper light, we can prevent our eyes from damage. Viewing things in the proper light uses to measures the length of our body movements with our tools. This can minimize accidents in our body as well as the equipment's we used. Too dim to view things can let the person to not find the things that can be used for their works. This can maximize the period of doing the work. And with excessive light can shine the things to our eyes which have an effect on the sight. This is so directly or indirectly affects the productivity of the work. Better lighting at the workplace will help prevent accidents, help workers improve eye-hand coordination and thereby improve productivity and lower rejection/defective rates. Good workplace environment, absence of noise, good ventilation, proper lighting as well as temperature has an effect on increase the productivity of the workers; there by the customer satisfaction will also increase, enhance safety and fewer rejection (Majekodunmi, 2012).

Study in the Banks and Insurance Companies in Pakistan explains the productivity of employees can be increased by developing working environment. Identifying the factors to develop the workplace

environment can lead to have a positive employee's productivity. Some of these factors are a good relation with coworkers, training and development, attractive & fast incentives and recognition plans and adequate work load are helpful in developing a working environment that can give positive employees' productivity in the organization (Ghafoor, 2015).

Studies on 'Workplace environment and its impact on employee's productivity' is a case study on banks in Raipur to identify how employee's productivity can be increased by developing effective work environment in the organizations. Their study shows that the behavioral factors and relationship with the supervisors has got the first rank to affect the productivity. And the other is comfortable office is much important than the lay out of the design which is affect the physical environmental factor. So, they reach on the conclusion that the overall working environment has an effect to increase the productivity (Lakshmi, 2016).

Even though the communication with the supervisor and workers has the great impact in the productivity; working on the office equipment's and office design should also considered improving the productivity. The human resource and administration managers must also participate in the consideration of the work station design. Including the respective departments can be increase the focus on the designing of comfortable work station as well as to measure the effect. At the end; one of the performance measurement of company can be measured by productivity of the employees, the office design and equipment's should be included in the plan of the administration management and human resource. This can contribute a great influence on the productivity as well as for the growth of the company.

Working environment and environmental variables such as noise, light, temperature and others has a great impact on productivity of an organization. Different researches shows that the effect is in different sectors and can be increased depend on the country, the city, type of work, the arrangement of work station, awareness of ergonomic design and other. Ignorance and neglecting to use ergonomic working station design can decrease the productivity of the company. The impact of proper lightening, noise, upshot of color, effect of office equipment & air quality should be considered in the working station to increase the productivity. Negligence in designing the work station with ergonomically factor consideration will minimize the productivity of employees. Effective use of office furniture, office equipment and communication within the department increase employee's productivity (Muhammad Faisal Sultan, 2016).

2.7 Current world class Sample bank (TD BANK)

A TD bank is head quarter in Toronto, Canada with more than 85,000 employees in office around the world (Fox, 2018). It offers financial products and services to more than 25 million customers in world wide. On the U.S. side it is America's most convenient bank and one of the 10 largest banks in US serving more than 9 million customers from Maine to Florida, with 26,000 employees and a full range of retail, small business and commercial banking products and services. The U.S. headquarters is in Cherry Hill, New Jersey.

Figure 2.4 TD Tower, Toronto, Ontario

According to the TD bank, to become competition for talent from progressive start-ups and technology companies coming into the banking space, so they took a human-focused approach in creating workplaces that offer unique and exceptional experiences for our employees. Workspace is now a distinguishing factor for TD to attract and retain talent.

For the past five or so years the TD employees have been moving away from dedicated desk to shared desks. And currently this also modified beyond desk sharing into more of an activity-based scenario where to provide a mixture of collaborative and focused spaces with in the offices. Employees are forefront for everything the responsible managers and section do with the workspace and understanding their happiness and productivity. They had a lot of discussion with the employees, conducted bench mark researches and also working with furniture manufacturers to customize certain products in order to meet specific focused-work needs.

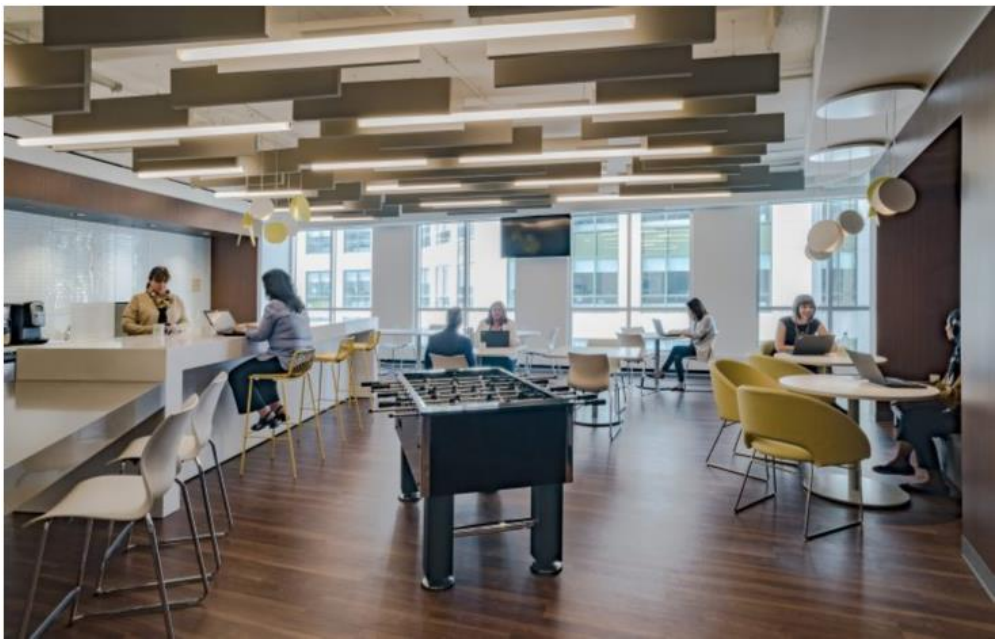


Figure 2.5 TD Bank workplace design

The agile team in TD bank require a lot of physical movement, but when they deployed linear-shaped sit-to-stand desks, the furniture wasn't being moved in some of the environments. This is because of the furniture was designed with right angles and it lined up nicely, so people hesitate to re-arrange it. To move their furniture as the employees' needs they did to install with rounded corner furniture that didn't lined up naturally.

Figure 2.6 Arrangement of TD bank office

The open floors on the TD are now 100 percent hackable, occupants are empowered to physically move desks, tables and other furniture's in order to create the best environment to do their work. Using different type of chairs and tables in the appropriate offices like meeting rooms like casual meeting

rooms with sofas and chairs, sit-to-stand meeting rooms where folks can change their posture and scrum areas without chairs for the teams to hold quick huddle sessions.

Figure 2.7 The overall TD bank view

Designing the premise of flexibility and leveraging demountable products to build rooms wherever they can as things change, they can easily adjust the environment also. The TD bank great attention to employees also it is in process to developing appropriate products for employees like furniture and other things it promotes better change.

2.8 Anthropometry measurement

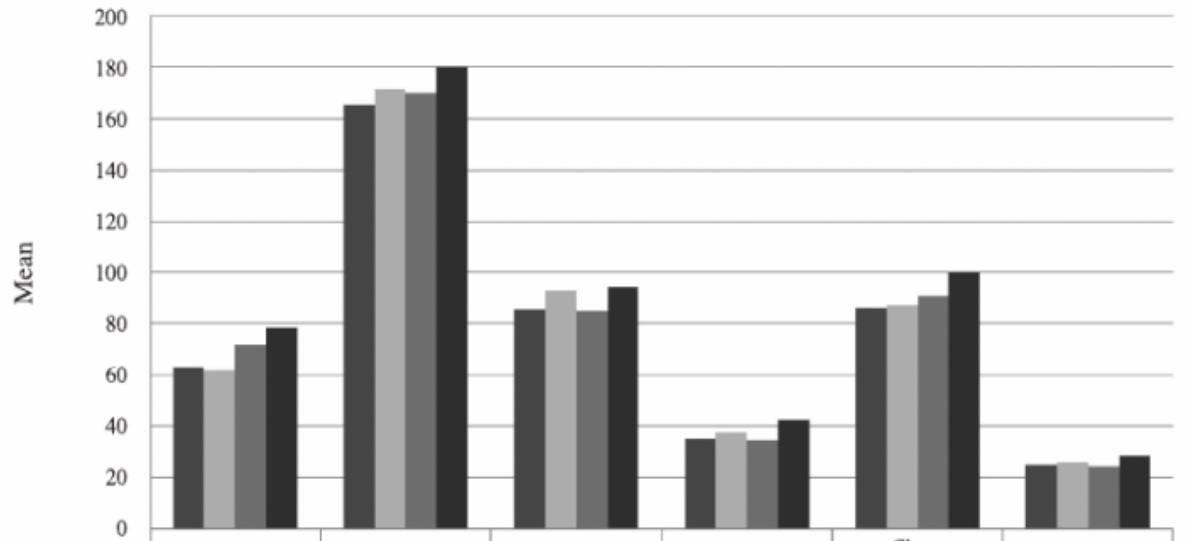
Anthropometry is the study of the measurement of the human body in terms of the dimensions of bone, muscle, and adipose (fat) tissue (Rockville, 1988). Others define; Anthropometry is defined as the science of measuring the size, weight and proportions of the human body (Group, 2009) . Both writers explain anthropometry is the measurement of human body which can be used for different purposes.

Anthropometry data are classified into three; size, structure and composition. The size measurements include height, length, mass, volume and surface area. The structural measurements include sitting and standing height, shoulder width, hip width, thigh length, leg length, neck length and neck circumference. The composition measurement includes percent body fat, lean body mass (L.B.M), water content and ash content (MAN, APRIL 2013).

Other study classified the anthropometry measurement into two; body size and body composition. Based on the research body size includes the weight, height, skinfold thicknesses length head

circumference and others. Human body is a composition of atomic, molecular, cellular, tissue-system and the whole body. A stable quantitative relationship exists between all these levels which remain relatively constant over months or years. Since age and disease can affect this quantitative relationship, anthropometry is a means that can be used to detect the resultant changes in the body (Group, 2009).

Because of peoples are different size and shape anthropometric measurements are useful to give reliable date. Enormous variations in body dimensions among individuals pose a great challenge for the design of equipment and workstations. This is especially true when designing something it should be known for what kind of people it will be applicable. For instant American peoples are different in size with relative to Japanese people. They are much taller than the Japanese. The below comparison graph explain how much peoples are different from country to country for aged 20-30 years; even if the research recommended further investigation including functional anthropometry has to be carried out for practical designing of workstations, tools and so on.



	Weight (kg)	Height (cm)	Sitting height (cm)	Shoulder-elbow length (cm)	Chest circumference (cm)	Foot length (cm)
Malaysian	62.68	165.45	85.43	35.03	86.03	24.66
Japanese	62.10	171.80	92.70	37.60	87.00	25.80
Arabian	71.60	169.92	94.90	34.60	90.84	24.40
American	78.60	180.60	94.50	42.40	100.10	28.20

Figure 2.8 Comparison of some anthropometric data between Malaysian, Saudi Arabian, Japanese and American males for 20-30 years (ZAHARI TAHA1, 2009).

As seen in the above designing of products should be done by implementing the anthropometry

measurements for the user people. Industries products like car, work station, furniture, clothes, textile factories and others. In this cases the measurements are use full to estimate the population size so that it can be designed to involve all the society. It can also help to give clearances, to have movement, to eliminate work on confined space and others. For instant by taking anthropometric measurements the handle of the door opener will have the height (length) to use by both the shortest and longest people. And also the door height can let the short and the long people to enter. This can satisfy both peoples and so implementing ergonomics.

Anthropometric measurements are used for different purposes. For example, it can be used to assess the nutrition status within a country, region, community, or socioeconomic group. It can use in the health centers; to identify nutritional status assessment in children and adults. Anthropometric data for children reflect general health status, dietary adequacy, and growth and development over time. In adults, body measurement data are used to evaluate health and dietary status, disease risk, and body composition changes that occur over the adult lifespan (Services, 2012).

Other studies use anthropometric measurements to evaluate the kinetic influence on release Speed in men's fast-medium bowling. This research studied the significant relationships between selected anthropometric and kinematic variables and ball release speed in men's fast-medium bowling. It uses different measurement to conclude the smaller inertial parameters, combined with a greater radial length, was the main reason for linear speed (Paradisis, 23 August 2000).

So; anthropometry measurements are one of the main input data to get correct ergonomics design. When designing something anthropometry measurements should be carefully measured in order to get relevant and accurate design. While designing work station, the anthropometric measurements used to estimate the reach dimensions were based on the most commonly used industrial operations which require a grasping movement, Appropriate allowances were provided to adjust the reach dimensions for other types of operations, the horizontal and vertical clearance dimensions and reference points for the horizontal and vertical clearances were established. This will help to get sustainable design which contributes a great role in the implementing of ergonomics.

2.9 Literatures

Different researches and studies are viewed for these researches. Basically, the ergonomics effects and its consequence in the organization can be viewed with these reviewed researches. Most of the researches shows the ergonomically effect in the company has an influence for the production of the company, the customer satisfaction, safety relation, stress on the workers, physical and psychological

effect on the workers and also for the growth of the country. The below ten sample literatures out off the readings and references for this paper reviewed below. The references published year seen in the below graph which can indicate the recent data source and the overhaul research idea is revised in the Appendix A.

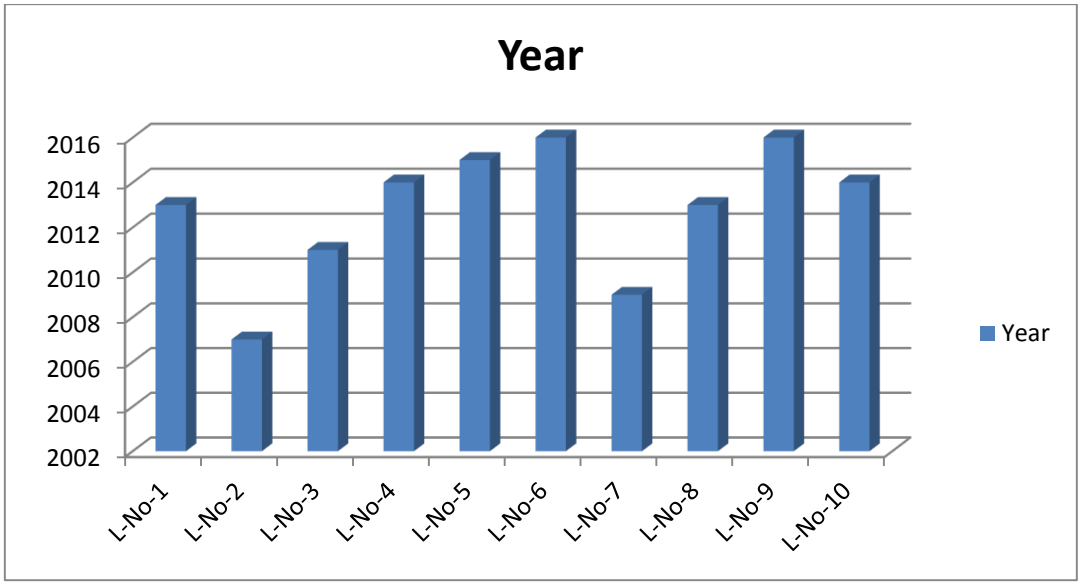


Figure 2.9 Classification of literature based on year

2.10 Mechanism to design and solve ergonomics problems

There are different mechanisms that are used to solve ergonomics problems. Different researches uses different kind of mechanism to solve their studies problem depend on the type of data they used, knowledge, time, effectiveness for the company other choosing methods. Some of them are mean, standard deviation, ANOVA, Chi-square, SPSS (Statistical Package for Social Sciences), EDA (Exploratory Data Analysis), PPMS (Pearson Product Moment Correlation) and also by mixing these

methods. The above researchers used the below analysis method for their research.

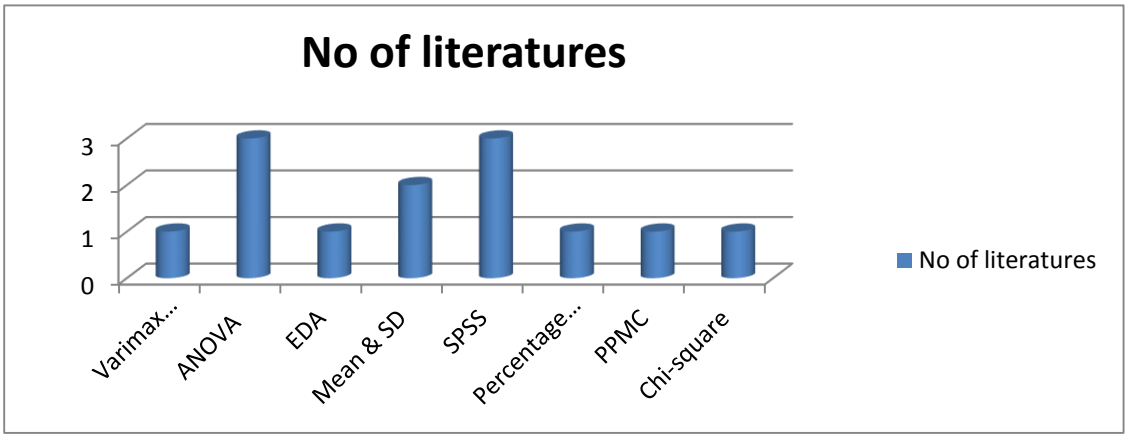


Figure 2.10 The type of mechanisms for analysis

Above the lists this research uses SPSS to solve the problem in the bank. SPSS is chosen because it has a very flexible data handling capability, it can read data in different format (binary, dollar, numerical, date, time) can perform complex data's and analysis with simple instruction. Some of the function of SPSS is T-test, ANOVA, Data examination, data transformation…

2.11 Literature gap

As discussed in the above literatures, ergonomics has a factor on the company's productivity, efficiency, quality, employee satisfaction and other performances. In the companies who can apply ergonomics workplace design achieved their company goal with employee satisfaction.

One of the industries in the world is a bank companies which needs attention for the ergonomic workplace design. As Bank companies give benefit for the person, the company itself as well as the country, it needs attention on the workplace design. If the productivity of the banks affected, the country productivity also affected as previously seen. And also productivity of the banks affected by the poor workplace design.

