ERGONOMICS DESIGN FOR SUPERMARKET CHECKOUT STATION

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A report submitted

in fulfillment of the requirements for the degree of

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DECLARATION

I declare that this project report entitled “Ergonomics Design for Supermarket Checkout Station” is the result of my own work except as cited in the references

Signature :……

Name :…….

Date :……..……

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Hons).

Signature :.....

Supervisor`s Name :……..

Date:……..

DEDICATION

I want to dedicate this report to my lovely parents and family,

lecturers, supervisor and friends.

ABSTRACT

Ergonomics is a study of human scientific discipline and their relationship to their occupational environment. Every working individual will expose to ergonomics risk due to the nature of the work itself. This study was conducted to make comparison from existing design and finalize design in term of ergonomics design and to analyze the ergonomics using RULA analysis. The methods used in this study is observation, questionnaire, quality function development (QFD), product design specification (PDS), morphological chart and weight decision matrix. From the morphological chart, four concept design have been proposed and one of them has been selected to be the final design by using weight decision matrix. The outcome of this study is the ergonomics analysis has been conduct by using CATIA software. The final design and existing design has been compare in order to see the different ergonomics results. The results have been obtained through the RULA analysis. Other than that, the ergonomics analysis has been divided into two position which are seating position and standing position. Each position has been analyzed into several posture there are standing and seating posture, placing item into the packaging machine or bagging area and pointing towards the LCD monitor or keyboard. From the analysis, the final design shows more ergonomics compared to the existing design in term of seating and standing position By having ergonomics analysis, the ergonomics design can help the cashier can be in a comfortable when doing job, less chance risk of injury happened and make the checkout process more effective.

ABSTRAK

Ergonomik merupakan suatu displin saintifik yang mengkaji hubungan diantara manusia dengan persekitaraan pekerjaan mereka. Setiap individu yang bekerja akan terdedah kepada risiko ergonomik kerana keadaan persekitaraan pekerjaan sendiri. Kajian ini dijalankan untuk membuat perbandingan dari segi reka bentuk yang sedia ada dan dengan reka bentuk yang muktamad dari segi reka bentuk ergonomik dan menganalisa ergonomik menggunakan analisa kaedah RULA. Kaedah yang digunakan dalam kajian ini adalah pemerhatian, soal selidik, pembangunan fungsi kualiti, spesifikasi reka bentuk produk, carta morfologi dan kaedah pemberat matrik. Dari carta morfologi, empat konsep reka bentuk telah dicadangkan dan salah satu reka bentuk tersebut telah dipilih untuk menjadi reka bentuk akhir dengan cara menggunakan kaedah pemberat matrik. Hasil kajian analisis ergonomik dilakukakan menggunakan perisian CATIA. Reka bentuk akhir dan reka bentuk yang sedia ada telah dibandingkan bagi untuk melihat perbezaan ergonomik. Hasil kajian tersebut diperoleh melalui analisis kaedah RULA. Selain itu, analisis ergonomik telah dibahagiakan kepada dua kedudukan iaitu kedudukan semasa duduk dan kedudukan semasa berdiri. Setiap kedudukan di analisa kepada beberapa postur iaitu postur berdiri dan postur duduk, meletakkan barang ke dalam mesin pembungkus atau dikawasaan pembungkusan serta semasa menunjukkan ke arah monitor LCD atau papan kekunci. Dari analisis juga, reka bentuk akhir menunjukkan lebih ergonomik berbanding dengan reka bentuk yang sedia ada dari segi keadaan semasa duduk dan keadaan semasa berdiri untuk kedudukan berdiri memberikan keputusan alanisa 2 daripada 8. Sementara untuk kedudukan duduk memberikan keputusan akhir yang sama iaitu 2 daripada 8. Dengan menganalisis ergonomik, reke bentuk yang ergonomik dapat membantu juruwang berada dalam keadaan selesa ketika melakukakan tugas, kurangnya peluang kemalangan yang berlaku serta proses daftar keluar barang akan menjadi lebih berkesan.

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CHAPTER 1

INTRODUCTION

1.1 Background

This study is about ergonomics and musculoskeletal disorders. The study is carry out in order to identify which musculoskeletal disorder have risk most to the cashier and to analysis whether the checkout station that cahier use is ergonomic and also help to the cashier work more effectively. Checkout station is a counter that place in a store where customers go to pay the stuff want to buy and there is several task of cashier while working at checkout station.

In order to understand the ergonomics and musculoskeletal disorders, the definition of the terms must be understood. According to form the author from the journal that has been published, ergonomics the combination of Greek words which are ‘ergon’ (work) and ‘nomoi’ (natural law) which mean the sciences of works and a person’s relationships to the work (Kolgiri, Hiremath, & Bansode, 2016). Other than that, the science of fitting the work to user instead of forcing the user to fit the work is also one of the ergonomics definition (Adams, 2017). As for musculoskeletal disorders defined injuries and disorders that affect the human body`s movement or musculoskeletal system (Middlesworth, 2015.).

The importance of this study is to help identify which musculoskeletal disorder have effect much to the cahiers. Once the factor is identified, the prevention step can be developed and implemented in order to reduce the risk. Other than that, the

important of this project is to design an ergonomics checkout station that can help the cashier work more effectively. The benefits gain form this study are raising the ergonomics awareness among the cashier, help the cashier decreasing the discomfort and pain and improve the work quality life of the cashier.

1.2 Objective

The objective of this study:

i. To design an ergonomic checkout station for the cashier at supermarket in Malacca.

ii. To analyse the ergonomics of the checkout station whether it is comfortable to use by the cashier using RULA analysis in CATIA V5 software.

1.3 Problem Statement

Typically design checkout station in Malacca is to accommodate standing cashiers. Every design of checkout station give an impact on a cashier whether directly or indirectly is depend on customer behavior (Kihlstedt & Hägg, 2011). On the other hand, there are several risk factors that can happened to the cashier such as awkward and static posture, this happen because some design does not follow the guideline give. These two are the biggest factor contributed to disorders and cashier have been appointed as one of the top ten occupations in developing musculoskeletal disorders (Zuhaidi & Rahman, 2017).

1.4 Scope

The scope of this study is only involved the supermarket checkout station. They are four company to be analyze the design of the checkout station. In this study, is to identify whether the current checkout station is ergonomics or not and to identify the strength and flaw every supermarket checkout station design.

For this study, the new ergonomics design of a checkout station for supermarket cashier is purpose and the design will be develop using CATIA V5 software. The design structure of the checkout station will be analyzing to ensure the ergonomics using RULA analysis. The implementation is depending on every supermarket manager whether they want to use it for their supermarket or not.

1.5 Organization of report

The first part of this chapter is background: ergonomics and musculoskeletal disorder are outlined in order to better define specific aspects of identify which musculoskeletal disorder have risk most to the cashier addressed in this study. The second part of this chapter provide an overview of objective and problem statement. The final section describes main elements of a fresh technique of performance analysis. Chapter 2 until chapter 3 explain the literature review of ergonomics and methodology steps to achieve the objective. Chapter 4 describe the analysis of ergonomics for existing design and final design. Chapter 5 discusses the conclusion of this study and recommendation in order to improve the analysis of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is the theoretical background or the foundation of the project. In this chapter it will only discuss about the material from the literature review that has been used for the study. In order to obtain the crucial information, the review was conducted to achieve the objectives of the study that has been determined.