This issues were viewed in the bank industries like Pakistan which increased the employees' productivity that's comes from Supervisor Support which is helpful in developing a working environment, Good relations with coworkers, Training and Development, good incentives, rewards and recognition plans and adequate work (Ghafoor, 2015) . In Islamic Banks of Karachi Office Furniture, Office Equipment and Communication has the impact on the employee's productivity (Muhammad Faisal Sultan, 2016). The other study in the Banking Supervision Department in ABC Bank shows due to body postures and health factors there is stress out come in the workplace. The

tasks that requires long hours input in the department makes the employees to work in longer hour to complete the task (Talib, 2011).

The above literatures show and agreed that the ergonomics workplace design can contribute its role in the productivity of the company. But which ergonomics factors can lead to the problem like unproductive, health issues, safety, efficiency, quality and others? This question is answered by the authors who can use his own technics to address the cause of the problem. Using different methods and analyzes the author can define the cause of the problem for the existing arrangement of the banks. And they are identified different ergonomic factors depend on the country, environment, arrangement, social life, communication, physical factors, and others...

Basically the country of the bank available, the environmental condition of the place, the way of communication between peoples and even the kind of work handling methods can vary countries to countries and banks to banks. These make the researchers to not identify the specific known factors of ergonomics that can cause the problems.

In different banks there are different factors affecting the workers as well as the company. All the above researches acknowledged the factors by using different method of survey and analysis for the existing arrangement of specific company. So researches should be done to identify the exact and correct factors that are occurs problems in the given sectors. In order to get the exact factor, analyzing the existing workplace environment is the first thing to do.

This is therefore; this research will identify the ergonomics factors for the existing workplace arrangement of Abay Bank S.C in counter cage area. Hence it can show the impacts that the company faced due to the lack of ergonomics workplace design. Once the factor and the effects identifies it can develop comfortable and satisfactory working area by improving those encountered problems.

Coming to the studies so far undertaken on Ethiopian banks (both private and public), it was emphasized the business generation aspect of profit and earnings optimization which in reality lacks the equally important fundamental of business acumen-the social benefit side from which employees' safety and health not only attracts proficient skills but also fosters retention and business sustainability. This study therefore intends to fulfill the missing point (ergonomic side) within the business milieu of bank researches.

Also this research integrated ergonomics knowledge with the engineering technics to design and get the required output.

3. CHAPTER THREE
METHODOLOGY OF THE STUDY

This section explains how this research is conducted from the beginning of the research up to the end. This section has different class to discuss the data source methods, the population size and sample determination, the analysis method used.

3.1 Research design

The research design is based on systems approach (Mapping the whole system of Abay Bank S.C) with both primary and secondary sources. The research design has a research design framework/conceptual framework, and data collection and analysis sections.

The conceptual framework is schematized in the following display ranging from problem identification to data collection and analysis results synthesis to forwarding recommendations.

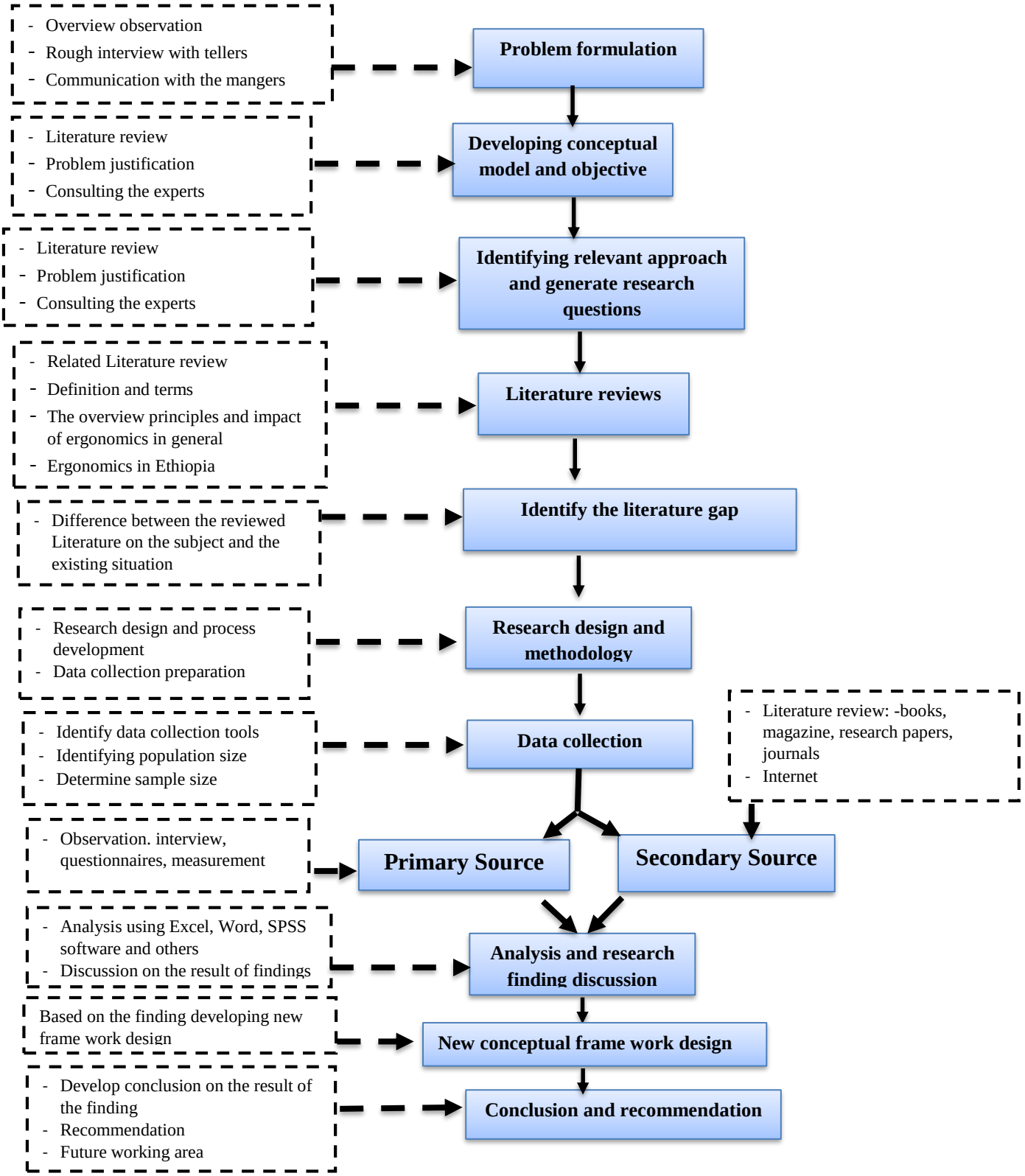


Figure 3.1 Research design frame work

3.2 Data source

3.2.1 Primary data source

A combination of quantitative and qualitative data will be gathered, and collated for further analysis. One data collection technique is supposed to complement and triangulate the other. Accordingly, the following data collection instruments are proposed for this study.

A. Key Informant Interviews [KIIs]. The study undertook interactive in-depth interviews using KIIs (both structured and semi-structured types) protocols to guide throughout the discussions with line managers and supervisors including the back-office like research and planning departments. Interview questions encompass issues related to ergonomic factors affecting the bank's workplace, the extent of suitable ergonomic workplace in the company, existing policy framework governing the ergonomic work dimension; elicit cases of ergonomic factors posing low productivity and inefficiency, health issues, and safety drawbacks.

B. Intercept Interview: During the intercept interviews, the study made contacts with tellers and customer service officers (front-lines) in the midst of service rendering time to assess the factors imposing impacts on the service delivery including test of flexibility, mobility, walk-around, and other employee-customer interactions and hindrances. With the same token, this will further exposure the equipment and facilities suitability for customer interface and better coordination by management echelons. It involves observing different branches when accomplishing the work gives the exact situation which helps to have reliable data's. This is because different branches have different type of arrangements regarding to the table, the chair, the customer serving place, the front window, and the money counting machine, the printer and others.

C. Employee Survey Questionnaire: A five interval Likert-scale questionnaire has been structured and distributed to employees of Abay Bank S.C. It is a nominal scale in which numbers are affixed to represent the magnitude of their perception regarding the issue. The questionnaires will be distributed to tellers and customer service officers. This scale is mainly to produce factor scores during the analysis in SPSS and rank the factors in accordance with their importance. The questionnaires are a combination of dichotomous questions (yes/no), scale-categorized questions, etc.

D. Stocktaking Measurements: it is also mandatory to take measurements for anthropometric dimensions while performing their jobs in their working area using tools like meter, caliper and other to get the reliable value.

3.2.2 Secondary data source

A. Desk Review: The existing documents and data are reviewed includes various published and unpublished research journals and articles, symposium and seminar papers, subject matter disciplines, industry and bank reports and case stories, generic documents of world bank and ILO concerned to ergonomics, ergonomic case reports of selected countries and online/internet resources. The data gathered through the desk review are used to prepare and improve the primary data collection plan through questionnaire, key informant interview and Delphi survey. The research questions also reviewed based on specific information obtained through this desk review. More specifically, operations manuals, safety manuals, policies and guidelines at National Bank of Ethiopia regulating the functions of Ethiopian private banks, insurances and share companies will be deeply examined.

B. **Data quality control:** The research managed and ensure the quality of data using a mix of triangulation among data sources and data collection instruments spot-check of the collected data, back-checking of values through physical observation/transect walk within the seat arrangements of the company, long-time telephone calls, recalls techniques and others.

C. **Data Analysis:** This research made analysis of the quantitative data using SPSS (Statistical Package for Social Scientists) to produce simple statistical summaries/tables, frequencies, mean, median/averages, percentages and percentiles. It also produces test-statistic values, significance tests, graphs and cross tabulations, and other attractive charts and pictures. Auto cad, CATIA software and RULA analysis also used to identify the effects and proposal of the new conceptual workplace.

Qualitative data will be analyzed using the narrative and content analysis approached with clearly discerned thematic issues relevant to the research questions. Audio and video files will be transcribed and translated/back-translated if deemed necessary.

3.3 Population and sample size determination

3.3.1 Population

The population of the data is from Abay bank. The study is conducted on the workers for the position of teller; so to select the representative tellers the random and simple and systematic sampling method used. Sample branches will be selected by the number of employment, the quantity of customer, more basic attention to the managements; working on shift and others…

Basically the bank classified branches in different parameters. One of the classification is depend on the grades like ‘A’’B’ and ‘C’. This classification is used on the bank based on the amount of

deposit in the branch. The more deposit in the branch; the higher grade which is 'A'. For example, 'A' grade branches are the one that has more deposit rather than others. These branches are more attention given by the mangers because the bank can get more customer as well as more income. So the bank encourages the branches to have a better grade.

Table 3.1 The total number of tellers in Addis Ababa

Branch Grade	No of branches	No of tellers	Working Hours			TOTAL NO OF TELLERS			
			6:00pm	7:00pm	9:00pm	6:00pm	7:00pm	9:00pm	TOTAL
A	3	6	0	1	2		6	12	**18**
B	9	4	2	2	5	8	8	20	**36**
C	55	2	31	14	10	62	28	20	**110**
					TOTAL	**70**	**42**	**52**	**164**

3.3.2 Sample size determination

Appropriate sample size is generally considered to be one of the most important steps in the studies. The target for the sample determination is to get optimum or adequate sample size. These can achieve through calculation to estimate the population prevalence with a good precision. Researches shows that the larger the sample size is not always means that the better the study. When the sample size is larger it is not cost effective and even it may unethical in some circumstances. (Naing, Winn, & Rusli, 2006) To determine the sample size, the below formula with finite population is valid; which is by applying simple or systematic random sampling method. (DANIEL, 2009)

$$n = \frac{NZ^2pq}{d^2(N-1)+Z^2pq}$$

Where q= 1-P

n= Sample size with finite population correction

N=Population size

Z=Z statistic for the level of confidence

P= Expected proportion of (in proportion of one)

d=Precision (in proportion of one)

For this study; 95% confidence level which is 1.96; 50% Expected proportion of (in proportion of one) P=0.5; if Precision d is 5%; d= 0.05 and we now the population N=164 the sample size will be

Sample size n =**116**

And also by using Yamane statically determination

$$n = \frac{N}{1+N(e^2)}$$ Where e=0.05 for the level of confidence 95%.

Sample size n =**116**

So by using the above formulas the sample size is 116; which is distributed to the tellers.

3.3.3 Sample size distribution through proportional allocation method:

To distribute the questionnaire on the branches, the below distribution sample size formula is used

$$n_i = \frac{Ni}{N} * \mathbf{n}$$

i=1,2,3…….

n=represents sample size

N_i= represents population size of the i^{th} strata and

N=represents the population size

$$n_i = \frac{116}{164} * Ni$$

To determine Ni; there are two different type of classification applied on the bank;

- Based on the grade of the branch (A, B, C) and
- Based on the working hour (6:00pm, 7:00pm; 9:00pm)

So to analysis this

- Based on the Grade classification of branches

Table 3.2 Sample distribution of branches based on grade

Branch Grade	No of branches(N_i)	Distribution sample size (n_i)	Actual sample size (n_i)
A	3	2.12195122	3
B	9	6.365853659	7
C	55	38.90243902	39
		TOTAL	**49**

- Based on the working hour classification of branches

Table 3.3 Sample distribution of branches based on working hour

	A	B	C	No of branches(N_i)	Distribution sample size (n_i)	Actual sample size (n_i)
6:00pm	0	2	31	33	23.34146341	24
7:00pm	1	2	14	17	12.02439024	12
9:00pm	2	5	10	17	12.02439024	13
					TOTAL	**49**

- By combining the above; the sample size distribution on the branches will be the below

Table 3.4 Sample distribution of branches based on grade and working hour

	A	B	C	TOTAL
6:00pm	0	2	22	**24**
7:00pm	1	2	9	**12**
9:00pm	2	3	8	**13**
TOTAL	**3**	**7**	**39**	**49**

So based on the above, the 116 population located on 49 branches were assumed to be satisfactory and representative for the data analysis. The data are distributing through proportion allocation method for the different branches.

3.3.4 Sample determination for measurements:

Measurement for the position of teller has been considered based on the questionaries' and response. Tellers are selected by random sampling method by the size and range of height (e.g. they can be very much tall, medium and short height). And then measurements will be taken to the selected workers who frequently working in the position of tellers. Totally 20 tellers from different branches are selected and measured for this study.

3.4 Data collection method

Data's are collecting in both qualitative and quantitative method from both primary and secondary data sources. Below are describing how the data are collected.

A. Data collection through Key Informant Interviews: Key informant interviews have been conducted for 30-40 minutes with each respondent to capture in-depth concepts and allowing the interviewee sufficient time to think over it and cover adequate scope.

The respondents are also sometimes probed so as to make them recall issues otherwise remain uncovered/ forgotten. The interview has been conducted both in Amharic and English that again facilitated flexibility.

B. Intercept Interviews: This interview was done simultaneous to the employees' service delivery time which perfectly discloses the challenges and inconveniences both the employee and client are facing due to ergonomic factors. It has been accompanied with transect walk and physical observations of facilities and ease of mobility including the seat arrangement. This in turn helps to verify or disprove the issues raised by the key informants. As an evidence, pictures of respondents and facilities as a status quo has been captured in photographs.

C. Data collection through Questionnaires: The main data input for this thesis is the questionaries' that are distributed to the managers, the supervisors and tellers. Prototype/piloting questionnaires has been given to few respondents and checked for ease of language, ambiguity, and redundancy. Then after, comments of these respondents have been integrated and the questionnaires has been refined once and for all and distributed to all the respondents to fill through the company email and also some are physically given to the employees. The questionaries' were developed in four chapters in order to have clear understanding. The first part to easily circle the answer, the second part for the managers to give general information on the company, the third part to select 'YES' or 'NO' to be filled by the tellers and 5-item Likert-scale (1 is strongly disagree to 5 strongly agree) finally the fourth part prepared in the 5-item Likert-scale (1 is the most comfortable and 5 is the most uncomfortable) which prepared in by picture. Finally, the replied questionaries' are collected by physically going to the branches and some of them are replied by the email. The responses are collected together and give analysis for the study.

D. Data collection through Measurements: Measurements are taken from the tellers and analyses using SPSS software. Tools are used like meter, caliper and other to give the reliable value from the tellers.

E. Data validation: -To check the reliability of the construct Cronbach's Alpha was used. The results showed that the coefficient is 0.646 which is above suggestion values 0.63. Therefore, on the basis of reliability test it was assumed that the scales used in this research is reliable to capture the constructs.

Table 3.5 Reliability of the constructs

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.646	.698	16

Therefore; Based on the primary data sources, the planned and the actual collected data are revised

Table 3.6 Planned and actual collected data

Instrument	Planned	Actual/Coverage	Success level
Interview/discussion	25	22	88%
Questionnaires	116	87	75%
Observation	20	17	85%
Measurements	20	20	100%

3.5 Method of data analysis

The data collected, which was quantifiable was put in a table form and unquantifiable data got through interview was carefully reviewed and stated as its and the observed data have been summed up. To analyze the data, collected photos and checklist are taken as evidential instruments beyond primary and secondary data source.

3.5.1 Quantitative Data Analysis

Primary and secondary data are inputs for this quantitative data analysis. The input data's from questionaries' are carefully coded to the analysis for different software like excel, office word and SPSS. These data's analysis using numerical/quantitative data analysis.

Also the data are analyzed using means, sample standard deviation and using 5^{th}, 50^{th} and 95^{th}values.

3.5.2 Qualitative Data Analysis

Data's gathered from interviews, observation and reports are used to support findings. These data are analysis with qualitative discussion.

3.5.3 Data Analysis Tool

Different researches use SPSS software for their study to analysis the data. This study also uses this SPSS software because it has a very flexible data handling capability and can perform complex data's and analysis with simple instruction. So the software analyses and gives results for the research which has a great contribution for the finding. Other software like excel; word, Auto cad, CATIA software and RULA analysis used to get the pictures and help for analytical calculation.

3.5.4 Anthropometry

There are different tools used to measure the body; among them caliper and meter are used depend on the size and shape. The measured data has been analyzed by using statistic of sample means, sample standard deviation and using percentiles of the fifth, fiftieth and ninety -fifth values. And then the data's will be analyzed by using the statistical bases of anthropometric formula to develop appropriate percentage of each required body dimension of the Abay Bank A.C. tellers. The output of the tables in cumulative percentage will have 5^{th},50^{th} and 95^{th} for group of men and women.

4. CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This section will explain how the collected data are analysis. The data collected from difference resources; observation, questionnaires', measurements, interviews were analyses to go to further and determines the difference between the existing and the standard workplace design. Based on the output evidence then develop the new proposed work station for the bank on the counter cage area.

4.2 The current state of the bank

4.2.1 Productive hour of employees

Report of the bank released on 31-Mar-19 showed that the overall performance of the company has increased from the last year and as of Jun-2018. This report shows different parameters under different measurements settled by the company like the financially perspective, under customer perspective, internal business perspective, learning and growth perspective and other. From Financial perspective the incremental deposit mobilization performance is 51% calculated as of 31-March-2019.And to achieve the given target settled by the company, employees should work hard by getting customer from different areas, working effectively for the available hour (turnaround time) and agile customer service is required. But this report shows the employees productivity is low. The employees should work 8 hrs. per day and 6 days per week according to the company policy. The data from HR department has collected yearly employees working data and it gives the below.

$$\textit{Labor Productivity time} = \frac{Input}{Output} = \frac{Productive\ time(hr)}{Available\ time\ (hr)} * 100$$

$$= \frac{1866hr}{2304hr} * 100 = 80.9\ \% = 81\%$$

$$\textit{Unproductivity time} = \underline{\underline{19\%}}$$

This means there are 19% unproductive hour registered by the HR department. This implies, the HR department only registered whether the employees are available in their working area or not. But interviews with the bank branch managers explains this is not the only unproductive hour even if the tellers are placed in their working area they are not effectively used the working hour. According to the bank employees should round and invite peoples to work with the bank. Unfortunately, they even not doing the actual job in the office.

Additionally, the company set a specific time for different type of services. The minimum serving hour set by the bank is 3 min which is transfer account to account. The other services, deposit and withdrawal from account has set time about 5 min. Even if this is the written bank policy, the actual time taken is 8 min and 9 min for transferring and deposit/withdrawal respectively per day according to the managers and collected data.

So, based on the company policy, the number of customer for the 8-hour service is 160 for the transfer account and 96 for deposit/withdrawal. But based on the actual service, it is 60 customers for transfer account to account and 53 customers for deposit/withdrawal from account per day.

Table 4.1 Service delivery time and productivity

Service Type	Company service delivery time (Min)	No customer per day	Actual service delivery time (Min)	No customer per day	Productivity of employees
Cash transfer-account to account	3	160	8	60	**38%**
Deposit to saving account	5	96	9	53	**55%**
Withdrawal from saving account	5	96	9	53	**55%**

Even if these unproductivity has different reasons, from interviews with managers; they believed that the existing environment design is not safe for the employees and not comfortable for the tellers. The branch managers preferred to change or modify the existing workstation with good layout which can fit the employees as well as the customer. They also think that the implementation of the ergonomics work place design would make employees safe and will improve the productivity and efficiency.

4.2.3 Workplace arrangement of the branch

The overall bank arrangements are taken by pictures as per below. The tellers are setting with their elbows suspend in the air. The teller's backrest is not aligning with the chair so that they are bending down to reach to customer and to touch the keyboard and mouse. The seating height is adjusted between 635mm-832mm(25-33inch). Even if it is adjustable to their height the tables height is too long to reach so they are forced to go up; and this makes them their foot is not fully enough to be supported in the ground or the foot rest. They use the chair to sit their foot or other foot rest mechanism. The other thing is using the printer; when one customer is served the receipt should be printed out to give as a confidential for the customers as well as the tellers. But in this situation the printer is lower than their

sitting height. And whenever they printed out the paper either they stand to bring the paper or the should be tilted down to get it.

Figure 4.1 Overlooking of the arrangement

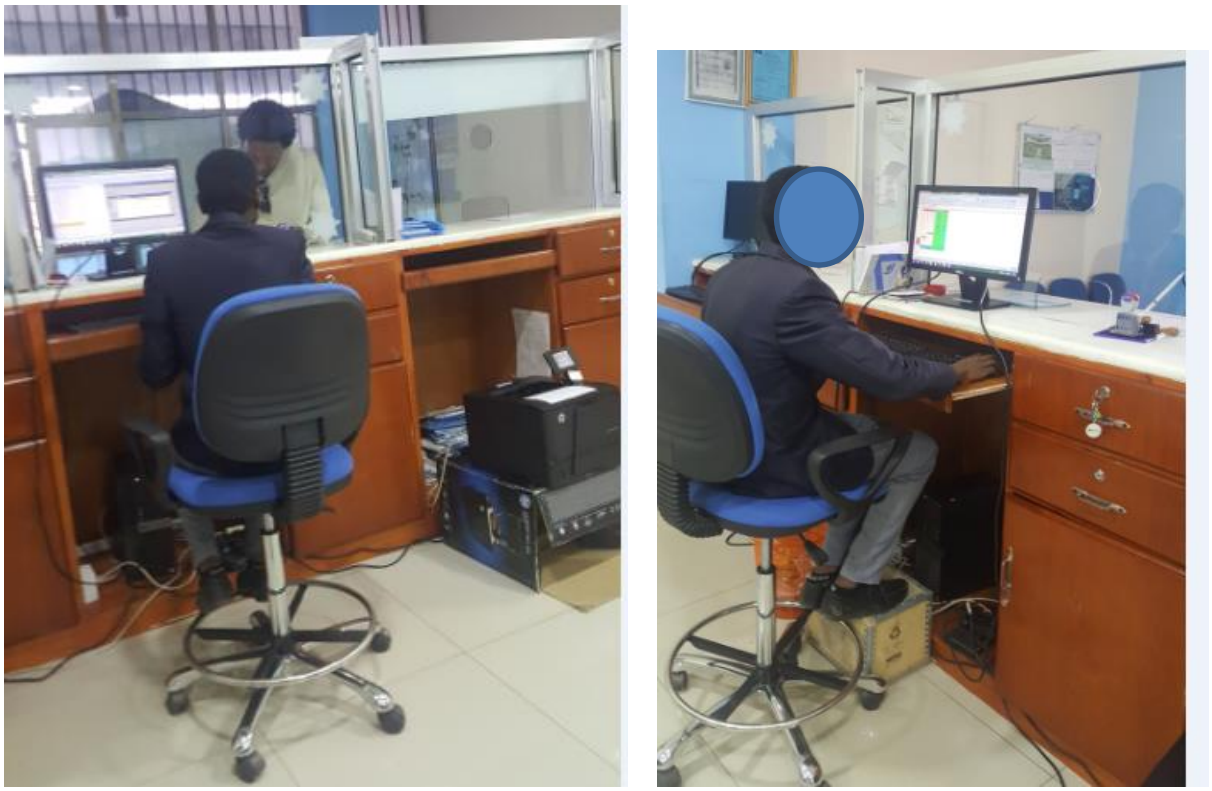


Figure 4.2 Employee sitting arrangement while working

4.3 Analysis of ergonomics factors

There are 87 responders there were 64% male and 36% Female. Different list of questions is presented to identify the factors affecting their productivity. The collected data are interpreted carefully and entered to the SPPS software in order to get the correlation between the factors and dependent variable. indicators variables of office design such as contamination, temperature, vibration, furniture, lighting, noise, working posture, ventilation, smell/odor and others are considered for the study. The overall response for each factor was analyzed using SPSS Pearson's correlation.

Among the overall factors vibration, contamination, space utilization, shift handling and job rotation are not the factors which affects the tellers. The correlation table on Appendix B, shows that the temperature, furniture. lighting, noise, working posture, and smell/odor has a highest positive relationship with the dependent variable. The correlation table indicates that there is a positive relationship between Temperature and absenteeism (r= 0.519) and is 0.01 significant. This implies that when there is uncomfortable temperature in the office their illness and absenteeism increase. Also there is a positive relationship of furniture and absenteeism due to illness with r= 0.553 and significant to 0.01. The other factor lighting also shows the positive relationship which can affect the employees healthy according to employees. The correlation coefficient is r=0.571 and significant to 0.01. Likewise,

the noise, working posture, and smell/odor has a positive correlation calculated in the SPSS with the values of r=0.390, r=0.472 and r=0.176 respectively with 0.01 significant. [Refer Appendix B]

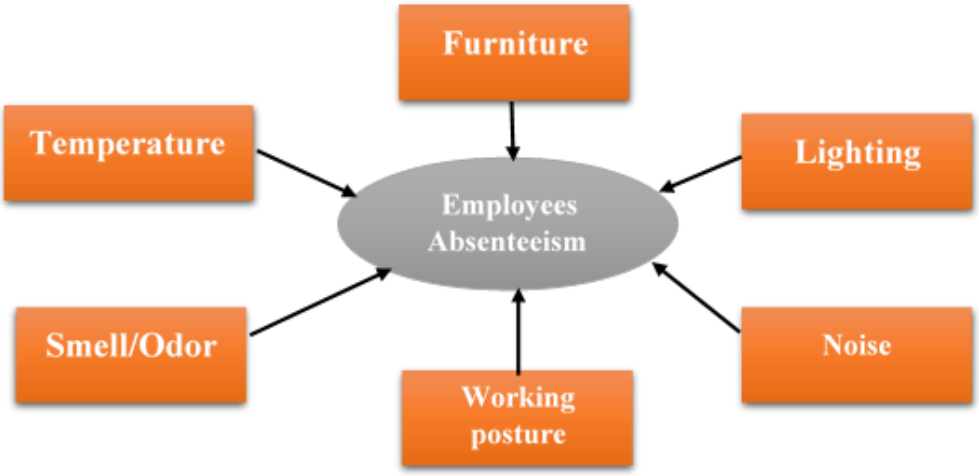


Figure 4.3 Independ and dependent variables

The dependent variable is the absence due to illness and the independent variable the temperature, furniture. lighting, noise, working posture and smell/odor has the below Pearson's correlation(r).

Table 4.2 Correlation between factors of ergonomic workplace design and absenteeism

Ergonomically factors	Pearson's correlation(r).
Lighting	0.571
Furniture	0.553
Temperature	0.519
Working posture	0.472
Noise	0.390
Smell/odor	0.176

r is Pearson's correlation coefficient.

After the finding from correlation, the above main factors are calculated in the regression of SPSS to see the ration of explained variation to total variation.

Table 4.3 Regression model summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.729[a]	.532	.497	.808

From the above table the coefficient of determination R. Square is 0. 532.By converting the R square value to percentage it will be 53.2 % approximately 53 %. This shows the 53 % of variability of employee's absenteeism is accounted for by variables on this model.

Table 4.4 Regression Coefficients for the ergonomics factors

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	-.257	.524		-.490	.625			
	There are uncomfortable temperature, (no prevention for heat generating equipment, heat radiation, humidity, heavy air, regulation of heat it)	.467	.100	.374	4.684	.000	.519	.464	.358
	I am not comfortable when I am working in my furniture and location of equipment	.060	.202	.059	.297	.767	.553	.033	.023
	I am not comfortable with Daylight, glare, reflections, mirroring or dim light	.258	.205	.242	1.258	.212	.571	.139	.096
	There is smell/odor in my working area	.027	.079	.028	.346	.730	.176	.039	.026
	There is noise in my workplace	.170	.124	.121	1.370	.175	.390	.151	.105
	I have been working on bad working posture(Seated, walking, standing, stooping posture, twisting the back, high and low work)	.235	.084	.243	2.785	.007	.472	.297	.213

From the above table the, Regression Coefficients for the ergonomics factors lighting, furniture temperature, working posture, noise and smell/odor are 0.258, 0.060, 0.467,0.235,0.170 and 0.027 respectively. This means that, the change in the employee's absenteeism is with a unit ergonomics variable factor; when the other variables are constant. For example; analyzing the coefficient value of lighting, it can increase 0.258 in the illness and absenteeism of employee for every unit increase in lighting condition of the office by keeping all other variable factors constant.

Therefore; for this analysis the Regression equation:

Effect on Employees productivity = -0.257 + 0.467T + 0.060F + 0.258L +0.170N +0.235WP+0.027S

Where T- temperature, F-furniture, L-lighting, N-noise, WP-working posture and S-smell/odor

4.4 Analysis of teller's fatigue and level of comfort

Questionaries' distributed to the tellers to determine in which part of their body experience excessive fatigue and discomfort in their day today activity. This helps to identify which parts of the teller's body is most feeling dis comfort. Again the body parts are related to the illness and working hour availability which has a direct effect on productivity level. The tellers fill the questionaries' from the most comfortable up to the most uncomfortable throughout the body parts neck, shoulder(s), mid back, elbow(s), lower back, forearm(S), wrist/hand(S), hip(S), thigh(S), knee(S), lower leg(s) and foot/ankle(S). These values are carefully interred to the SPSS software and analyses to get the acquired output.

Table 4.5 Correlation of fatigue body part with absenteeism

Correlations

		There are circumstances in my work that contribute to absence due to illness	Neck	Shoulder (s)	Mid Back	Elbow (s)	Lower Back	Forearm (s)	Wrist/Hand (s)	Hip (s)	Thigh (s)	knee (s)	Lower Leg (s)	Foot/ Ankle (s)
There are circumstances in my work that contribute to absence due to illness	Pearson Correlation	1	.116	.611**	.463**	.078	.539**	.185	-.052	.019	.125	.214*	.433**	.018
	Sig. (2-tailed)		.283	.000	.000	.474	.000	.086	.636	.865	.250	.047	.000	.870
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Neck	Pearson Correlation	.116	1	-.128	-.027	.119	-.077	.188	-.121	-.098	-.096	-.097	-.193	-.004
	Sig. (2-tailed)	.283		.237	.801	.273	.479	.081	.263	.367	.376	.370	.073	.967
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Shoulder(s)	Pearson Correlation	.611**	-.128	1	.366**	.032	.429**	.086	.112	.203	.195	.215*	.382**	.126
	Sig. (2-tailed)	.000	.237		.000	.772	.000	.431	.300	.059	.071	.045	.000	.244
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Mid Back	Pearson Correlation	.463**	-.027	.366**	1	.080	.430**	-.234*	-.119	-.072	.035	.244*	.352**	.017

	Sig. (2-tailed)	.000	.801	.000		.460	.000	.029	.274	.505	.745	.023	.001	.872
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Elbow(s)	Pearson Correlation	.078	.119	.032	.080	1	-.053	-.033	.023	.078	-.027	-.012	.063	-.036
	Sig. (2-tailed)	.474	.273	.772	.460		.626	.761	.833	.470	.802	.916	.563	.738
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Lower Back	Pearson Correlation	.539**	-.077	.429**	.430**	-.053	1	-.184	.064	.007	.054	.127	.408**	.029
	Sig. (2-tailed)	.000	.479	.000	.000	.626		.089	.558	.945	.622	.240	.000	.787
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Forearm(s)	Pearson Correlation	.185	.188	.086	-.234*	-.033	-.184	1	-.179	.051	.080	.066	-.045	.026
	Sig. (2-tailed)	.086	.081	.431	.029	.761	.089		.097	.638	.462	.546	.680	.810
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Wrist/Hand(s)	Pearson Correlation	-.052	-.121	.112	-.119	.023	.064	-.179	1	.463**	.182	.069	.056	-.108
	Sig. (2-tailed)	.636	.263	.300	.274	.833	.558	.097		.000	.091	.524	.606	.318
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Hip(s)	Pearson Correlation	.019	-.098	.203	-.072	.078	.007	.051	.463**	1	.344**	.392**	-.038	.066
	Sig. (2-tailed)	.865	.367	.059	.505	.470	.945	.638	.000		.001	.000	.730	.543
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Thigh(s)	Pearson Correlation	.125	-.096	.195	.035	-.027	.054	.080	.182	.344**	1	.406**	-.063	.141
	Sig. (2-tailed)	.250	.376	.071	.745	.802	.622	.462	.091	.001		.000	.561	.192
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
knee(s)	Pearson Correlation	.214*	-.097	.215*	.244*	-.012	.127	.066	.069	.392**	.406**	1	.117	.139
	Sig. (2-tailed)	.047	.370	.045	.023	.916	.240	.546	.524	.000	.000		.279	.198
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Lower Leg(s)	Pearson Correlation	.433**	-.193	.382**	.352**	.063	.408**	-.045	.056	-.038	-.063	.117	1	-.080
	Sig. (2-tailed)	.000	.073	.000	.001	.563	.000	.680	.606	.730	.561	.279		.462
	N	87	87	87	87	87	87	87	87	87	87	87	87	87
Foot/Ankle(s)	Pearson Correlation	.018	-.004	.126	.017	-.036	.029	.026	-.108	.066	.141	.139	-.080	1
	Sig. (2-tailed)	.870	.967	.244	.872	.738	.787	.810	.318	.543	.192	.198	.462	
	N	87	87	87	87	87	87	87	87	87	87	87	87	87

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

From the Pierson correlation the shoulder has the most related body part for the cause of illness and absenteeism of tellers with value of 0.611 significant to 0.01. The second and the third body parts are lower back with 0.539 and mid back 0.463 significant to 0.01. The lower legs 0.433 significant to 0.01, knee with 0.214 significant to 0.05 and forearm 0.185 are the next body parts that produce fatigue due to uncomfortable working arrangement. These are the higher mentioned areas to play some role on illness and consequence for the absenteeism of tellers. Identifying these areas are help to focus while designing the work place.