This chapter, it reviews the previous literature review (research journal, research article, and etc.) that already being studied or used. This chapter will provide much more information about comfort in the working environment, which is ergonomic. Besides that, this chapter will include the discipline of the study which are ergonomics risk factor (ERF). Other than that, ergonomics of grocery checkout station will provide information about daily routine and specific task of the cashier, best and preferred work zone for cashier and design guideline for checkout station. Lastly, the conclusion it the last sub part in this chapter that will summarize the whole chapter literature review in this study.

2.2 Ergonomics

Ergonomics come from the combination of two Greek words which are “Ergo” means works and “Nomos” means natural law or system. According form the author from the journal that has been published, ergonomics is designing a job to fit the worker so the

work is free from danger and more productive (Orosha, 2013). In other journal, ergonomics can be directly defined as the study of work which more specifically do not physically forcing the worker`s body to fit the job (U.S. Department of Labour, 2000). The goal of ergonomics is to make the work place more convenient to work and help to improve both healthy and make the work more productiveness. On the other hand, according to International Labour Organization, ergonomics is to obtain best satisfaction for the worker to help them to enhance productivity by human biological sciences that function in conjunction with engineering sciences to the worker and working environment.

Proper nutrition, posture, workplace, and exercise is a practice for good ergonomics (Rajvanshi, Batra, Singh, Effendi, & Zaidi, 2015). The importance of good ergonomics is to reduce the stress on the body during doing a job by an awkward posture, extreme temperature, or repeated movement (Orosha, 2013). Other than that, ergonomics is important for preventing risks such as fatigue, discomfort, and pain.

Furthermore, practicing good ergonomics has many advantage. According to Middlesworth (2013) the advantages of ergonomics are:

i. Ergonomics improves productivity of workers:

   Designing the efficient workstation which allow a job for good posture, less exertion, fewer motions and better heights and reaches will often improve the productivity of the workers.

ii. Ergonomics help improves quality:

   The quality of the product will reduce if the ergonomics of their workstation is poor. So the worker cannot do their best work due to frustrated and fatigued. Therefore, optimizing an ergonomics workstation is important to workers

because it can help improve the quality of the product produce and increase the performance of the worker.

iii. Ergonomics help improves employee engagement:

By putting best efforts to provide best health and safety of their employee. Therefore, it can reduce turnover, decrease absenteeism, improve morale and increase employee involvement because the employee does not experience any fatigue and discomfort during their workday.

iv. Ergonomics can create a better safety culture:

To get better human performance in organization by creating and fostering the safety and health culture in the company because healthy employees are most valuable asset.

2.3 Ergonomics Risk

Ergonomics risk is a condition that causing the uncomfortable posture or condition to the workers such as awkward posture in handling job task, force and repetition of specific movement including vibration and noise, while in term of aspects condition is includes uncomfortable static position, contact stress of muscles and tendon and also include extreme temperature and environment conditions (Kolgiri et al., 2016). While risk is defined as how many injuries or accidents involve a component of how likely or what the possibility of an event is and the severity of the consequence if something happens (Jaffar, Abdul-Tharim, Mohd-Kamar, & Lop, 2011).

There is are some important element in ergonomics risk which is ergonomics risk factor (ERF). According to the article that has been published, the author state that ERF is situations that occur or are deliberately or unintentionally produced that could or could contribute to outcomes or contrary to the basics of ergonomics that could or

could harm the health and well-being of employees or customers at job or after work (Jaffar et al., 2011). In other article, the author has discussed about types of ERF. There is eight types of ERF which are awkward posture, force, repetition, vibration, static loading, extreme temperature, contact stress and sound (Kolgiri et al., 2016).

2.1.1 Type of Ergonomics Risk Factor (ERF)

i. Awkward posture.

It can occur when any joint is excessively bends or wrists. Besides that, awkward posture also can happen when outside a comfortable range of motion various work activities.

ii. Force.

Is a mechanical effort to accomplish a particular motion or effort. As the quantity of physical effort to preserve machinery or instruments, force can also be defied.

iii. Repetition.

Is a performing the same motion repeatedly. By repeated the same motion over period of time can lead to muscular fatigue.

iv. Vibration.

Is described merely as any motion made by the body on a fixed point. In addition, vibrations happen when an object fluctuates, like a swinging pendulum, moves back and forth around its stationary points.

v. Static loading.

Static loading is generally the performance of a task for an extended duration from one postural position. Static loading condition is a mixture of strength, posture and length.

vi. Contact stress.

Hard, sharp objects, tools when grasping, balancing or manipulating can be defined as injury. If the hard object contacts an area without much protective tissue, the effect of contact stress can be worse.

vii. Extreme Temperature

It can be classified into two which are extremely cold and extremely hot. Extremely cold temperature will make the workers to experience some systemic symptoms such as shivering, dilated pupils and extremity pain. While extremely hot can cause the heat stroke which can life threatening.

viii. Sound

Unit measuring for sound is decibels dB (A). Any audible noise greater than 85 dB (A) or greater is very dangerous. Preventative strategies are made to in counter the effect of noise include avoidance of noise generation by using protective hearing devices such as caps or plugs.

Type of Ergonomics Risk Factor (ERF) were summarize above can lead to Musculoskeletal Disorder (MSD). According to U.S Department of Labor, 2000, MSDs are injuries and disorders of the soft tissues (i.e. muscles, tendons, ligaments, joints and cartilage) and nervous system.

2.4 Ergonomics of Supermarket Checkout Station

Checkout station or checkout counter is a counter that place in a store where customers go to pay the stuff want to buy. Checkout counter also affects the work environment of the cashier, directly and indirectly by influencing customer behavior, and cashier work has also been associated with high rates of disorder in the shoulder

or neck, hand or arm. (Kihlstedt & Hägg, 2011). According to the article that has been published, the researcher observed cashier can handle up to 500-1000 items per hour which equivalent of filling over 80 bags while wrist flexion or extension reaching up to 600 times per hour. Other than that, cashier also will lift over 6000 lb. or 2722 kg of groceries during an average eight-hour shift.

Specific task required for a cashier position include (Dsouza, & Poster, 2012):

i. Greet the supermarket entry customers.
ii. Handling all their supermarket's money transactions.
iii. Receiving payment and making change.
iv. Counting or checking cash accounts before and after shift.
v. Give customer service.
vi. Train and assist new members of the cashier.
vii. Scanning in price of purchases.
viii. Totalling the purchase.
ix. Bagging or wrapping purchases.

Because of the poor awareness during these activity, cashier might encounter several risk factor for injury such as forceful exertion which cashier require to use force on the hand to reach the goods up the conveyor. Another risk factor is the awkward posture when cashier tend to reach item across a conveyor which would deviate the shoulder from its neutral position. Repetition motion may also cause injury because the cashier do same action is done quickly and too often in a matter of time. According to the article that has been published, all of the activities have increases the potential for developing MSDs (Rahman & Zuhaidi, 2017). On the other hand, based on several studies cashiers will suffer from cumulative trauma disorder which is

growing form time to time that will to prolonged exposure to repetitive bending or twisting movement at work (Zuhaidi & Rahman, 2017).

2.4.1 Type of Checkout Station in The World

There is four type of checkout station used in major supermarkets in the world. There are belt out feed, drop in bag well, carousel bagging and self-checkout. Their major different of this type is the size, there are small and large size of checkout counter. One of the design is accommodate for wheelchair person which is carousel bagging checkout station. And the rest of the design is for normal people. On the other hand,

The following are the four main types of checkout station used in major supermarkets in the world:

2.4.1.1Belt Out Feed Checkout Station.