4.5 Analysis using RULA

Based on the RULA analysis of the existing workplace almost all postures have the highest score and needs an investigation and change immediately. This implies that the workers undergone the awkward and bad posture while performing their tasks. They are need to bend and twist their body to bring papers from the printers. And they used their hands fully stretched to hold the papers from the printers. Therefore, the new design should consider this to prevent the tellers from twisting and bending their body to reach to the papers and customers. [APPENDIX C]

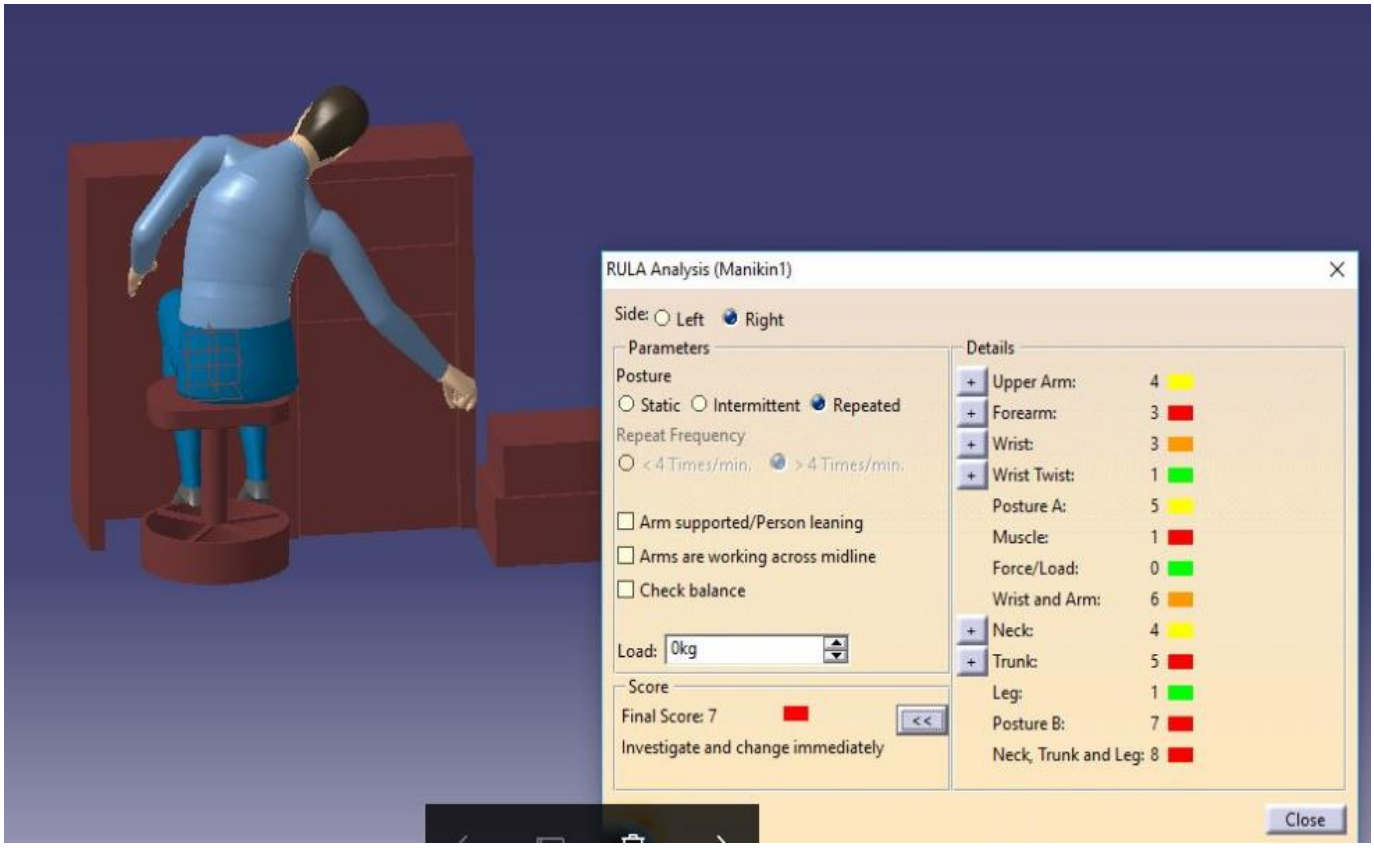


Figure 4.4 The final score of body posture

4.6 Analysis of training and awareness on ergonomics

From the distributed questionaries' it shows that the awareness on the ergonomics is very much poor. Let's see the below questions and percentile.

Table 4.6 Safety training analysis

1. Do you conduct safety training specifically for new employees					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	2.3	2.3	2.3
	Yes	13	14.9	14.9	17.2
	No	72	82.8	82.8	100.0
	Total	87	100.0	100.0	

From the respondent the 82.8% of tellers are not conducted safety training. Only 14.9% of the tellers are taken the training. This shows that the safety trainings are not scheduled and given to the tellers specially for the new employees.

Table 4.7 Neutral position concept analysis

2. Do you know about neutral position concept and practical application?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	2.3	2.3	2.3
	Yes	20	23.0	23.0	25.3
	No	65	74.7	74.7	100.0
	Total	87	100.0	100.0	

One of the main thing in the ergonomics is the aware about the neutral position. This can be achieved through trainings and by reading several books, journals, internet and discussing with peoples. But from the above data the only 23% of tellers are aware about the neutral position concept. The other 74% needs to know more about this concept.

Table 4.8 Effective training and ergonomic concept analysis

3. Are you familiar with ergonomic concepts?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	2.3	2.3	2.3
	Yes	32	36.8	36.8	39.1
	No	53	60.9	60.9	100.0
	Total	87	100.0	100.0	

4. Did you find the most effective training with related to safety?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	2.3	2.3	2.3
	Yes	31	35.6	35.6	37.9
	No	54	62.1	62.1	100.0
	Total	87	100.0	100.0	

Awareness about the ergonomics concept and the general view is one of the questionnaires distributed to the tellers among them 37% of them familiar with the concept and 63% are not. They are asked also if they have got the effective training with related to safety. Most of the tellers about 62% didn't got effective training and the rest are found safety related training.

This is therefore the tellers should be aware on the ergonomics principles, concept and most effective training to develop their mind on health and safety issues. Top managements, HR offices, mangers, supervisors and all concerned section and personnel should plan and prepare to give effective training on safety, ergonomics effect and even how to arrange their personal uses to get effective products. As described in the literature reviews the impact of ergonomics is seeming negligible but has a great effect on the productivity, stress, cost, quality and performance of employees.to protect this and to achieve the best performance trainings and awareness to the employees should be given and encouraged. Even for the senior employees this activity should be repeated in every given interval to refresh and remind some forgettable factors. Employees by themselves have to learn from different books, journals, internet and other data sources about the positon they have faced on their day to day activity.

4.7 Anthropometric data

Ergonomic Office work station design needs anthropometric data to ensure effective design. Therefore, the body size of each staff was assessed using standard anthropometric measurement techniques. All anthropometric measures were taken with the subjects wearing proper office attire and erect posture and considering without shoes. The measurements were taken in different working days and different shifts to ensure accuracy of recorded data. Also recorded with the measurements was the information on/regarding sex.

4.7.1 The existing measurements

Figure 4.5 The existing workplace arrangement and measurement of the bank

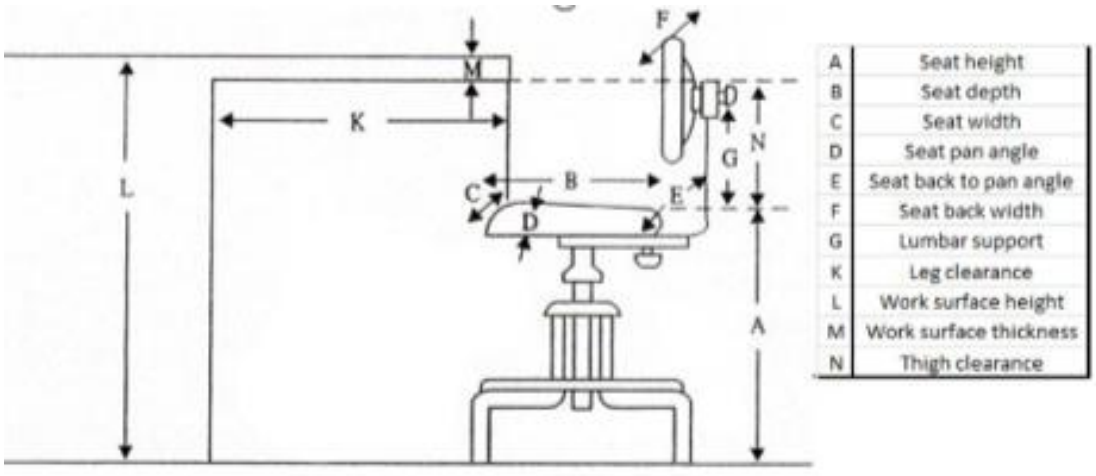


Table 4.9 Dimension of equipment's

CHAIR	**In inch**	**In mm**
seating height(A)	25-33	635-832
backrest height (N)	18	457
seat depth(B)	17	432
seat width(C)	16	406
Armrest	9	229
TABLE		
table height key board(L)	44	1118
table height monitor(L)	51	1295
table width	44	1118
table depth(K)	12	305

FOOT REST		
Foot arm height	10	254
Foot arm width	12.5	318
Foot arm depth	9	229

4.7.2 Seated body dimension of tellers

The below table shows the anthropometric measurement of the teller body dimension required for this research. This is important in ensuring that the measurement processes for selected tellers are done correctly and accurately to minimize the measurement error in data collection. All measurements were measured in Inch (in).

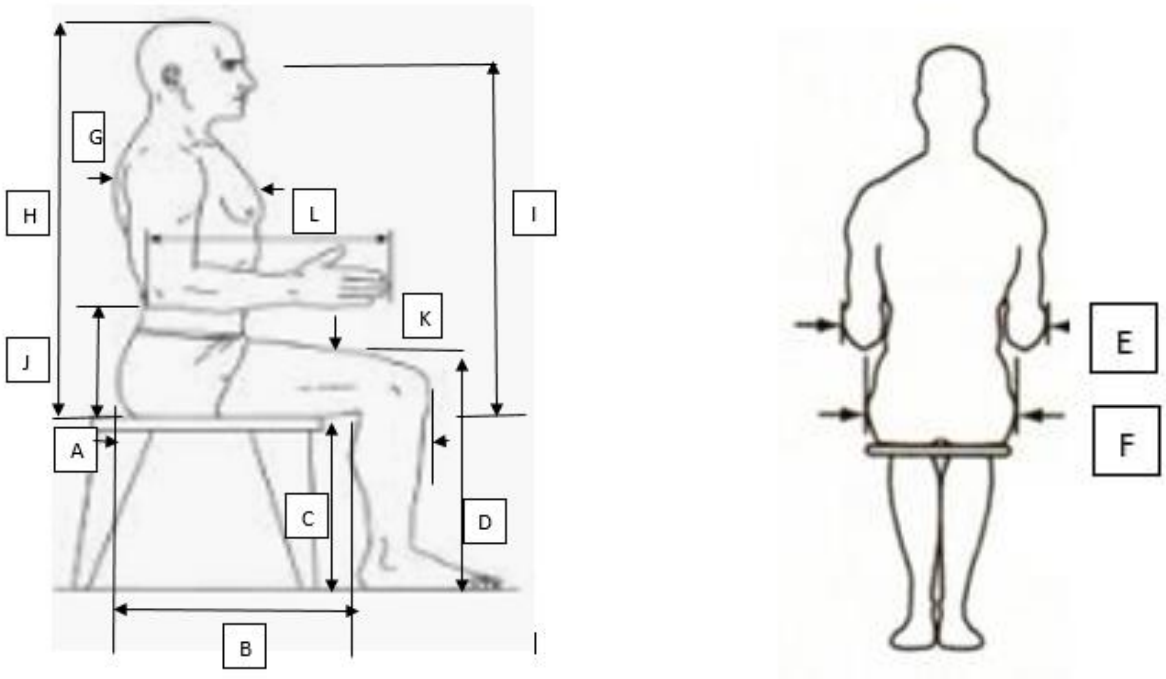


Figure 4.6 Measured anthropometric data for the tellers

Legend: -

A- Buttock knee length
B- Buttock popliteal length
C- Popliteal height
D- Knee height
E- Elbow-to-Elbow breadth
F- Hip breadth
G- Whole depth
H- Erect sitting height
I- Eye sitting height
J- Elbow rest height
K- Thigh clearance height
L- Forearm length

Table 4.10 Seated body dimensions of tellers

		Legend											
	Person	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Men	**1**	23	19	18	22	19	13	12	32	28	9	5.5	18
	2	21	17.5	17	21	16	12	6	31	28	7	5.5	15.5
	3	20	16	17	21.5	16	13	8	31	27	7	6.5	14
	4	25	20	18	23.5	17	14	6	36	32	11	6	19.5
	5	22	18	17	22	22	13	12	34	30	9	6.5	16.5
	6	20	16	15	22	24	15	13	36	32	8	7	15
	7	27	24	20	24	18	13	5	38	33	9	6	22
	8	19	15	15.5	19	17	14	7	30	26	7	5.5	15
	9	24	21	17	23	16	12	5	35	31	9	5.5	19
	10	22	19	19	23	18	12	7	37	32.5	10	6	16
Women	**11**	23	20	19	23	19	15	6	32	29	8	5	17.5
	12	21	17.5	16	19.5	17	21	8	31	28	8	5	15.5
	13	21	17	18	22	18	14	5	34	31	6	6	15
	14	18	15	15	19	14	13	5	28	24.5	7	4	12
	15	18	15	13	17	16	15	8	27	23	5	4.5	12.5
	16	24	19	19	25	18	15	5	34	30	8	6.5	19
	17	19	16	13	17	22	23	11	29	25	6	7	14
	18	26	22	20	25	20	17	8	36	33	10	6	21
	19	21	17.5	15	19	17	19	9	30	27	9	5.5	14
	20	19	15.5	14	18	21	14	7	31	27	8	5	13

4.7.3 Calculating the mean, standard deviation and the X percentile

To calculate mean, standard deviation the below formula is used

Mean $(\bar{X}) = \sum_{i=1}^{n} Xi/n$

Standard Deviation (s) = $\sqrt{\frac{1}{n-1}\sum_{i=1}^{n} (Xi-\bar{X})^2}$

Where: -

- X_i= measurement value of each teller
- n= number of sample taken
- $\overline{X}$= mean value
- S= standard deviation

To calculate 5th, 50th and 95th percentile the below formula is used

$X_p = \overline{X} + Zp * S$ Where:-Zp=Standard normal value corresponding to the Pth percentile value of X

From standard table

- For 5th percentile $Z_{0.05}$= **-1.645**
- For 50th percentile $Z_{0.5}$= **0**
- For 95th percentile $Z_{0.95}$= **1.645**

The below table revised the above calculated data of mean, standard deviation and the X percentile for the tellers.

A. Male anthropometric data

Table 4.11 Male anthropometric data

Anthropometric Dimension (in)		Mean ($\overline{X}$)	Std. dev. (S)	Min	Max	5th perc. ($X_{0.05}$)	50th perc. ($X_{0.5}$)	95th perc. ($X_{0.95}$)
A	Buttock knee length	22.3	2.50	19	27	18.19	22.30	26.41
B	Buttock popliteal length	18.55	2.69	15	24	14.12	18.55	22.98
C	Popliteal height	17.35	1.49	15	20	14.90	17.35	19.80
D	Knee height	22.1	1.43	19	24	19.75	22.10	24.45
E	Elbow-to-Elbow breadth	18.3	2.71	16	24	13.84	18.30	22.76
F	Hip breadth	13.1	0.99	12	15	11.46	13.10	14.74
G	Whole depth	8.1	3.07	5	13	3.05	8.10	13.15
H	Erect sitting height	34	2.83	30	38	29.35	34.00	38.65
I	Eye sitting height	29.95	2.52	26	33	25.80	29.95	34.10
J	Elbow rest height	8.6	1.35	7	11	6.38	8.60	10.82
K	Thigh clearance height	6	0.53	5.5	7	5.13	6.00	6.87
L	Forearm length	17.05	2.51	14	22	12.92	17.05	21.18

B. Female anthropometric data

Table 4.12 Female anthropometric data

Anthropometric Dimension (in)		Mean ($\bar{X}$)	Std. dev. (S)	Min	Max	5th perc. ($X_{0.05}$)	50th perc. ($X_{0.5}$)	95th perc. ($X_{0.95}$)
A	Buttock knee length	21	2.67	18	26	16.61	21.00	25.39
B	Buttock popliteal length	17.45	2.30	15	22	13.66	17.45	21.24
C	Popliteal height	16.2	2.62	13	20	11.90	16.20	20.50
D	Knee height	20.45	3.08	17	25	15.39	20.45	25.51
E	Elbow-to-Elbow breadth	18.2	2.39	14	22	14.26	18.20	22.14
F	Hip breadth	16.6	3.34	13	23	11.11	16.60	22.09
G	Whole depth	7.2	1.99	5	11	3.93	7.20	10.47
H	Erect sitting height	31.2	2.86	27	36	26.50	31.20	35.90
I	Eye sitting height	27.75	3.10	23	33	22.65	27.75	32.85
J	Elbow rest height	7.5	1.51	5	10	5.02	7.50	9.98
K	Thigh clearance height	5.45	0.93	4	7	3.93	5.45	6.97
L	Forearm length	15.35	2.95	12	21	10.49	15.35	20.21

C. Calculated mean, standard deviation and the X percentile of result for anthropometric data

Table 4.13 Calculated mean, standard deviation and the X percentile of result for anthropometric data

Anthropometric Dimension (in)		Mean ($\bar{X}$)	Std. dev. (S)	Min	Max	5th perc. ($X_{0.05}$)	50th perc. ($X_{0.5}$)	95th perc. ($X_{0.95}$)
A	Buttock knee length	21.65	2.60	18	27	17.37	21.65	25.93
B	Buttock popliteal length	18.00	2.50	15	24	13.88	18.00	22.12
C	Popliteal height	16.78	2.16	13	20	13.23	16.78	20.32
D	Knee height	21.28	2.48	17	25	17.19	21.28	25.36
E	Elbow-to-Elbow breadth	18.25	2.49	14	24	14.15	18.25	22.35
F	Hip breadth	14.85	3.00	12	23	9.92	14.85	19.78
G	Whole depth	7.65	2.56	5	13	3.44	7.65	11.86
H	Erect sitting height	32.60	3.12	27	38	27.47	32.60	37.73

I	Eye sitting height	28.85	2.97	23	33	23.96	28.85	33.74
J	Elbow rest height	8.05	1.50	5	11	5.58	8.05	10.52
K	Thigh clearance height	5.73	0.79	4	7	4.43	5.73	7.02
L	Forearm length	16.2	2.81	12	22	14.39	19.01	23.63

From the above analysis the training and awareness of the employees in ergonomics is very poor and needs higher management attention. The collected questionaries' showed that the factors that are affecting the employees absents are lighting, furniture, temperature, working posture, smell and noise. These factors are a relationship on employee's absenteeism and so for the employee's productivity. Because of their siting arrangement and working environment they feel pain and fatigue on their body parts. Shoulder, lower back, mid back, lower leg, forearm are the most affected body parts in this research. Their body postures are analyses using RULA and the outcome is seven which needs immediate attention and need change. To solve those encountered problem and identified factors the anthropometric measurements of tellers are taken and the mean, standard deviation, and percentiles are calculated for the input of the new design.