This type of checkout station incorporates a take away belt after the scanner which moves the items closer to the bagger or the customer. The process flow for this type of checkout station is smooth and fast. And it also has large counter space are which is easy for cashier to do their job comfortably and efficient. Large counter space also gives the customer to put all of their items on the counter easily. This checkout station also provides multiple belts which provide more efficiency to the cashier and sometimes the take away belt is useful to the bagger because after bagging process he just need to put the plastic bag on the conveyer then the items send to bagging area for customer to collect their items. On the other hand, this checkout station used bi-optic scanner which gives quicker scanning process to help the cashier do faster and efficient job.

Compare to other checkout station this station require two employees which is cashier and bagger. Cashier is a person who scan a bar code, receive payment and making change for customer and totaling the purchase, while bagger is a person who bagging items for the customer. This station will be major problem if the bagger takes leave, therefor cashier has to do all work by their self. Other than that, the bagger have to keep a very fast pace if the items pile up quickly if not the process will be longer because of the slow pace.

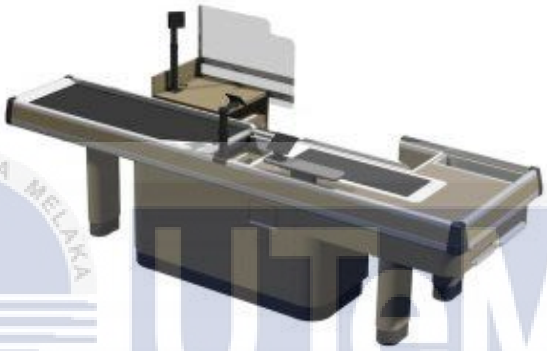


Figure 2.1: Belt out feed checkout station (R.W. Rogers.)

2.4.1.2Drop in Bag Well Checkout Station.

Drop in bag well is a small checkout station and the design is more simple compare to belt out feed checkout station. This type of checkout station provides a bag well after the scanner which reduces lifting items for bagging and bagging directly after scanning is very efficient and faster process. Usually, this type of checkout station only used for small supermarket. But some of this checkout station that used in large supermarket, only used for customer who buy less than ten items per customer.

Due to lack of counter space, they will be an issue if the customer purchases a large item. Also, because of small counter space the counter does not have

enough space for bagging, this will lead item will fall to the floor and probably break the item. On the other hand, the cashier will feel uncomfortable to do their job also because of the small counter space. Cashier cannot move freely, so the cashier have to stand firm at the counter.

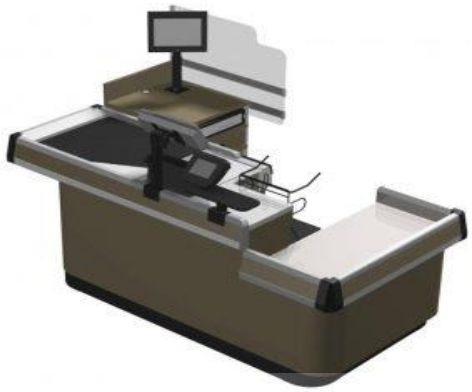


Figure 2.2: Drop in bag well checkout station (R.W. Rogers.).

2.4.1.3 Carousel Bagging Checkout Station.

Carousel bagging checkout station is unique compare the other checkout station because this checkout station accommodates only for wheelchair person. The design is more complex compare other checkout station because at the end of the counter there is carousel cabinet which a place for hanging the plastic bag for bagging process. This carousel cabinet also can rotate 360° and easier for customer take their items after bagging process. Sometimes, customer also is forced to participate in bagging process to make the process flow faster.

Most of the problem in this checkout station happen at carousel cabinet. Where the conveyor cabinet area too small, only four plastics can be place on the conveyor and only one size of plastic bag can fit on the conveyor. The cashier also cannot control the spinning of the conveyor, whether it is too fast or too slow.

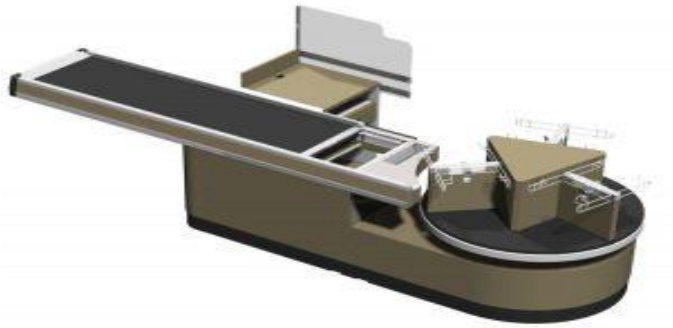


Figure 2.3: Carousel bagging checkout station (R.W. Rogers.).

2.4.1.4 Self-Checkout Station

Nowadays, people are getting tired because of they stuck in a queue for a long time due to the lack of open cahier counters. Therefore, self-checkout station has been introducing for people to process their own purchases from a retailer. This design is a quick checkout because the customer has to do by their self without any help form another people. This checkout station only good for customers with few items, if the customer has many items the time takes longer for them to process their own purchases.

However due to lack of practice using the station, customer tend do errors. For example, the customer scanned items more than one times. For the first time user probably need helps form a worker to help them how to use this checkout station because the customer does not know how to scan a bar code, how to pay their purchase by using credit card or debit card. This checkout station also has high probability to be malfunctions frequently. It is because the customer does not know what menu they have to press that lead to be malfunctions. Most of the self-checkout station have small bagging area, this will be major problem to customer who purchase a lot of items because the customer does not have enough space to put all of their items.

Figure 2.4: Self-checkout station (Pymnts, 2017).

2.4.2 Best and Preferred Work Zones

According to U.S Department of Labor, 2004, best and preferred work zones where work is safest when lifting and reaching is performed in zones and if working outside zones results in non-neutral postures that may increase the risk of injury and it is important to perform heavy lifting tasks within the best work zone.

i. The preferred work zone for standing users (U.S. Department of Labour, 2004):

- As far forward as your hand when you hold your arm out straight.
- A foot on both sides of the shoulders.
- Upper level at height of the shoulder.
- Lower level at the fingertips with hands on the side.

ii. The best work zone for standing users (U.S. Department of Labour, 2004):

- When you hold your arm slightly bent, as far forward as your wrist.
- As broad as the shoulders.
- About the height of the heart.

- Lower level around height of the tail.

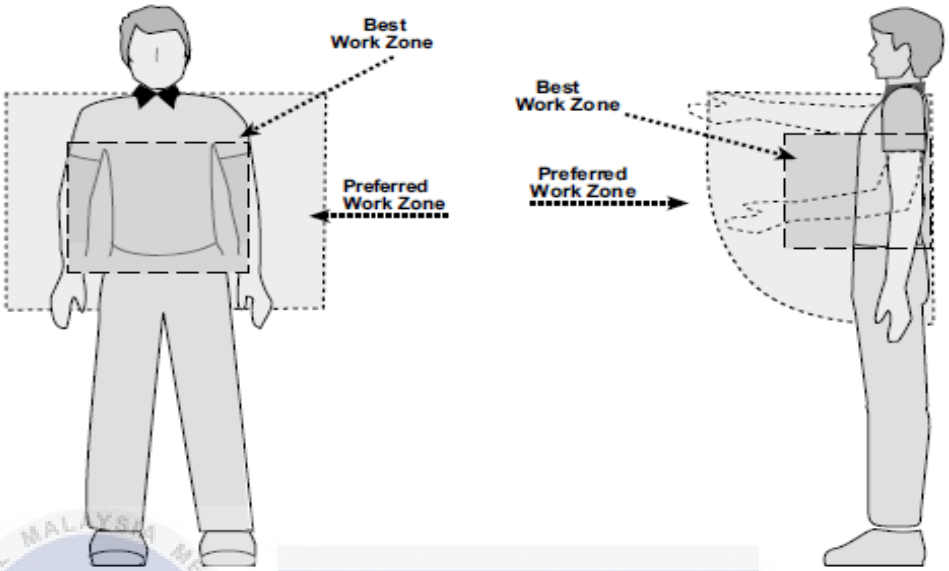
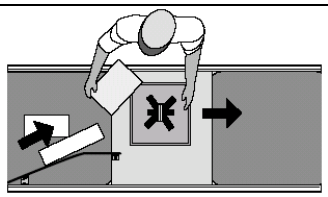
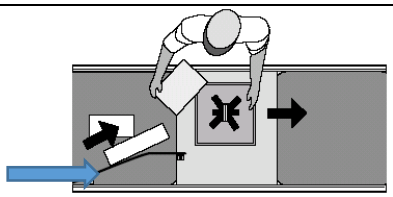


Figure 2.5: Best and preferred work zones (U.S. Department of Labour, 2004).