5. CHAPTER FIVE

CONCEPTUAL FRAMWORK DEVELOPMENT

5.1 Introduction

In this subtopic the new propose frame work for better ergonomics workplace design is routed. Findings from the analysis, from different literature reviews and based on the considering the general view and observation of branches the new conceptual framework design is developed.

5.2 Top management commitment

According to the bank mangers they are in need to change the current workplace environment and layout. They strongly believe that the productivity and efficiency of employees can increase due to modification of the workplace design. So they should work with the respective departments in order to address this situation. The top managements with respective section including HR department Facility department, Engineering department should seat together and discuss to improve the current workplace design. As seen in different literatures the participation of the front faced employees has a great input to the thriving of employee's productivity. The tellers are the one who are sited in the front place and should give agile service to the customers so that they know their problems in their day to day activity. Gathering information from them, asking their difficulties and then identifying the critical problem will contribute to get the right solution. Top managements should do this to get the required output and so as to increase the company productivity.

In the mean while the top managements should arrange trainings to aware the employees about the ergonomics and its benefits, about neutral position concept, healthy, safety and related issues to keep the employees refresh and remind forgettable concepts. Addressing the concept will minimize the factors that can cause to MSD. As seen on the literatures the MSDs can be caused by different factors and can be illuminate with a simple idea. Employees trained and aware about ergonomics concept, use and effect would develop their own idea and prepare their own comfort zone to encountered those ergonomically factors without any cost. This way they can be safe, protect their own health, improve their efficiency, their productivity will grow, customer satisfaction will increase and at the end the overall productivity and performance will be rise.

5.3 New conceptual workplace design

5.3.1 Lightening

A brightly illuminated work area will wash out the images on a computer screen because the monitor produces its own illumination and contrast. Computer workstations should have lower light levels than

typical office areas. Illumination should be 20-50 foot-candles for screen viewing and 50-70 foot-candles for reading printed documents. The workstation should be located away from and at right angles to windows; windows should have adjustable blinds or drapes to reduce glare and eye fatigue. (Vertical blinds reduce glare more effectively than horizontal blinds.) Walls, furniture, and equipment near a monitor or display screen should have no reflective, subdued colors to minimize glare. Workstations should be spaced between rows of overhead lights to reduce glare and reflection.

The workstation arrangement also has been designed to front face to the outside which has a capability to directly affected by the light and reflection of buildings. As the tellers are front to the outside environments they are directly affected by the light. While opening new branches, this should be into account. Arrangement of the benches will have direct impact on the reflection of light. To eliminate this effect, the benches should be arranged in the side way in such a way that it cannot affect the customer comfort.

In the standard world branches, the separate glass is not available. This is because they have the principle that has a direct relationship with the trust of customers. The banks think that we cannot protect ourselves from our customers because they give their money because they belief us, so we don't need to cover or shield from them. This principle gives a good view to the customers and the bank relationship. But when they are making this kind of arrangements they are protected with the hidden cameras, securities and other modern controlling systems. Countries like Ethiopia this will be difficult unless the developing system down to be implemented. So the communicating window is covered by the transparent glasses. This glass used to separate the customer and the tellers which are fully transparent to the visual pictures from the outside. This kind of glasses are able to reflect lights directly to the tellers and can hurt eyes. So they should also be replaced by Anti-reflection type glasses. Anti-reflection type of glasses can fully transfer clear view from the outside and as the same time it can provide broadband reduction of reflection across the visible light spectrum. The main advantage of anti-reflection glasses is to minimize the amount of surface reflection seen from the face of the glass. They can achieve a surface reflectance of 1% to 3% and a light transmission of 98% which can relieve the eye strain, reduce glare and helps in clear vision.

5.3.2 Temperature

High environment temperature, high humidity and impaired heat dissipation may cause a variety of heat disorder including heat syncope, heat edema, heat cramps, heat exhaustion and heat stroke as systemic disorders, and skin lesions as local disorders. Some of these disorders are needs serious medical attention which may resulting death.

A variety of heat disorder can be treated by different mechanism. The First the heat generating equipment, heat radiation, humidity, heavy air, regulation of heat should be identified. By eliminating these factors, the temperature of the workplace environmental be controlled.

To lower body temperature, reducing the heat load and promoting heat dissipating from skin. The employees should work on shady, safe, cool and well ventilated place and also removing unnecessary clothing and fanning. Fanning can promote evaporation from skin which can reduce the core temperature by 0.03 to 0.06 degree centigrade per minute.

The workers should aware the work load and the level of heat stress they may encountered and also the risk of heat disorder. Aware about the environment temperature helps to wear clothes with related to the season. For example, fabric clothes are water absorbent and permeable to air and water vapor facilitate heat dissipation.

Free access to water is a mandatory to employees which encourage rehydration and they should eat balance diet like lower salt content.

Using ventilation diffusers and deflectors to keep cold air from blowing directly to employees can avoid the temperature problem. This can prevent the systematic symptom such as shivering, clouded consciousness, extremity pain, dilated pupils, and ventricular fibrillation.

And add heatshields around the heat generate equipment minimize the heat in the workplace environment as to reduce heat exhaustion, heat cramps, and heat-related disorders (e.g., dehydration, electrolyte imbalance, loss of physical/mental work capacity).

Finally, workers should be taught the symptom and signs of heat disorder, like dizziness, faintness, palpitations, breathlessness and extreme thirst and learn basics of first aid and to call to get medical access when recognize this signs.

5.3.3 Furniture and Equipment's

A. Working chair

Ass this study is conducted in Abay bank tellers who are worked in 3 shifts with different sized, the design should be appropriate for all type of personnel. Therefore, Standard chairs suit the majority of the tellers to fit all size. An office chairs are preferred to have comfortable cushioning and covering on the seat and curved lower lack (lumbar) supporting on backrest. It should be the five-point base to minimize tip over and arresting in comfortable way.

Seating height: - The new proposed working chair for tellers is adjustable seat height to which the minimum length is to fit with the 5th percent of the people and the maximum height is the 95th percent

of the peoples. So tellers between 5th and 95th height ranges can vary the height of their chair in order to fit their seating height. This is related with the popliteal height with the minimum height of the 5th and maximum height of 95th adding the shoe clearance about 0.12inch to get the required height.

**** SEAT HEIGHT= between 5th and 95th height popliteal height = 14 inch up to 21 inch

Backrests or lumber support height: - Raising and lowering the backrests is necessary because Backrests should support the upper and lower back. Adjusting between 5th and 95th to all tellers that the lumbar support fits snugly against the curve of the lower back. If it is not possible to have the backrest adjustment chair, it is better to use the full lumber covered backrest type chars.

And also it should be adjustable in the forward and backward direction with an angle of 100-120 degree between the trunk and thighs enables better spinal posture. This can be achieved by adjusting the backrest angle in combination with the seat pan tilt. This allows the backrest to move through a pre-set range as the back moves. The tellers are able to move through a range of acceptable postures while still remaining in a supported seated position.

*** BACKRESTS HEIGHT= between 5th and 95th erect sitting height= 28 up to 38 inch

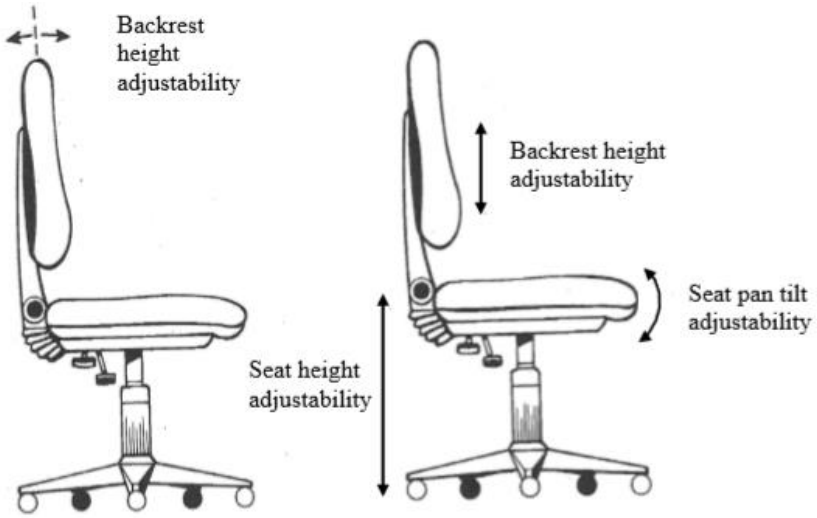


Figure 5.1 Chair design

Seat pan depth: -this is related to the buttock to pop tile length; which should allow to fit the shortest and tallest peoples to rest their lower back into the chair. This is so designed for 5th percentiles of people which is so the 95th percentile peoples also can reach their lower back to the chair.

*** SEAT PAN DEPTH= 5th percentiles of people =14 inch

Seat pan width: - this is related to the hip breadth. It gives the overall seating area with the seating dept. the seating width should be designed for 95th percentile of hip breadth to include the wider hips and can allow also the other peoples. And the cloth clearance is around 3 inch additional to hip breadth.

*** SEAT PAN WIDTH=95th percentile of hip breadth =23 inch

Armrests or elbow rest height: - armrests are helpful for forearm support for comfortable rest with shoulder relaxed. They are used to lowering and rising from the chair. Some chairs are manufactured without armrests. This is because they block the space to the working desk/table, when there is no enough space to turning chair or stand up easily, there is interfere to use mouse and keyboards. But it will be better to design the armrests with adjustable height and turned inward and outwards. If this is difficult to do the 5th% Elbow height is recommended.

ARMRESTS OR ELBOW REST HEIGHT= between 5th and 95th height= 7 up to 12 inch or 7 inch

B. Working station(table)

The workstation or table should be flat and smooth surface to use the keyboard and mouse in the same level. And the space should be appropriate to place all the necessary equipment's on the right position to avoid an awkward posture and to agile the given task. The clearance below the desk also should be enough to stretch legs. In this case study the tables of the tellers are somehow different from the normal office working tables. Because the tables are served for both the tellers as well as to the customer side.
Table surface height= 95th % Seat Height + 5th% Elbow height +Shoe allowance (0.12)

*** TABLE SURFACE HEIGHT= 28 inch

Table surface width= 95th % hip depth or more

*** TABLE SURFACE WIDTH= 23 inch and more

Table surface depth = 50th % forearm hand length and more

*** TABLE SURFACE DEPTH = 21 inch and more

C. Foot rest

The tellers are sitting a little bit higher than the floor in order to view the customer with a certain height. So the footrests should be arranged in such a way that stable enough, a non-slip surface (does not slide or move) and can arrest both feet in a comfortable way. Its standard limit is about 12 inch by 12 inch

and tilted about 10-12 degree. The foot rest in this case should be placed with the table as the height to rest the shortest people foot.

D. Monitor

To protect the neck and the chin from arched back and extended forward the monitor should place in a clear, comfortable and suitable for eyewear worn by the tellers. It preferred to tilt 10-20 degree to protect the eyes from glare from window. The font size, the brightness helps to the characters and contents to read easily.

Screen height= Eye sitting height or lower= 95^{th} percentile of eye seat height

*** SCREEN HEIGHT= 34 inch and lower

Viewing distance= Arm length away or more= 95^{th} percentile of Arm length

*** VIEWING DISTANCE= 24 inch

The tellers should adjust the monitor into different positions to get required viewing height and distance to minimize the visual fatigue.

E. Keyboard and mouse

The position of keyboards and mouse should be straight and flat smooth surface kept in front of the tellers to eliminate the twisting of neck, straight to wrist and awkward posture. To minimize pressure on the wrist and forearm support, away the position of the keyboard and mouse from the edge of the table/workstation. Adjustment of the angle and height of keyboard by folding and unfolding the small and larger leg under the keyboard to get proper hand writing position. Check the mouse also to fit comfortable in the hand to minimize load and pressure in the forearm and wrist.

Takeoff hands from keyboard and mouse when there is no use to reduce muscle fatigue from hovering over the equipment.

F. Other equipment's

Other equipment's like cash counting machine, paper documents, plastic band, cupboard and others should keep in semi-circle zone to easily reach. On the teller position the frequently used equipment like cash counting machine, placed in the primary zone of semi-circle area, so that no further away than the distance between the elbow and knuckles when seated and upper arm is close to the body.

Table 5.1 Proposed design and standard

Legend	PROPOSAL		STANDARD	
	In inch	In mm	In inch	In mm
Seating height	14-21	355-584	16-20.5	406-508
Backrest height	28-38	711-965.2	20-30	508-762
Seat depth	14	355.6	15-18	381-457
Seat width	23	584.2	16-21	406-533
Armrest	12	304.8		
Table height key board	28	711.2	24-30	609-762
Table height monitor	28	711.2	24-30	609-762
Table width	more than 23	more than 584	24-60	609-1524
Table depth	more than 21	more than 533	20- 30	508-762
Foot rest height	11	279.4	-	-
Foot rest width	12	304.8	12	305
Foot rest depth	12	304.8	12	305

5.4 Analysis of variance

Analysis of the difference is calculated by the actual measurements of the chairs, table and foot rest in the branches and the proposed new design is calculated.

Table 5.2 Analysis of variance

Legend	ACTUAL		PROPOSAL	
	In inch	In mm	In inch	In mm
Seating height	25-33	635-832	14-21	355-584
Backrest height	18	457	28-38	711-965.2
Seat depth	17	432	14	355.6
Seat width	16	406	23	584.2
Armrest	9	229	12	304.8
Table height	44	1118	28	711.2
Table height for keyboard & monitor	51	1295	28	711.2
Table width	44	1118	more than 23	more than 584
Table depth	12	305	more than 21	more than 533
Foot rest height	10	254	11	279.4
Foot rest width	12.5	318	12	304.8
Foot rest depth	9	229	12	304.8

Seating height: -The seating height is too high for 5th percentile people. This peoples may not touch the ground even they adjust the minimum height to of the current chair.

Backrest height :-It is too short for to support backrest; shoulder and mid back and also the lower back is affected by this chair.

Seat depth: -the 5th percentile people sitting in this chair couldn't reach to the backrest support. To keep the right angle between the Buttock popliteal length to Popliteal height, the shortest people will far from the backrest of the chair.

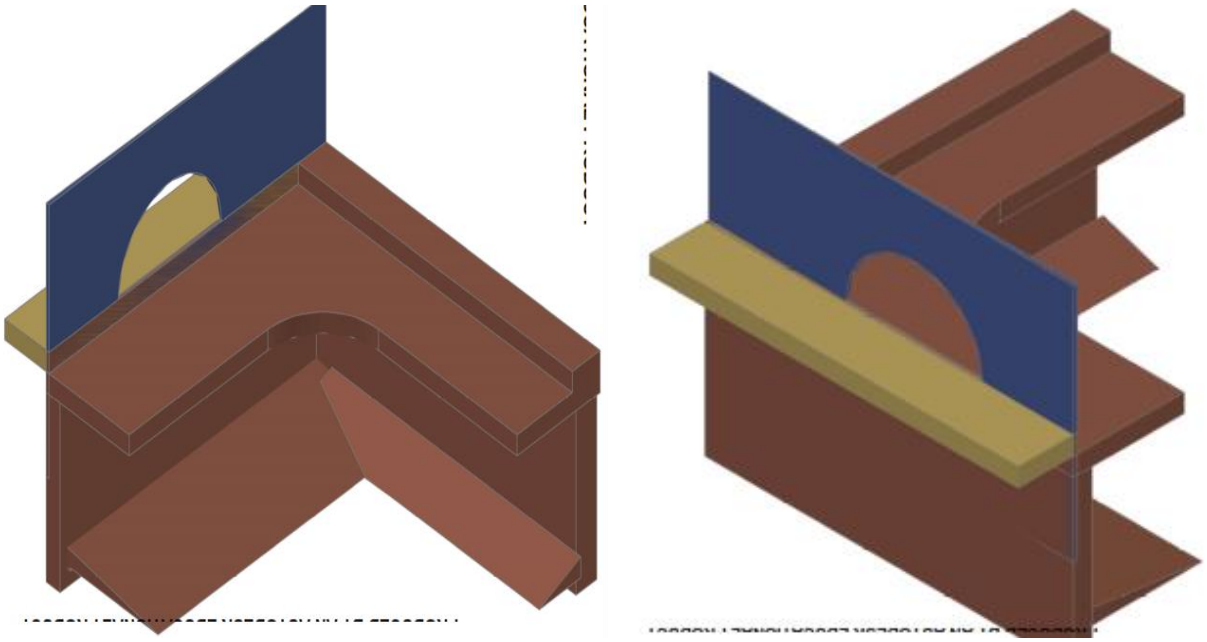
Seat width: - the fat people in this chair arrangement which are above 16-inch hip breadth my not sit or comfortable because of the small width of the chair

Armrest height: - this is a little smaller than the tellers that is why their armrest is suspended in the air without any support.

Table height: - to keep up with both customer and teller side the table arrangement is too high from the floor; in such a way that the tellers should raise up their char to lineup with the table.

Table width and depth: - the table width is prepared to hold required equipment's such some paper folders, staplers, binding plastic, printers and so on but in this case they cannot support even their arms

Foot rest: - the foot rest support can be prepared for a person to support their foot and tilted about 10-12degree.