2.4.3 Design Guideline for Checkout Station

According to U.S Department of Labor, 2004, design guideline for checkout station is to provide a guideline to an easy to use and have safer checkout station. This guideline can be implement at any supermarket to improve the quality of the employees and the business. Table 2.1 shows the design guideline for checkout station:

Table 2.1: Design guideline for checkout station.

Guideline	Diagram
1. Use a powered in-feed and take away conveyor belts to bring items to the cashiers.	
2. Use a sweeper in order to move items on the conveyor within the cashier reach.	
3. Locate the POS cash drawer and scanner in horizontal for cashier to easy reach.	
4. Remove any hard edges that may injured the cashier.	
5. The checkout station need to have toe space at the bottom of the checkout station to allow cashier to move closer to the checkout	

counter to reducing reaching posture.	
6. In order to reduce twisting motions and extended reaches to the side the checkout station need to use front facing checkout station.	
7. The areas where the cashier stand need to have anti fatigue mats to reduce the fatigue and improve in comfort.	

2.5 Seated Versus Standing Working Positions

Supermarket checkout station varies throughout the world depending on workstation design and the posture adopted while working. In Malacca, supermarket checkout counter typically designed to accommodate standing cashiers. Study showed that, even though differences in the average working posture of cashiers, no geographical area or check stand design is exempt from reports of musculoskeletal disorders or discomfort complaints (Lehman, Psihogios, & Meulenbroek, 2001). According to the article that has been published, there is two work of muscles in ergonomics which is static and dynamics work (Grandjean & Hünting, 1977). Static work is defined by slow contractions with heavy loads or by long lasting holding postures which the blood supply is impaired and waste products accumulate in the muscles if in a strong static

contraction. While dynamics work is defined by a rhythmic change of contraction and relaxation of the muscles where is a favorable condition for the blood supply of the working muscle.

In order to reduce fatigue while working is by changing in work posture from time to time whether standing or sitting position. A standing position gives more stable to low back because of by preserving the natural lordosis of the lumbar spine. On the other hand, standing position also gives better for handling loads and enables one to cover larger work areas because of dynamics use of the arms and trunk. While sitting position gives less energy consuming and less stressful on the lower extremity joints compare to standing position. However, in seating position cashiers might encounter risk factor for injury such as low back pain and disc pressure. Cashiers who are do work in seated position can get greater shoulder abduction, which means more stress on the shoulder joints.

2.6 Seating Versus Standing Workstation

2.6.1 Seating Workstation

According to department of occupational safety and health, 2003, the design for seating workstation should be at a comfortable height and all equipment is need for easy to reach. All this thing helps the workers to reduced repeated twisting or stretching movement that cause injury to them. Furthermore, seated worker will normally prefer to do their job with both hands at roughly elbow level or lower as raising of the forearms above the horizontal for any length of time is tiring.

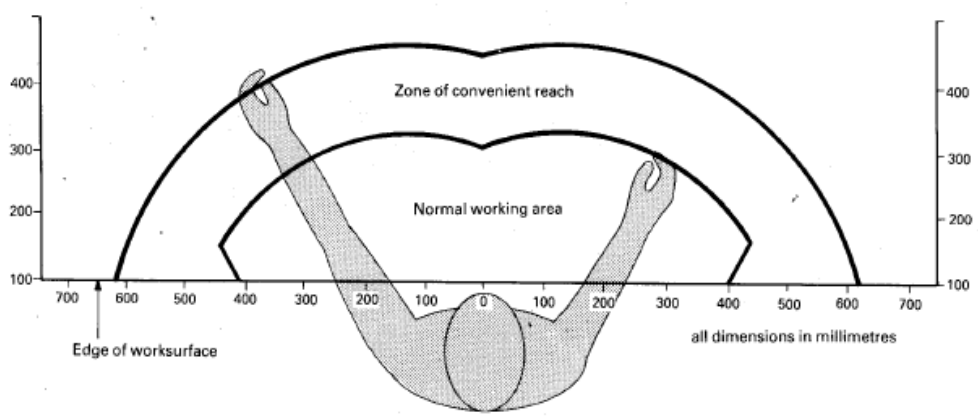


Figure 2.6: Reach in the horizontal plane (Department of Occupational Safety and Health Ministry of Human Resources, 2002)

i. Design standard for basic requirement for seating workstation (Department of Occupational Safety and Health Ministry of Human Resources, 2002):

i. It is possible to work comfortably and efficiently in support of a worker in a position.

ii. The worker can easily and without losing support change his position.

iii. On the buttocks or thighs there is no uncomfortable pressing.

iv. The working surface height and the furniture and equipment layout must be appropriate for the workstation.

v. Provide any particular needs. There are, for instance, very large or short works or people with disabilities that may require unique seats for them.

2.6.2 Standing Workstation

According to department of occupational safety and health, 2003, standing work is a combination of dynamics and static action because it is based on leg movements, when there is leg movement it is dynamics activity while when there is no leg movement it is static activity. On the other hand, standing workstation also can contribute to reducing overall inactive postures during the day (Manager, 2016). By doing work while standing also is an energy-efficient because it is requiring little in metabolic cost (energy).

Figure 2.7: Acceptable standing working posture.

2.7 Ergonomics Analysis

Ergonomics analysis is a scientific process to determine ergonomics risk. It is essential to apply a science and evidence-based strategy to your ergonomics method. The objective is to define ergonomic risk factors, then quantify, and then create measurable workplace changes, ensuring that jobs and duties are within the skills and constraints of employees (Middlesworth, 2016).

2.1.7 Ergonomics Analysis Tools

i. WISHA Lifting Calculator

WISHA stands for Washington industrial safety and health act. This WISHA lifting calculator to perform simple ergonomic risk assessments on big kinds of manual lifting and reducing tasks. It needs real weight, vertical hand position, horizontal hand position, lifts per minute, hours per day, and input twisting (Middlesworth, 2018). All inputs are chosen from drop-down lists except for real weight. The angle of torsion should be either greater than 45 degrees or less than 45 degrees.

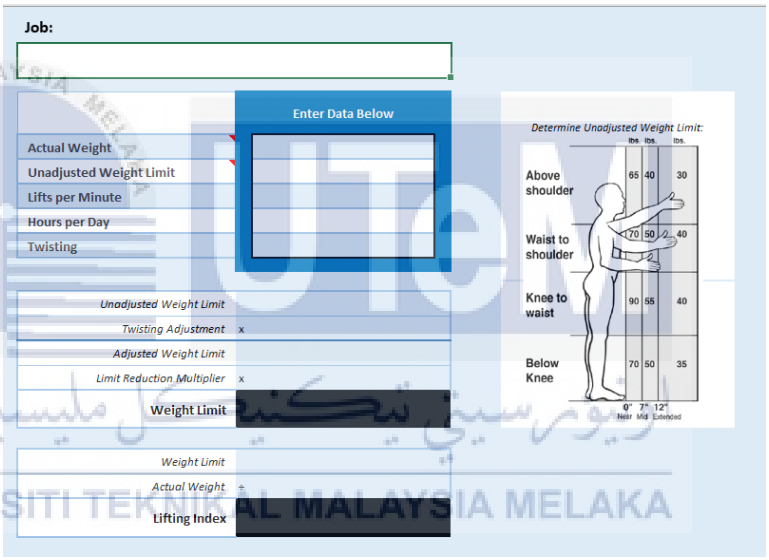


Figure 2.8: WISHA lifting Calculator (Middlesworth, 2018).

ii. NIOSH Lifting Equation

The NIOSH Lifting Equation is an instrument used by occupational health and safety experts to evaluate the hazards connected with the lifting and reduction of employee duties connected with manual material handling. This equation considers variable work tasks to determine secure procedures and instructions for lifting (Middlesworth, 2018).

The NIOSH lifting equation's primary product is the Recommended Weight Limit (RWL), which defines the maximum acceptable weight (load) that could be lifted by almost all healthy employees during an 8-hour shift without increasing the risk of musculoskeletal disorders (MSD) to the lower back (Middlesworth, 2018). In addition, the calculation of a Lifting Index (LI) provides a comparative estimate of the rate of physical stress and MSD risk connected with the assessed manual lifting duties.

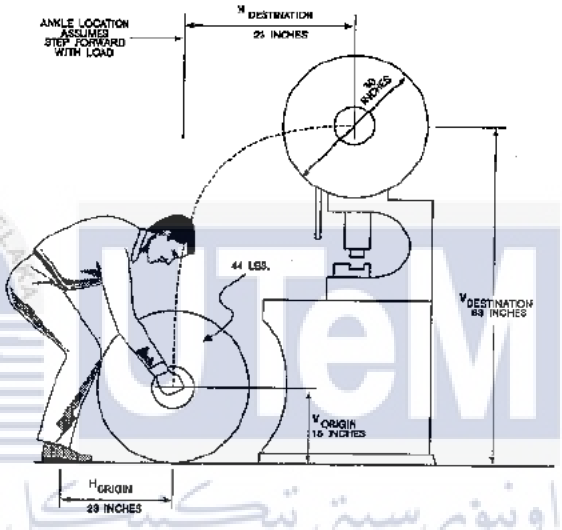


Figure 2.9: Example of NIOSH Lifting (Prevention).

iii. Rapid Entire Body Assessment (REBA)

REBA was created to realize a perceived need for the field tool of a practitioner, specifically intended to be vulnerable to the sort of unpredictable working postures observed in the healthcare and other service industries.(Hignett & Mcatamney, 2000). On the other hand, it was intended to be simple to use without the need for sophisticated ergonomics or costly machinery. Only the worksheet and a pen are needed. For each of the following body areas, the evaluator will assign a score using the REBA worksheet: wrists, forearms, elbows, shoulders, neck, trunk, back, feet, and

ankles (Middlesworth, 2018). After collecting and scored information for each region, tables on the form are then used to compile variables of the risk factor, producing a single score representing the amount of risk of MSD.

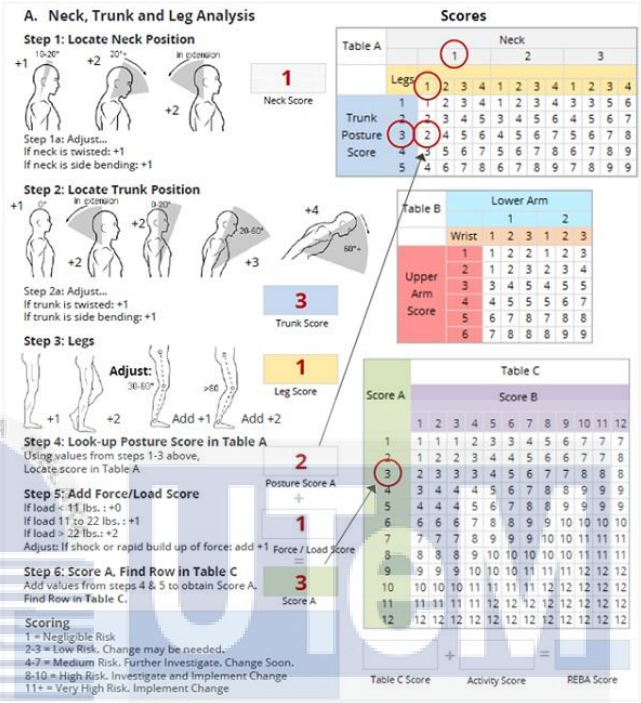


Figure 2.10: REBA worksheet (Middlesworth, 2018).

iv. Rapid Upper Limb Assessment (RULA)

Rapid Upper Limb Assessment (RULA) is a subjective posture analysis observation technique focusing on the upper body but incorporating the lower body (Dockrell et al., 2012). On the other hand, RULA is a study technique initially created to evaluate posture in workplace ergonomic inquiries where work-related upper limb disorders are reported, such as operators and operators working in a multitude of production duties in the Visual Display Unit (VDU) (Gandavadi, Ramsay, & Burke, 2007).

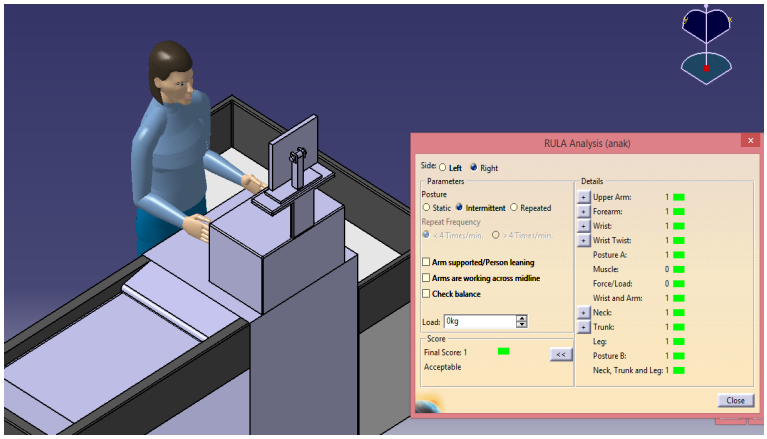


Figure 2.11: RULA analysis using CATIA software.

2.8 Summary of Chapter 2

In conclusion, this chapter has described about the contents related with this study from the previous published research papers, journals, articles and books. Ergonomics is the main topic for this study and was explain and described. The other scope that were being explain in this study was the ergonomics risks and ergonomics of supermarket checkout station with the sub parts which are type of checkout station in the world and best preferred working zone. Also done is the literature review on the seated versus standing workstation. Lastly, the literature review on the methods has been selected. The method that will used in for ergonomics analysis is RULA method.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In the methodology, the methods specifically used in the study were discussed. The aim of specifically debating the techniques used in the study is to guarantee that if someone wishes to duplicate the research without any problems, a clear and appropriate instruction can be readily understood.

In this chapter, justifies the methods that has been used for the study. Other than that, every single steps that involved in carrying out the study is describe in detail. The survey results will show the customer requirement based on the questionnaire which has been distribute. From the questionnaire also it will help to produce some concept design in order to fulfil customer requirement.

3.2 Justification for the Methodology

For this study, a few design of an ergonomic checkout station need to produce that can help to reduce musculoskeletal disorder among the cashiers. The benefits from this study is raising the awareness to the cashier about musculoskeletal disorder while their work, thus decreasing the percentage of musculoskeletal among the cahiers.