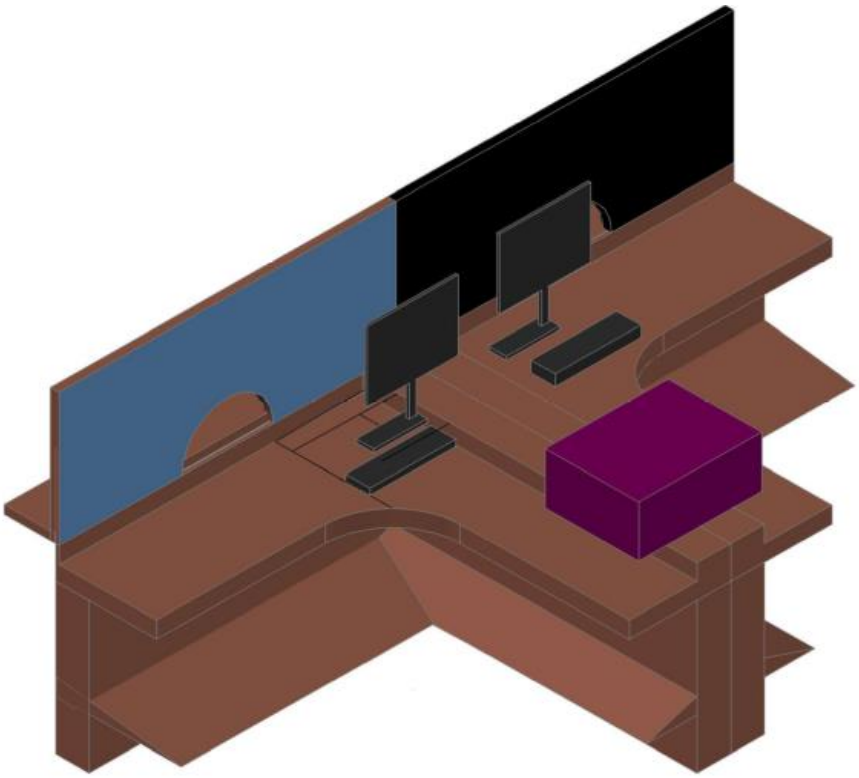


Figure 5.2 New Workplace design

The printer is on the table so both the left and right teller can use it without any difficulty. The monitor is on the table with enough space to move on the required direction. This can help the arms can properly rest on the table. Also the monitor and mouth is on the same level and they can move it whenever they don't need it. The money counter can also be seat on the table. The foot rest is available to rest their foot for whom the pop tile height of the tellers is short to reach to the floor.

The front window is prepared to have clear visual with glared glasses. This will help the tellers to protect their eyes from reflection that comes from inside and outside areas like building windows, colors, promotion windows and others…

The other is the processor for the computer and the cabinet will be near to the table in the left and right side. This can give an advantage to reach both with the left and right hand whenever it needed. The receipts, personal documents and other stationary items can be avail in the cabinet box and locked any time. [APPENDIX D]

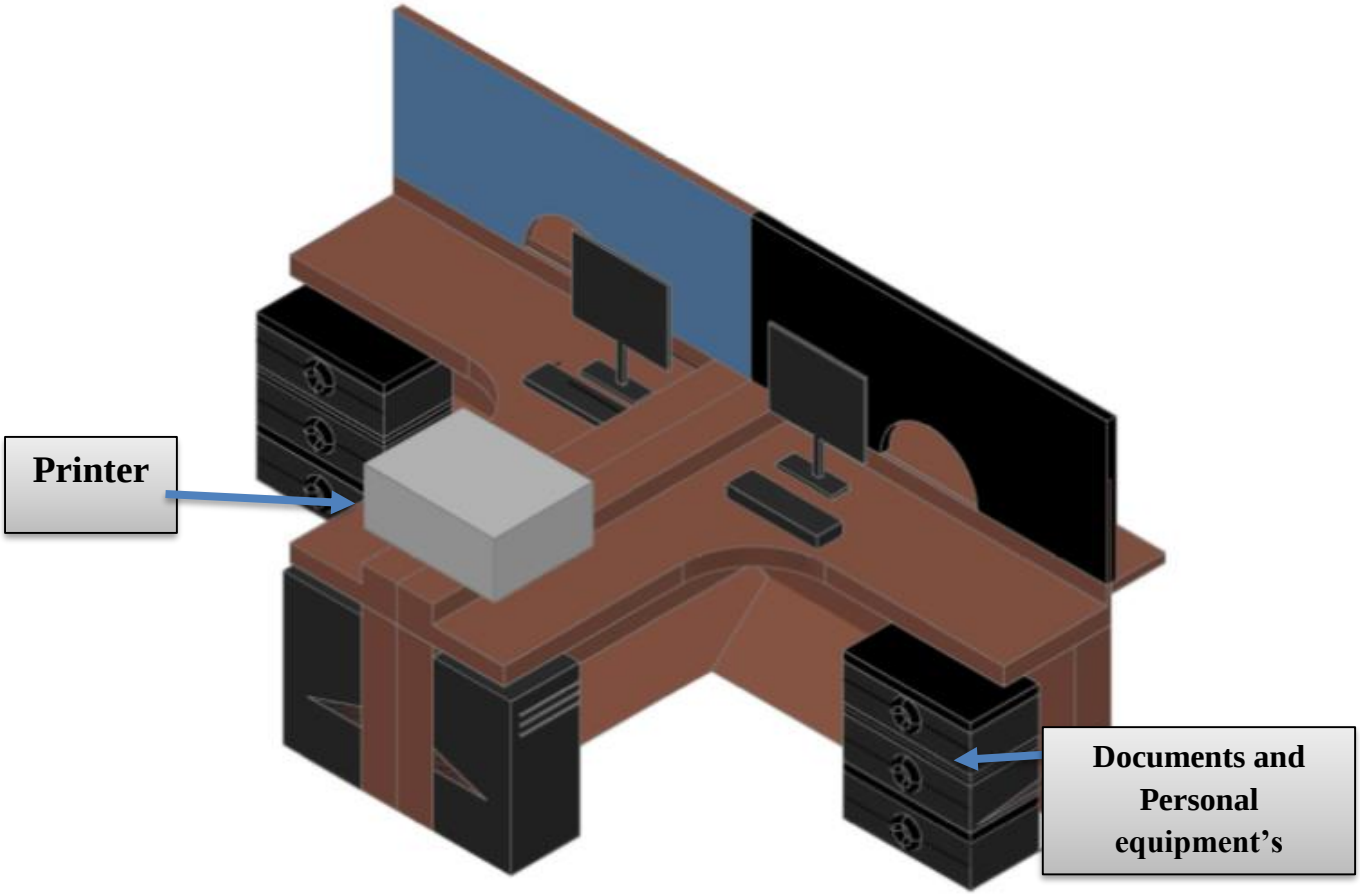


Figure 5.3 Position of equipment's

5.5 Analysis of the proposed design

The new proposed design has modified the dimension of the tables to reach and access all necessary equipment's required for their work. The design was tested using RULA analysis and final score of 2 which is in acceptable level. Compared to the existing arrangement it reduced to two from seven. This can reduce their back pain, mid back, lower back, legs and then Musculoskeletal disorder(MSD). When the main causes are minimized the illness and injuries on the tellers also decreased and there by absenteeism due to sickness. Also employees could benefit by enhancing their healthy. Some little investments in the workplace, ensures a better health and safety to the employees operate as a win-win. From reducing the sickness absenteeism, the company will avoid huge productivity drop. Especially high-levels workers (task specific) persons are absent the impact on the productivity will increase.

Even considering the existing workplace arrangement and the proposed design it has a big difference in the employee's body posture. This will reduce the pain on the employees as well as the time takes to give service to the customer. Keeping other process as it is before; if the new proposed design improves

the time takes to bring the paper from the printer by one min for deposit/withdrawal service, it would be 8 min. This can improve the number of customer from 53 to 69. This is the fact that only considering the printer issues keeping other sub-process as it is. [APPENDIX E AND F]

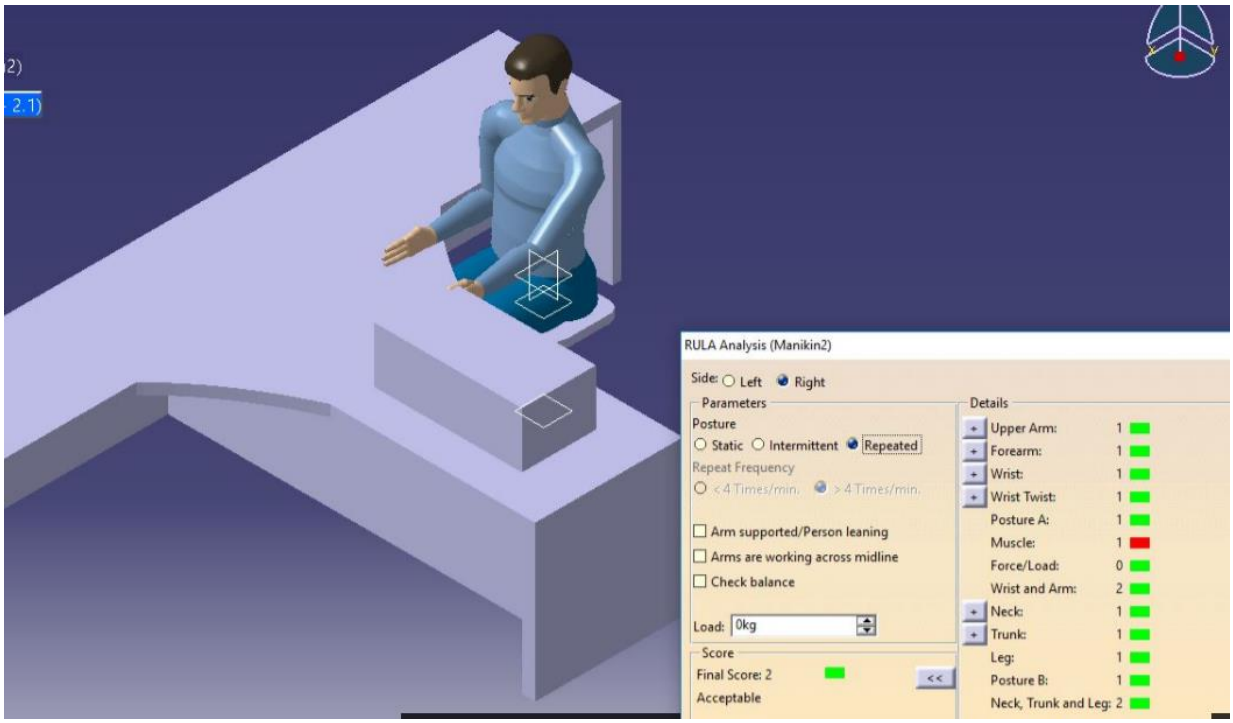


Figure 5.4 The posture of tellers after improvement

From the above RULA analysis, the employees are safe and healthy while working their given task. By providing comfortable workstation the workers can develop their health and safety. This will help to minimize their absenteeism by reducing sick leaves. It implies that their productivity, according to HR, will increase from 19%. Additionally, the service time will minimize by reducing awkward posture, keeping necessary equipment's nearby them and flexible working environment. If the new proposed design is implemented, there will be 1-minute improvement even by taking printed papers from the printers.

Table 5.3 The productivity improvement

Service Type	Company service delivery time (Min)	No customer per day	Actual service delivery time (Min)	No customer per day	Productivity of employees
Cash transfer-account to account	3	160	7	68	**43%**
Deposit to saving account	5	96	8	60	**63%**
Withdrawal from saving account	5	96	8	60	**63%**

5.6 Ergonomic Control Strategies

Ergonomic control strategies mainly focus on the hazards that contribute negative impact on humans in their working environment. It main aim is to identify ergonomic hazards and points out control mechanism according to safety and ergonomic principles point of view. Generally, we can apply Ergonomic control strategies as below:

5.6.1 Engineering Control

From the aspects of engineering, the ergonomic factors can be control by implementing the below

- Try to Keep neutral posture at any movement including working on the computers using keyboard, mouse and foot arrest position.
- The work surface should be large enough to support the keyboard, mouse, and monitor
- Keyboard and work surface edges should be rounded to eliminate Sharpe aged damages
- Documents should be the same at height and distance as the screen
- A variety of working positions avoid static postures
- Full range of motion and adequate range of leg room, etc.

5.6.2 Administrative Controls

These are control measures designed to reduce to the exposure of the employees to ergonomic stressor through the development of specific polices/procedures.

- Revision of work rest schedule, Scheduling breaks depend on the manpower and shift
- Adjusting the workplace by discuss with the employees who are the forefront of everything
- Rotating workers among jobs based on the skills and the desired position
- Give training in the recognition of ergonomics risk factors specially for new employees who will take care of the future tasks and playing great roll for the productivity of bank.
- Give refreshment course, awareness, meeting on some interval time for the seniors to refresh themselves

5.6.3 Use of Personal Protective Equipment

- Update themselves on how to protect injuries and illness by implementing simple ergonomics principles by their level like using kneepad, working in neutral position, applying appropriate load handling, keeping objects near to them etc…
- To address the problems to the immediate supervisor before the problem becoming top issue
- Seek professional medical assistance soon

6. CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Productivity can be achieved through different mechanism and tools and also can be affected by different parameters.one of them is ergonomical workplace. The ergonomic work place design has a significant impact on the productivity of employees. Workplaces has a great fascinate to customers as well as employees. Especially for employees the workplace should be comfortable, safe, inspire and then to be more productive. As seen in different literatures the workplace condition determines the employees comfort and boost to their productivity.

This paper focused on the impact of ergonomics on productivity of employees worked in Abay bank S.C. From the study, the awareness and implementation of ergonomics is very low and needs an enormous attention by the top managements. Trainings and safety related classes should be arranged to fill the gap in the ergonomics effects and to prevent the impact.

The study also found the most significant ergonomics risk factors that may increase the likelihood of illness and injury to musculoskeletal system and causes absenteeism. The main identified risk factors include light, furniture, temperature, working in bad posture, noise and smell. Ergonomics problems will cause the employees either fast or slow effect. Working in uncomfortable static position or contact stress of muscle and twisting of the body position increases the injury and then to their absenteeism through time.

The tellers worked in the front face of counter cage area has a high fatigue effect on their shoulder, lower back, mid back, lower leg and forearm position due to uncomfortable working arrangement. While performing a given task the sitting arrangement should be more flexible to access the equipment's and specially in this positon to serve customers. Managers also believed that the existing workplace arrangement affects the teller's efficiency and productivity. The existing layout modification or replacement would increase the employees as well as company's productivity.

The new proposed design for the branches will provide flexible environment and can access different working tools nearby them. The new design also tested by the CATIA software and RULA analysis to view the improvement that can reduce the several bad posture.

Finally; this study is concluding that the ergonomics workplace design need to pay more attention for the safety and health of employees. Ergonomic risk factors are caused fatigue on the employees and make them to injuries and illness which has impact on their productivity directly or indirectly.

6.2 Recommendation

From the overall analysis, finding and conclusion of this study, the below recommendation points are made.

- Ergonomics in the bank need to pay attention due to employees healthy and safety is depending on it. Therefore, training and Awareness on ergonomics should prepare to employees to prevent the ergonomic related illness and injuries faced due to work. This helps to increase the productivity of the employees by minimizing the sickness absenteeism.
- Employees to use ergonomics principles by gathering information from different sources like books, journals, internet and other mechanism to enhance their health and safety.
- The size of tables and chairs should meet the anthropometric standard of dimension of employees. The equipment's should place on their proper position to eliminate awkward body posture of the employees. Therefore, this study recommends to use the new proposed design to eliminate those encountered factors.
- To consider the location of branches to eliminate light reflection, noise, smell and other factors from outside. Since location of branches has significant factors on the employee's day to day activity it has the impact for the overall company productivity.

6.3 Future research direction

Due to largeness of the bank located in different region, this study covers only Addis Ababa branches. Since the data are collected from different branches in Addis Ababa, it is not fully enough to alleviate measurement related problems and to improve all dimension. Therefore, established Ethiopian standard measurements and preparing new workplace design are an interesting future research design.