3.3 Flow Chart

The methodology of this study is summarized in the flow chart as shown in Figure 3.1.

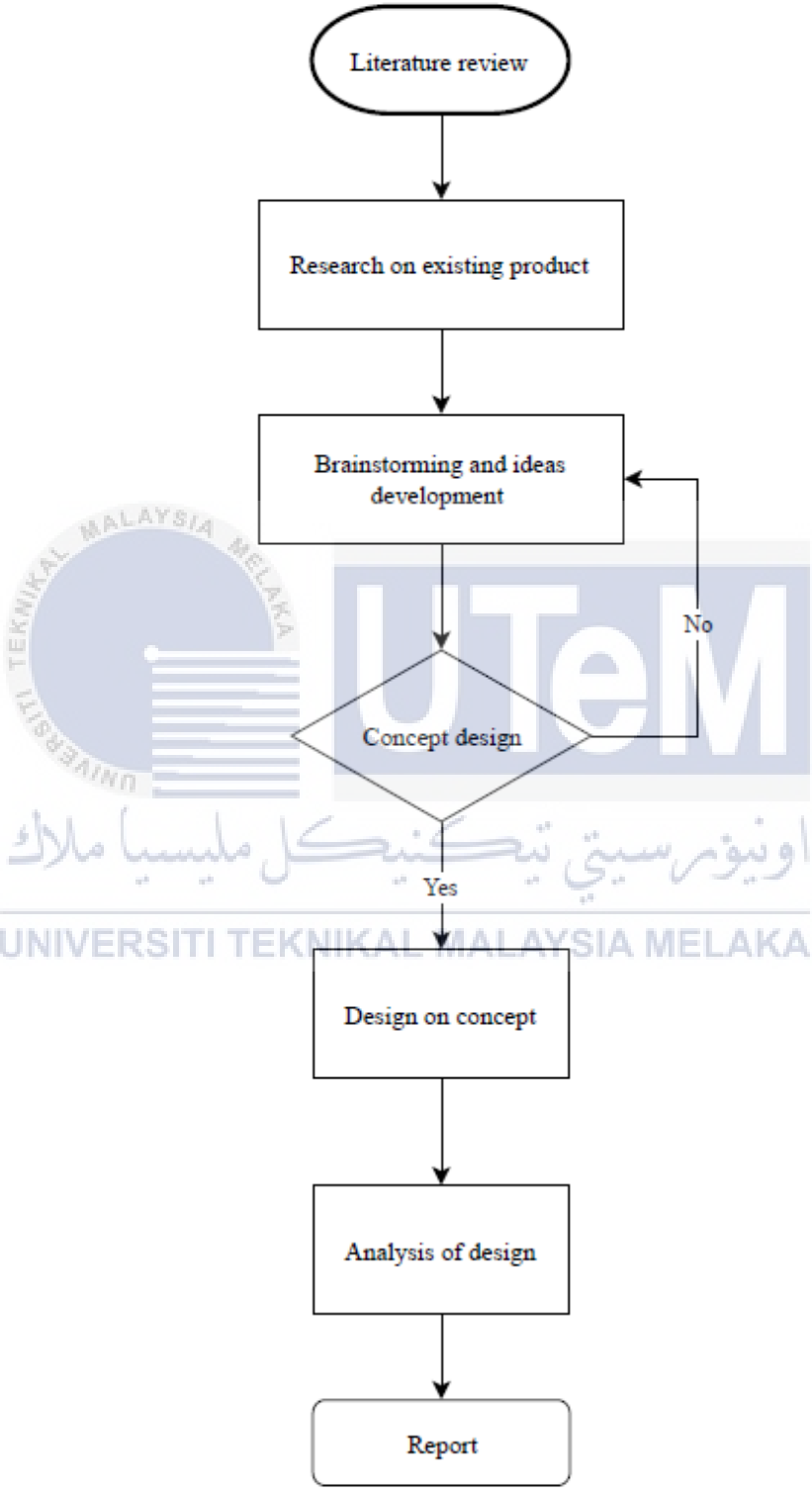


Figure 3.1: Flow diagram for methodology

The flow chart shows the sequent that have taken to make a design for checkout station from the beginning until the analysis of design. It starts with the literature review which is will be doing some research about checkout station, standing versus seating position when doing a job and to learn about musculoskeletal disorder that can happen to the workers.

After that, start generating some idea to purpose to the supervisor whether the design is suitable to use for this project. By generating the idea is to create the design that will follow the standard to make sure that design is ergonomic to use for the cashier.

Next, supervisor will make a decision whether any of the purpose design meet the concept of this project. If not, need to brainstorming new idea to purpose again to the supervisor. If yes, start the design the final design by using CATIAV5 software to achieve the meet of this project.

Then, the design will be analysis by using RULA analysis that provided in CATIA V5 software which is will be determine that design is good or not. And probably slightly adjustment is need if there is something wrong to the design. Finally, report writing will be done after all the analysis is finish.

3.4 Observations

Observation at supermarket were conducted to become familiar with the design of supermarket checkout station and to identify issues with current checkout station. Four supermarket location in Melaka were observed and they are Mydin, Aeon, Tesco and Family store. The main purpose was to know the different design used in every supermarket and to determine strength and flaw of each checkout station. From this observation, common cashier activities are identify and demands while working at

checkout station. Picture of checkout station in every supermarket are taken in order to make comparison each of the checkout station. On the other hand, recorded a notes about the cashier tasks and have divide them into two categories which is behavioral activities and mechanical activities. The observation time was 1 hours for each supermarket visit. They are different size checkout station were found in the supermarket which are small and large size.

3.4.1 Comparison of Checkout Counter Between Supermarkets in Melaka

i. Mydin

Mydin is one of Malaysia's biggest hypermarket chain. Mydin also performs retail and wholesale business activities. On the other side, in all parts of its company, Mydin is focused on ' Halal ' ideas and emphasizes honesty, sincerity and excellent discipline. Here is the picture of Mydin checkout counter design and the strength and flaws of Mydin checkout counter.

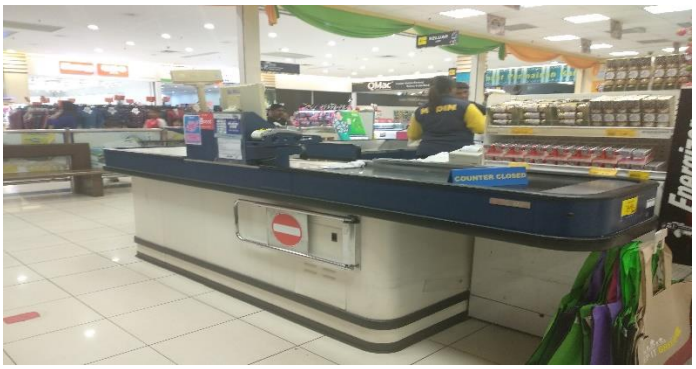


Figure 3.2: Mydin checkout counter (Author).

Table 3.1: Strength and flaws for Mydin checkout counter.