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APPENDICES

Appendix A

Sample Literature reviews

ITEM NO	WRITTERS	TITLE AND CASE STUDY COMPANY	PROBLEM	OBJECTIVE	OUT COME	CONCLUSION	METHODOLOGY
1	Zafir Mohd Makhbul, Nor Liza Abdullah and Zizah Che Senik	Ergonomics and Stress at Workplace: Engineering Contributions to Social Sciences:-(Multinational electronic manufacturing companies that are registered with Malaysian International Chamber of Commerce and Industry (MICCI).) [2013]	To examine the relationship between factors relating to ergonomic workstation components (human, machine, work area, and environment) and work stress.	To identify the significant factors among ergonomic workstation variables that contribute to stress in organizations.	The major components of ergonomic workstation reveals that 38.4% of the changes in workplace stress outcomes are due to the relationship between stress and ergonomic factors, which include human; machine; work area; and environmental factors.	An ergonomically designed working environment can reduce human resource problems, including fatigue, job dissatisfaction and intention to quit.Management must ensure that the work environment suits the workers by matching human resources anthropometry distinctiveness and employee demands.	questionnaire distributions; Loading based on varimax rotation
2	Zafir Mohamed Makhbul, Durrishah Idrus and Mat Rebi Abdul Rani	Ergonomics design on the work stress outcomes:-(Manufacturing operators in one multinational electronic company, Malaysia) (9-Jun-2007)	Negative effècts workers' quality and productivity due to the ignorance of the stress outcomes in organizations	To find alternatives to reduce work stress outcomes in organization.	62.9% of the variance in stress outcomes is accounted by the independent variables such as chair, work area, acoustics, lighting, working hours and humidity.And also the longer working hours will affect the work stress outcomes.	Organization should pay higher attention as ergonomic factors namely chair, working hours and humidity. These factors were found to have significant effect on the outcome of stress. Ergonomic issues will continue even the best designed jobs if employees ignore proper handling of equipment's or do not possess ergonomic-related knowledge.	questionnaires; Kolmogorov-Smirnov test, The ANOVA for the regression
3	Zafir Mohd Makhbul, Syed Shah Alam, Shaza Marina Azmi and Norliza Abu Talib	Ergonomics and Work Stress Issues in Banking Sector:-(Banking Supervision Department in ABC Bank) [Sep 2011]	The increasing in work stress has the negative forces and health issues onto the individual as well as organizations. Information on ergonomic application in developing countries where the knowledge and awareness towards the importance of ergonomic are still low is hard to be obtained even though ergonomic is a very interesting disciplines to study.	To examine the most significant factor in the ergonomic workstation variables that influences the stress level.	47.2 percent of the changes in stress outcomes at the workplace were due to its relationship with body postures and health factors. Health factor is a major concern in stress outcome at the workplace due to the demanding tasks that requires long hours input in the Department. This is especially true when major reporting events or special tasks takes place where employees put in longer hours to complete the given tasks than any other normal working hours.	A solution to all problems related to somatic complaints, fatigue, burnout, job dissatisfaction, and intention to quit could be reached once the management takes into account improving employees' work flow. Other solutions include having comfortable and suitable arrangements of employees' workstation to avoid congestions, sharing health hazard programmes on less bending over and long standing hours to overcome body posture issues, and investing in new ergonomically designed working chairs to help overcome stress factors at workstations.	questionnaire distributions; Exploratory Data Analysis (EDA),Multiple Regression Analysis,Mean and Standard Deviation

4	Emmanuel Majekodunmi Ajala	The influence of workplace environment on workers' welfare, performance and productivity:-(Government parastatals of Ondo State, Nigeria) [Sep. 2014]	It is observed that most researches on workplace environment and productivity have been concentrated on profit oriented organizations and not much focus have been placed on social service organizations.	The objective of the study is to analyse the influence of workplace environment on workers welfare and productivity in government parastatals of Ondo State, Nigeria.	Better lighting at the workplace will help prevent accidents, help workers improve eye-hand coordination and thereby improve productivity and lower rejection/defective rates. The other one is the absence of noise, good ventilation and room temperature increased workers' productivity and reduces stress in workers due to less distractions and reduction in job-related stress. And also communication plays a key role in the success of any workplace program and practices.	A conducive workplace environment that aid the performance of work automatically improves productivity improved or adequate lighting improves productivity, fewer rejects, enhanced safety, lower insurance premiums, better morale and increased customer satisfaction.	questionnaire distributions; MEAN AND STANDARD
5	Prof.Dr.Abdul Ghafoor Awan,	Impact of working environment on employee's productivity: - (A case study of Banks and Insurance Companies in Pakistan) [2015]	The study was conducted to find out that how employees' productivity can be increased by developing a conducive working environment. Whether the selected environmental variables are helpful in developing a working environment that has positive impact on employees' productivity in the organization.	To measure the impact of working environment on productivity of employees by describing importance of work place environment in the organizations, factors that develop work place environment and impact positively on employees productivity and by explain results for validating the proposed frame work.	Good relations with coworkers, Training and Development, good incentives, rewards and recognition plans, adequate work, working environment and Supervisor Support helpful in developing a working environment that leads to increase in employees' productivity.	This research concludes that working environment is helpful increasing employees' level of productivity. Factors like supervisor support, good relation with co workers, training and development, attractive and fast incentives and recognition plans and adequate work load are helpful in developing a working environment that has positive impact on employees' level of productivity in the organization. The results also support our proposed model that was developed for conducting research study in banks and Insurance Companies and also by developing a conducive environment, the level of employees' productivity can be increased and maintained.	questionnaires; Microsoft Excel and the Statistical Package for Social Sciences (SPSS 17.0)

6	Sheetal Sharma & Rvijaya Lakshmi	Workplace environment and its impact on employee's productivity:-(A case study of banks in Raipur) [Dec 2016]	The study will find out that how employee's productivity can be increased by developing effective work environment in the organizations.	To measure the impact of working environment on productivity of employeesby understanding the relationship between the employees and their work environment,by describe the factors that develops work place environment and impact positively on employee's productivity and to suggest the measures to improve the working conditions for better performance.	The study results that the relationship with the supervisors, fair treatment and communications is important. Added to behavioral, also attendees evaluated the importance of physical factors. The behavioral part emotional factors and relations are gotten the first two highest ranks. Comfort level of the offices is more important factor than the office lay out for the employees as physical environmental factors. In this part of the survey, employees' satisfaction towards the behavioral environmental factors is remarkably high.	The overall research study has reached the conclusion that working environment is helpful increasing employees' level of productivity.	questionnaires; Percentage method and interpretation
7	Amina Hameed & Pr. Shehla Amjad	Impact of Office Design on Employees' Productivity: A Case study of Banking Organizations of Abbottabad, Pakistan [January 2009]	To find out the effects of office design on employees' productivity.	To find out the relationship between office design and employees' productivity and the impact of office design on employees' productivity.	The overall impact of different elements showed that lighting affects the productivity of most employees. The overall mean of all the factors show that female employees are more concerned about their workplace surroundings, whereas, their male counterparts are less concerned with it.	There is a direct relationship between office design and productivity.58 % of the variability in employees' productivity is accounted for by the variables in this model.In order to establish a greater understanding of these relationships research, which combines human resource management, workplace layout and performance management, needs to be developed.	questionnaires; Pearson's Correlation in SPSS

8	Revati C. Deshpande	Ergonomics and its Stress Relating Issues for the Employees Working in Banking Sector in Gujarat : [March 4,2013]	This research will examine this particular issue as findings from the present study would benefit various parties in the Banks to understand the benefit of office design and workplace issues which has a great impact on the stress factor of the employees in this sector which might result in fatigue and productivity negatively.	To evaluate the ergonomics and its stress relating issues in banking sector in Gujarat	i) Gender issues as a variable in describing the relationship between ergonomic workstation and work stress; (ii) A study on cognitive ergonomics in order to support the widest variety of diverse work activities in all organizations. (iii) A study on organizations' health policies in relation to ergonomic factors and stress at workplace.	It is concluded that ergonomics had significant influence on stress and it is suggested that regular breaks are taken if working on a computer, leaving the workstation for a few minutes every hour to engage briefly in some other work-related activity, stretching exercises, foot and body exercises, to refresh all of the body's muscles, promoting personal health and a safe learning environment and thereby leads to reinforce the importance of humanworkplace interaction.	questionnaires and visual; Chi-square & ANOVAs
9	Muhammad Faisal Sultan, Muhammad Raghib Zafar, Anila	Office Design and its impact on employees' productivity: Evidence from Islamic Banks of Karachi: [June 2016]	There are only very few research works addressing the effect of office design on employee's productivity. Not only this most of the organizations operating in Pakistan are continuously neglecting the requirement and importance of office design and this ignorance is the main reason for the decrease of employee productivity and also causing frustration and lid on the level of personal growth of employees.	To analyze the impact of proper lightening, noise, upshot of color, effect of office equipment, check the result of office furniture & air quality on the productivity of Islamic Bank employees	Office Furniture, Office Equipment and Communication has the impact on the employees productivity and all the other variables associated with the office design are not creating any impact on the employees productivity.	Human Resource and Administration Managers of Islamic Banks must focus on the effective use of office furniture, office equipment and communication within the department.	questionnaires,Field Experiment. Probability Sampling, Anova Test and SPSS
10	Ikonne, Chinyere N.	Influence of Workstation and Work Posture Ergonomics on Job Satisfaction of Librarians in the Federal and State University Libraries in Southern Nigeria [Sep. 2014]	Due to slow in adopting ergonomic principles in designing facilities in the libraries, the library workforce is encountering ergonomic challenges that could influence the achievement of job satisfaction	To examine the relationship between the suitability of workstation and work posture equipment designs on the job satisfaction of librarians in the Federal and State University libraries in Southern Nigeria.	Condition of work posture, suitable workstation and equipment designs can significantly contributed to job satisfaction which is seriously affects organizational behavior and the achievement of organizational goal.	Neglecting ergonomic principles in the designing of workstations and equipment at the workplace on job satisfaction, the resultant decrease in performance and production, and the numerous health effects that could result from poor ergonomics	questionnaires; Pearson Product Moment Correlation (PPMC) analysis

Appendix B

Co-relation of ergonomics factors

Correlations

		I have a work-related injury or illness	There are uncomfortable temperature, (no prevention for heat generating equipment, heat radiation, humidity, heavy air, regulation of heat it)	There are circumstances in my work that contribute to absence due to illness	There are initiatives made to ensure that I can perform my work safely before I start working	I am affected by airborne contamination in my working area	I have been working on the stress condition	I am feeling tired and bored after finishing my work	I am not comfortable when I am working in my furniture and location of equipment	There is enough space for putting down objects	There no vibration internally that makes Hand and whole-body shake	I am not comfortable with Daylight, glare, reflections, mirroring or dim light	I have been working on bad working posture(Seated, walking, standing, stooping posture, twisting the back, high and low work)	There is noise in my workplace	There is smell/odor in my working area	I have been working in the same shift schedule for long period of time	There is no frequency of the job rotation (from one type of work to another)
I have a work-related injury or illness	Pearson Correlation	1	.387**	.844**	.094	-.007	.150	.647**	.649**	.022	-.017	.697**	.567**	.394**	.255*	-.034	.034
	Sig. (2-tailed)		.000	.000	.388	.952	.165	.000	.000	.842	.874	.000	.000	.000	.017	.758	.752
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
There are uncomfortable temperature, (no prevention for heat generating equipment, heat radiation, humidity, heavy air,	Pearson Correlation	.387**	1	.519**	.175	-.223*	.236*	.394**	.250*	-.018	.213*	.265*	.157	.217*	.057	-.186	.053
	Sig. (2-tailed)	.000		.000	.105	.038	.028	.000	.020	.866	.048	.013	.145	.043	.601	.085	.625
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87

regulation of heat it)																	
There are circumstances in my work that contribute to absence due to illness	Pearson Correlation	.844**	.519**	1	.116	-.097	.220*	.838**	.553**	.098	.054	.571**	.472**	.390**	.176	-.088	.014
	Sig. (2-tailed)	.000	.000		.283	.371	.041	.000	.000	.365	.622	.000	.000	.000	.103	.415	.901
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
There are initiatives made to ensure that I can perform my work safely before I start working	Pearson Correlation	.094	.175	.116	1	.052	.212*	.062	-.055	-.133	.012	-.032	-.164	-.022	.078	-.236*	.024
	Sig. (2-tailed)	.388	.105	.283		.634	.048	.569	.614	.221	.913	.772	.128	.837	.471	.028	.826
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
I am affected by airborne contamination in my working area	Pearson Correlation	-.007	-.223*	-.097	.052	1	-.044	-.006	.085	-.052	.009	.052	-.153	.058	-.001	-.137	.009
	Sig. (2-tailed)	.952	.038	.371	.634		.684	.955	.435	.635	.936	.635	.157	.595	.993	.205	.936
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
I have been working on the stress condition	Pearson Correlation	.150	.236*	.220*	.212*	-.044	1	.188	.027	.016	.153	.013	.020	-.034	-.010	-.182	.155
	Sig. (2-tailed)	.165	.028	.041	.048	.684		.081	.804	.884	.157	.902	.855	.754	.926	.091	.152
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
I am feeling tired and bored after finishing my work	Pearson Correlation	.647**	.394**	.838**	.062	-.006	.188	1	.430**	.127	.065	.432**	.334**	.287**	.048	-.067	-.051
	Sig. (2-tailed)	.000	.000	.000	.569	.955	.081		.000	.241	.549	.000	.002	.007	.658	.538	.640
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87

I am not comfortable when I am working in my furniture and location of equipment	Pearson Correlation	.649**	.250*	.553**	-.055	.085	.027	.430**	1	.100	-.168	.915**	.461**	.490**	.295**	.005	.063
	Sig. (2-tailed)	.000	.020	.000	.614	.435	.804	.000		.359	.120	.000	.000	.000	.006	.965	.563
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
There is enough space for putting down objects	Pearson Correlation	.022	-.018	.098	-.133	-.052	.016	.127	.100	1	-.067	.075	.132	-.102	-.094	-.134	.157
	Sig. (2-tailed)	.842	.866	.365	.221	.635	.884	.241	.359		.537	.492	.222	.349	.384	.217	.145
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
There no vibration internally that makes Hand and whole-body shake	Pearson Correlation	-.017	.213*	.054	.012	.009	.153	.065	-.168	-.067	1	-.153	.007	.176	-.152	-.083	.071
	Sig. (2-tailed)	.874	.048	.622	.913	.936	.157	.549	.120	.537		.157	.945	.103	.159	.446	.512
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
I am not comfortable with Daylight, glare, reflections, mirroring or dim light	Pearson Correlation	.697**	.265*	.571**	-.032	.052	.013	.432**	.915**	.075	-.153	1	.475**	.444**	.267*	.033	.063
	Sig. (2-tailed)	.000	.013	.000	.772	.635	.902	.000	.000	.492	.157		.000	.000	.012	.760	.564
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
I have been working on bad working posture(Seated, walking, standing, stooping posture, twisting	Pearson Correlation	.567**	.157	.472**	-.164	-.153	.020	.334**	.461**	.132	.007	.475**	1	.200	.139	.143	.082
	Sig. (2-tailed)	.000	.145	.000	.128	.157	.855	.002	.000	.222	.945	.000		.064	.201	.186	.450
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87

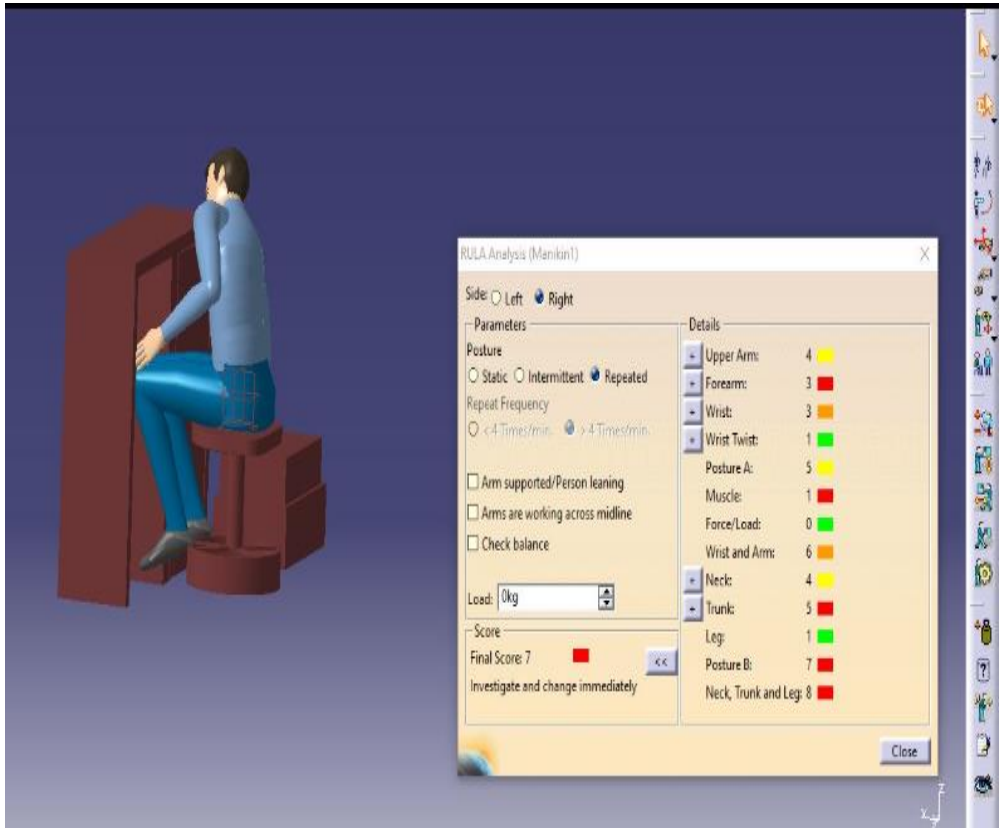
the back, high and low work)																
There is noise in my workplace	Pearson Correlation	.394**	.217*	.390**	-.022	.058	-.034	.287**	.490**	-.102	.176	.444**	.200	1	.096	-.163	.043
	Sig. (2-tailed)	.000	.043	.000	.837	.595	.754	.007	.000	.349	.103	.000	.064		.379	.133	.693
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
There is smell/odor in my working area	Pearson Correlation	.255*	.057	.176	.078	-.001	-.010	.048	.295**	-.094	-.152	.267*	.139	.096	1	-.086	-.064
	Sig. (2-tailed)	.017	.601	.103	.471	.993	.926	.658	.006	.384	.159	.012	.201	.379		.428	.554
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
I have been working in the same shift schedule for long period of time	Pearson Correlation	-.034	-.186	-.088	-.236*	-.137	-.182	-.067	.005	-.134	-.083	.033	.143	-.163	-.086	1	-.164
	Sig. (2-tailed)	.758	.085	.415	.028	.205	.091	.538	.965	.217	.446	.760	.186	.133	.428		.130
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87
There is no frequency of the job rotation (from one type of work to another)	Pearson Correlation	.034	.053	.014	.024	.009	.155	-.051	.063	.157	.071	.063	.082	.043	-.064	-.164	1
	Sig. (2-tailed)	.752	.625	.901	.826	.936	.152	.640	.563	.145	.512	.564	.450	.693	.554	.130	
	N	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87

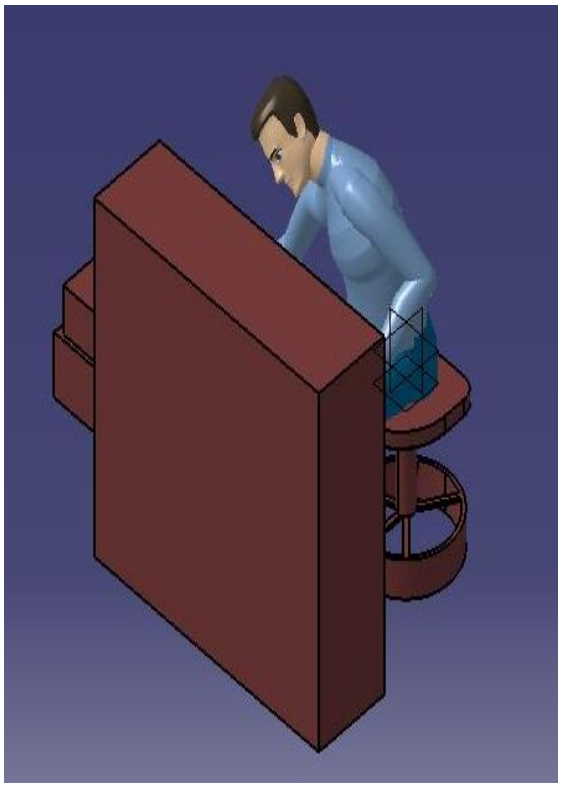
**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix C

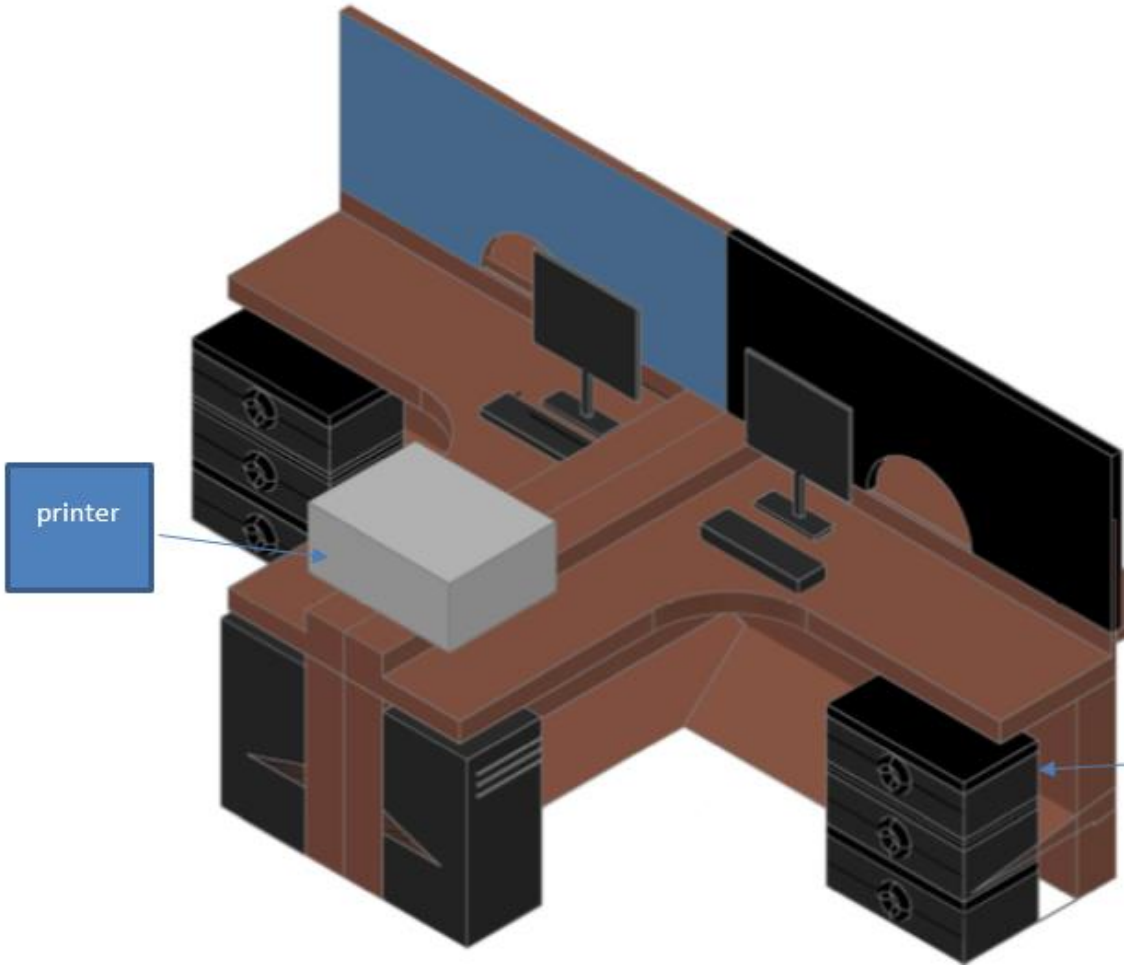
RULA analysis for the existing workplace arrangement





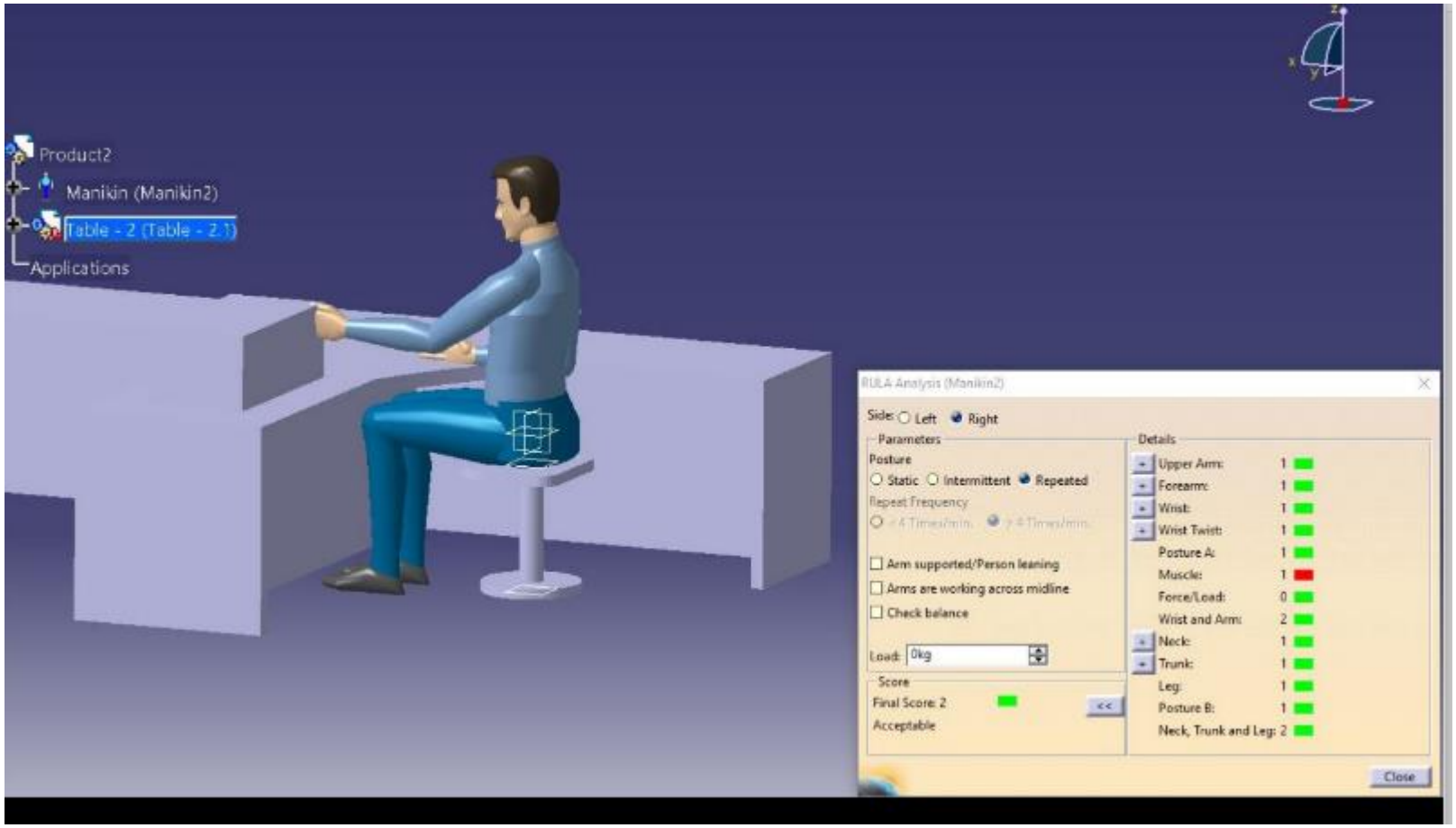
Appendix D

New conceptual workplace design



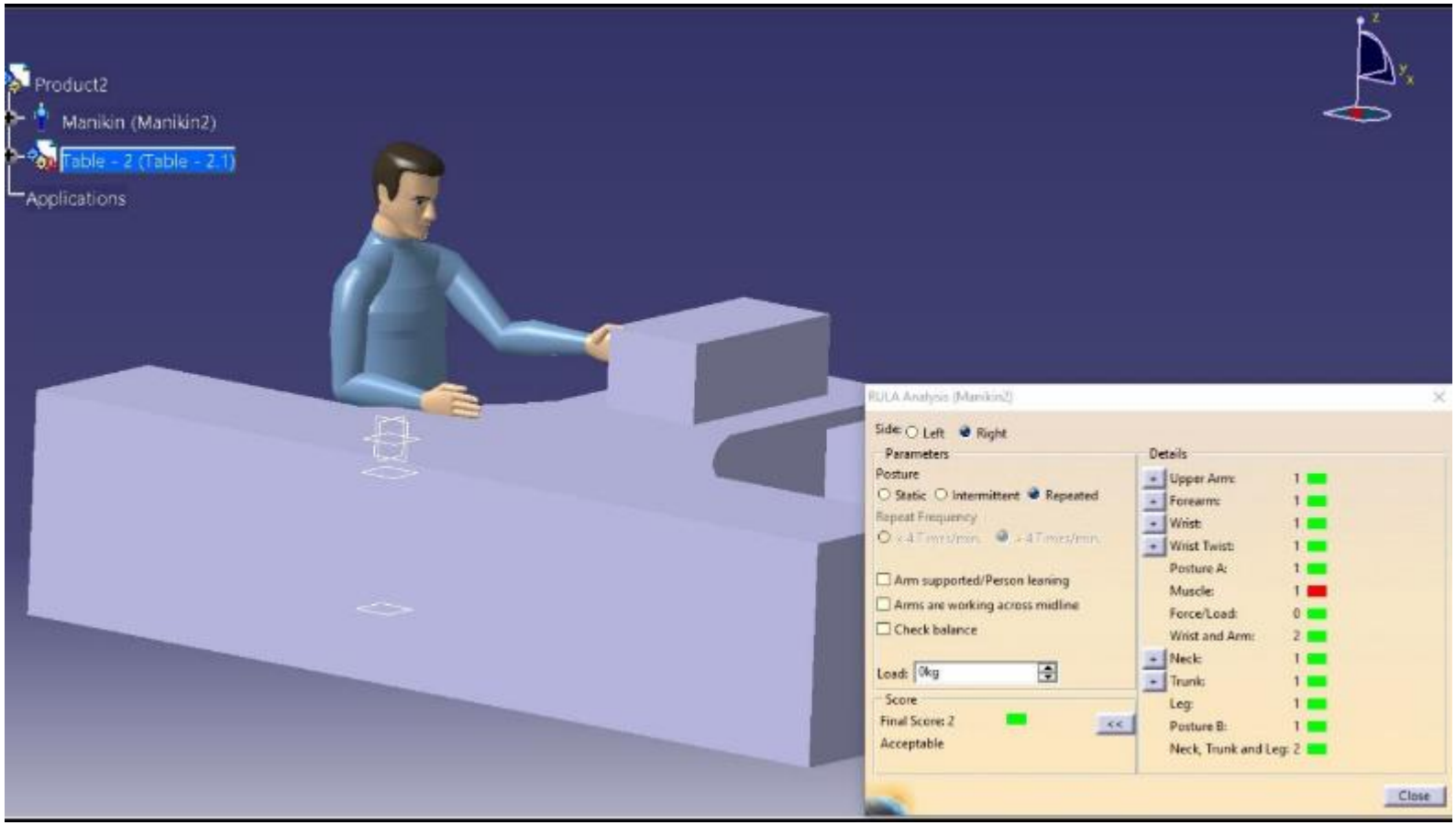
Appendix E

RULA analysis for the new design workplace arrangement



Appendix F

RULA analysis for the new design workplace arrangement



Appendix G

ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY (AAIT)

School of Mechanical and Industrial Engineering

Graduate Program in Industrial Engineering

Survey Questionnaire on ABAY BANK A.C

I. Part one - General Information

1. Indicate your responsibility in your company

Teller [ ] Supervisor [ ] Manager [ ]

Other: Please specify it----------

2. Your work experience in this company

Below 1year [ ] 1-2 year [ ] 2-5 year [ ]

5-10 year [ ] more than 10 year [ ]

3. Sex Male [ ] Female [ ]
4. Age 20-25[ ] 25-30 [ ]30-35 [ ]

35-40[ ] 40-45[ ] Above 45[ ]

5. The major problem of the company

A. Productivity. B. Attention to employees C. Efficiency

D. Customer satisfaction problem E. Skilled man power F. Employees turnover

6. In your opinion the major cause for Employees turnover and Customer dissatisfaction
   a. Arrangement of the office
   b. Shift handling
   c. Repetitive work
   d. Comfortable environment (noise, light, temperature…)
7. Do you think you overall productivity would increase if office environment problems are solved?

1) No change 2) Increased by 20% 3) Increased by 30%

4)Increased by 40% 5) Increased by 50% and more

II. Part two

For Managers Use only

This interview is prepared to collect primary data on impact of ergonomics and its effect on the functions of the company. In addition, I would like to express the confidentiality of the information and that is required only for conducting study.

1. What are the impacts of ergonomics on the company efficiency, productivity?

   _____

2. Does the current work environment design safe for the employees?

   _____

3. What do you think about implementing ergonomics workstation in your branch?

   _____

4. Do you think the current layout of the counter cage comfortable for the tellers?

   _____

5. Do you have anything to add about your company workstation design?

   _____

III. Part three

Please fill the below questionnaires with remark ''✓'' for **YES** and **NO** column

	Training and awareness	**YES**	**NO**
1	Does your facility/company have meetings regarding health and safety issues?		
2	Do you conduct safety training (specifically for new employees)?		
3	Do you know about neutral position concept and practical application?		
4	How familiar are you with ergonomic concepts?		
5	Did you find the most effective training with related to safety?		

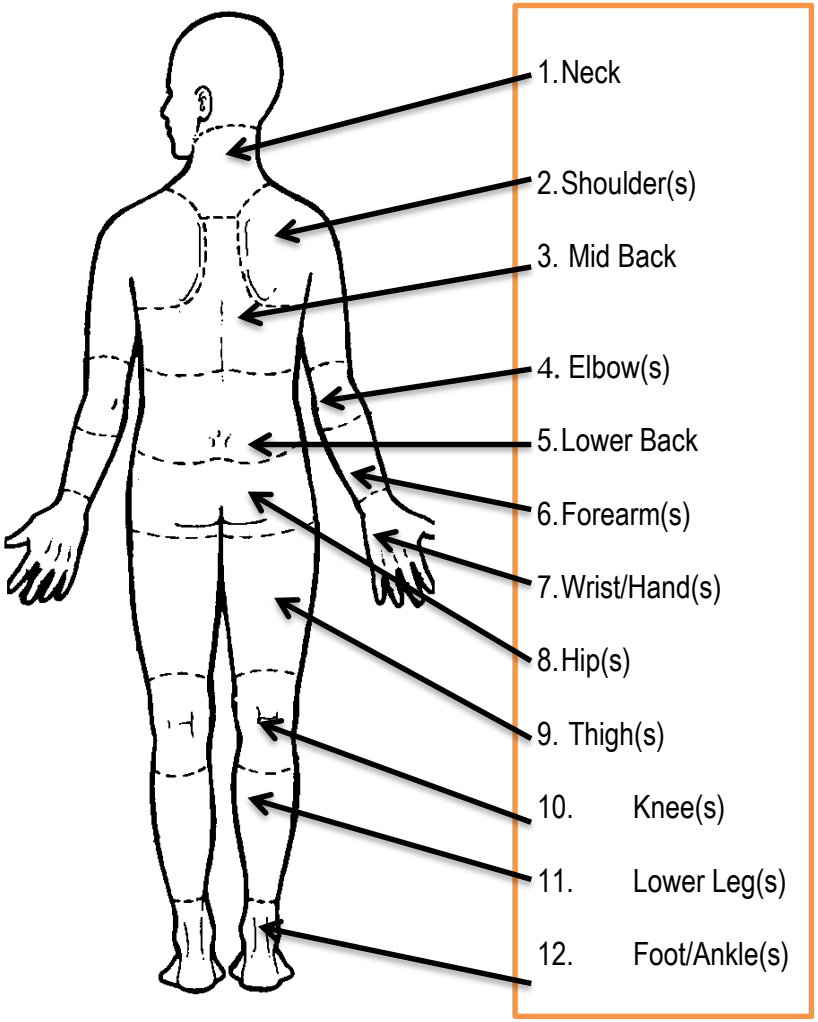
Please fill if the below questions as

5- Strongly Agree; 4- Agree; 3- No change/Neutral;2- Disagree and **1- Strongly Disagree**

		1	**2**	**3**	**4**	**5**
	Health and safety					
1	I have a work-related injury or illness					
2	I am affected by airborne contamination in my working area					
3	There are circumstances in my work that contribute to absence due to illness					
4	There are initiatives made to ensure that I can perform my work safely before I start working					
5	There is noise in my workplace					
6	I have been working on the stress condition					
7	I am feeling tired and bored after finishing my work					
	Physical-Ergonomic					
8	I am not comfortable when I am working in my furniture and location of equipment					
9	There is enough space for putting down objects					
10	There is no vibration internally that makes Hand and whole-body shake					
11	I am not comfortable with Daylight, glare, reflections, mirroring or dim light					
12	There are uncomfortable temperature, (no prevention for heat generating equipment, heat radiation, humidity, heavy air, regulation of heat it)					
13	There is smell/odor in my working area					
	Ergonomic Conditions					
14	I have been working on bad working posture(Seated, walking, standing, stooping posture, twisting the back, high and low work)					
15	I have been working in the same shift schedule for long period of time					
16	There is no frequency of the job rotation (from one type of work to another)					

IV. Part four

Do you experience excessive fatigue or discomfort in any part of your body as a result of your day-to-day work activities? For those body parts affected, please '✓'the score which you feel best describes your level of comfort (1 is the most comfortable and 5 is the most uncomfortable)when performing your job.



		1	2	3	4	5
1	Neck	☐	☐	☐	☐	☐
2	Shoulder(s)	☐	☐	☐	☐	☐
3	Mid Back	☐	☐	☐	☐	☐
4	Elbow(s)	☐	☐	☐	☐	☐
5	Lower Back	☐	☐	☐	☐	☐
6	Forearm(s)	☐	☐	☐	☐	☐
7	Wrist/Hand(s)	☐	☐	☐	☐	☐
8	Hip(s)	☐	☐	☐	☐	☐
9	Thigh(s)	☐	☐	☐	☐	☐
10	Knee(s)	☐	☐	☐	☐	☐
11	Lower Leg(s)	☐	☐	☐	☐	☐
12	Foot/Ankle	☐	☐	☐	☐	☐