Strength	Flaws
• Smooth and fast process flow. • Helps customer go through easily. • Large counter space area. • Quicker scanning process. • Cashier more free to move because large distance between counter.	• Items pile up quickly. • Don't have any bagger to bagging all items. • Customers can load up too many items. • Didn't provide proper floor mat for the cashier. • Cashier are hard to reach item that place ends of the bagging area.

ii. Aeon

Aeon is Asia's biggest retailer, and Jaya Jusco was established in 1984 in Malaysia. The reason Jaya Jusco opened in Malaysia is because the request from Malaysia's Prime Minister Dato's Seri Dr. Mahathir to help modernize the retail industry in Malaysia using the most advanced management expertise in the world and Jaya Jusco Dayabumi was Malaysia's first open store. In September 2004, Jaya Jusco Stores Bhd. Has changed the name officially to Aeon CO. (M) Bhd. Here is the picture of Aeon checkout counter design and the strength and flaws of Aeon checkout counter:

Figure 3.3: Aeon checkout counter (Author)

Table 3.2: Strength and flaws for Aeon checkout counter

Strength	Flaws
• Takes up less space than other type of checkout station. • Quick for customers. • Items can be put very easily into the bags. • Bagging directly after scanning is very efficient.	• Large item will be the main issue because lack of counter space. • Not enough space for bagging. • Too small, not comfortable. • For large purchases doesn't work. • Didn't provide proper floor mat for the cashier. • Bagging area is too low and make the cashier always to stoop.

iii. Tesco

Tesco had lunch of the business since in 2002, have open many stores across Peninsular Malaysia. Tesco offers fresh produce, groceries, household items, apparel, and its own food and non-food products. Tesco also offers its products through internet which easier to household to buy

item without to go to the supermarket. Here is the picture of Tesco checkout counter design and strength and flaws of this design:

Figure 3.4: Tesco checkout counter (Author)

Table 3.3: Strength and flaws for Tesco checkout counter.

Strength	Flaws
• Smooth and fast process flow. • Helps customer go through easily. • Large counter space area. • Quicker scanning process. • Provide proper floor mat for the cashier.	• Items pile up quickly. • Don't have any bagger to bagging all items. • Customers can load up to many items. • Cashier are hard to reach item that place ends of the bagging area. • Cashier less free to move because the distance between counter is small.

iv. Family Store

Family Store was established on 19th of April 1989 and the first store located at Rasah Jaya, Seremban. Family Store also has opened almost 11 outlets in Negeri Sembilan just within 28 years. All of the store located

strategically nearby residential areas and here is the Family Store checkout counter design and strength and flaws of this design:

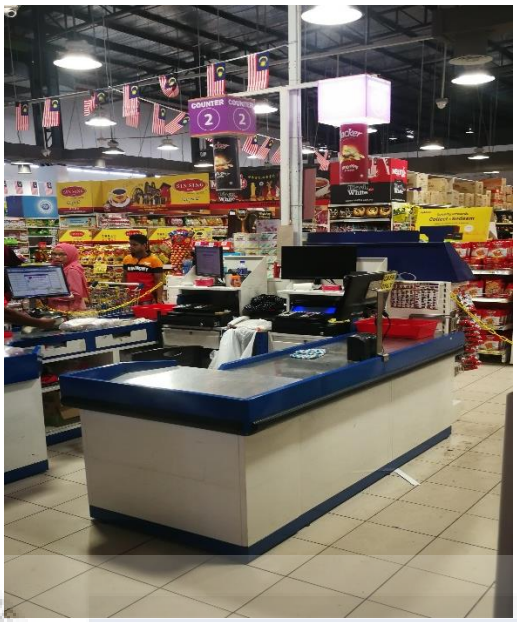


Figure 3.5: Family store checkout counter (Author)

Table 3.4: Strength and flaws for Family Store checkout counter.

Strength	Flaws
• Takes up less space than other type of checkout station. • Quick for customers. • Fast bagging process because small counter. • Works for few items purchase. • Less lifting for cashiers.	• Large item will be the main issue because lack of counter space. • Not enough space for bagging. • Too small, not comfortable. • For large purchases doesn't work. • Didn't provide proper floor mat for the cashier. • Slow process flow because don't have any conveyer to move the item.

3.4.2 Implication for a Grocery Checkout Workstation

Current checkout station found in Malacca only accommodate standing users. The main difference is the size of the workstation. There is small and large checkout station. For example, lifting was identified as one of the main factors of injury while bagging items, this factor usually happens at small workstation like Aeon checkout counter. Where the bagging area is too low and need the cashier to stoop while bagging the items. Small workstation also make the process become slower compare large workstation, where it is fast and smooth process. This makes the customer have to wait a little longer until their item complete bagging. With small workstation, they can only do small purchase where they have to limit customer item up to 10 items. However, in this case, Aeon and Family store checkout counter, they use the small counter to do large purchase. This happen because their supermarket has limited space for their checkout counter and this small counter are hard to customer because they can`t put all of their item on the counter due to lacking of space. Sometime, small workstation also can make their cashier become uncomfortable because they can`t freely to move any way.

Compare to large checkout counter, the process is much smooth and fast because of help from the conveyor to move the items, so the cashier do not need to reach up the items to scan. On the other hand, the large checkout counter use bi-optic scanner which help cashier to scan the items faster and use less energy to scan the bar code. Large checkout counter also gives the cashier to move freely and help the cashier work effectively and large space also comfortable to the cashier to take rest if there is no customer. However, the cashier need to work more because the cashier need to go to bagging area to bagging the customer items. Next, items pile up quickly when the

customer buy many items, so the cashier need to do their job much faster in order to make the customer wait longer.

According to U.S Department of Labour, 2014, the design guideline for checkout station is to have powered in-feed conveyor which helps the cashier to bring items to the cashier best work zone and on the conveyor also must have sweeper, the function is to move items on the conveyor within the cashier reach. On the checkout station the POS podium cash drawer and scanner need to be in horizontal for easy the cashier to reach. On the other hand, some cashier need to stand for a long periods and make the cashier fatigue, therefore anti-fatigue mats is needed in order to reduce the fatigue. Finally, the cashier need to perform work within the preferred work zone to make sure the cashier can do best in job. By following this design guideline, Tesco checkout station have the best design and the design follow all the guideline given.

3.4.3 Behavioral and Mechanical Activities

From the observation have been made, two categories have been analyze which is behavioral and mechanical activities. Behavioral activities are an activity that relate to the behavior of a person, in this case is the cashier. While mechanical activities are an activity that relate to mechanical things such as the checkout station. Table below shows the result from this observation:

Table 3.5: Behavioral and mechanical activities.

Behavioral activities	Mechanical activities
• Cashier stand during shift with no apparent place to sit. Sometimes the cashier has to stand almost 30 minutes.	• Small checkout station lack space to put large items before and after being scanned.

• Small checkout station is usually much faster than large checkout station. • Cashier can only sit when there is no customer. • Grip strength is required for constantly lifting bags to put on the bagging area. • Noisy environment.	• One of the checkout station didn't provide conveyor to move the items to scan. • Small checkout station cannot load up too many items. • Checkout station with one shared display didn't offer a proper viewing for either the cashier or customer. • One of the checkout station have cash drawer that place beside the cashier which forces twisting movement.

3.5 Questionnaire

For this study, 30 set of questionnaire has distributed, 30 respondents had participated in order to obtain the data. The objective of this questionnaire is to know whether the current checkout station design is ergonomics to use for the cashier. The questionnaire consists of twelve question. The data obtained from this questionnaire is presented in pie chart and in tables for better understanding.

3.5.1 Multiple Choice Questions

For this sections, it consist of 11 questions with 2 to 5 choicces of answer and it requires the respondents to choose only one answer. The results for each question are as follows;

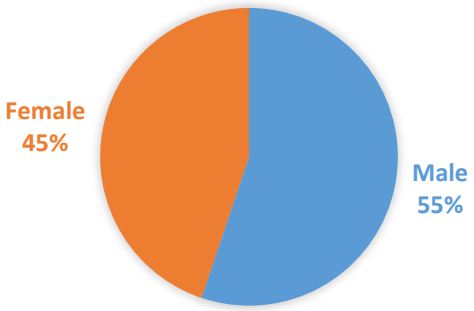


Figure 3.6: Gender

Table 3.6: Frequency and Percentage for Question 1

Gender	Frequency	Percentage (%)
Male	16	55
Female	14	45

Based on Figure 3.6: Gender and Table 3.6: Frequency and Percentage for Question 1, out of 30 respondents, there are 16 males respondents (55%) and 14 females respondents (45%).

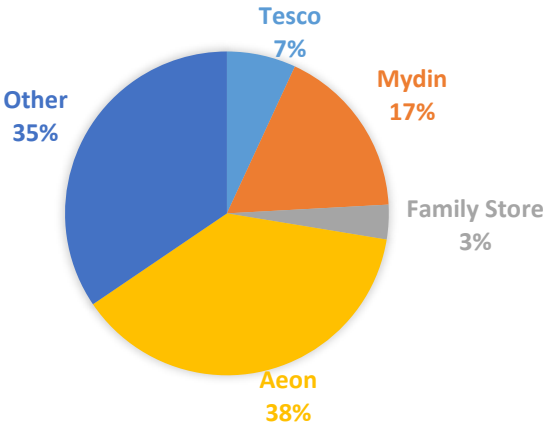


Figure 3.7: Workplace.

Table 3.7: Frequency and Percentage for Question 2

Workplace	Frequency	Percentage (%)
Aeon	11	38
Mydin	5	17
Tesco	3	7
Family Store	1	3
Other	10	35

Next is workplace, based on Figure 3.7 and Table 3.7. Out of 30 respondents, they are 11 respondents (38%) that choose Aeon, 5 respopondents (17%) choose Mydin, 3 respondents (7%) choose Tesco, 1 respondents (3%) choose Family Store and 10 respondents (35%) choose other.

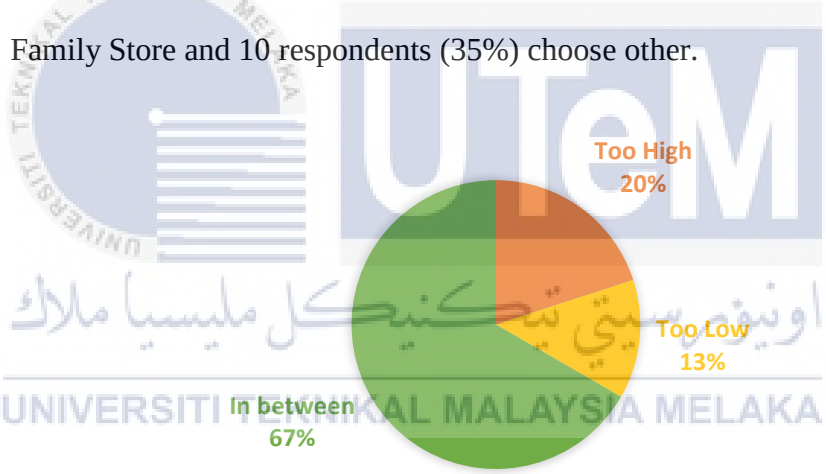


Figure 3.8: Height of Checkout Station.

Table 3.8: Frequency and Percentage for Question 3

Height	Frequency	Percentage (%)
Too high	6	20
Too low	4	13
In between	20	67

Figure 3.8 and Table 3.8 show the number of frequency and percentage of height of checkout station, out of 30 respondents, they are 6 respondents (20%) that choose too high, 4 respopondents (13%) choose too low and 20 respondents (67%) choose in between.

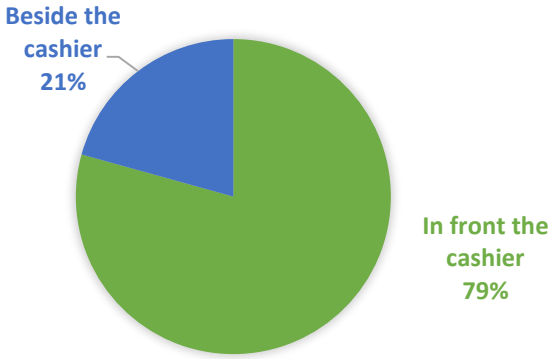


Figure 3.9: Location of cash drawer

Table 3.9: Frequency and Percentage for Question 4

Height	Frequency	Percentage (%)
In front the cashier	23	79
Beside the cashier	7	21

To determine the best location of the cash drawer, Figure 3.9 and Table 3.9 show the results and percentage, out of 30 respondents, they are 23 respondents (79%) that choose In front the cashier and 7 respopondents (21%) choose beside the cashier.

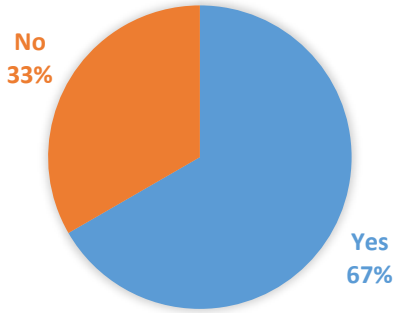


Figure 3.10: Easy to reach a plastic bag.

Table 3.10: Frequency and Percentage for Question 5

Workplace	Frequency	Percentage (%)
Yes	20	67
No	10	34

Results shows does the cashier is easy to reach a plastic bag. Out of 30 respondents, they are 20 respondents (67%) that choose Yes and 19 respopondents (34%) choose No. The results shows on Figure 3.10 and Table 3.10 of easy to reach a plastic bag.

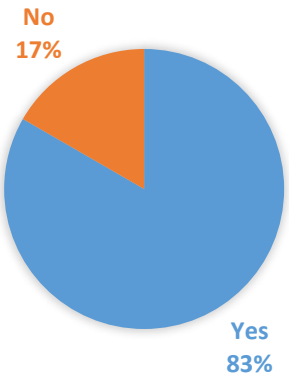


Figure 3.11: Scanner place.

Table 3.11: Frequency and Percentage for Question 6

Workplace	Frequency	Percentage (%)
Yes	25	83
No	5	17

Figure 3.11 and Table 3.11 shows the result of does the scanner place at the right place, out of 30 respondents, they are 25 respondents (83%) that choose Yes adn 5 respopondents (17%) choose No.

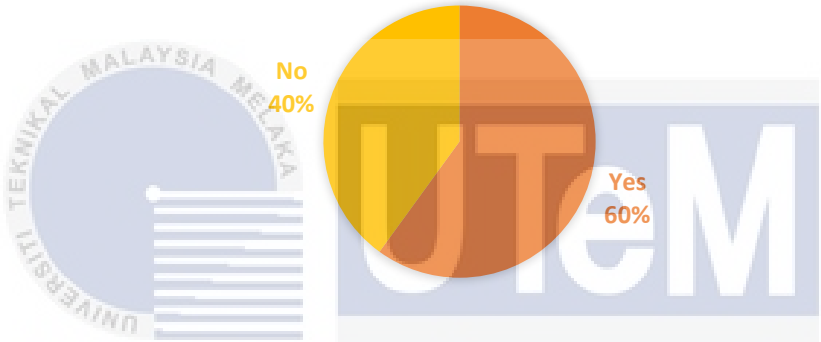


Figure 3.12: Space for checkout station.

Table 3.12: Frequency and Percentage for Question 7

Workplace	Frequency	Percentage (%)
Yes	18	60
No	12	40

The result shows for space for checkout station and does the space fit to place a chair. Based on Figure 3.12 and Table 3. Out of 30 respondents, they are 18 respondents (60%) that choose Yes and 12 respopondents (40%) choose No.

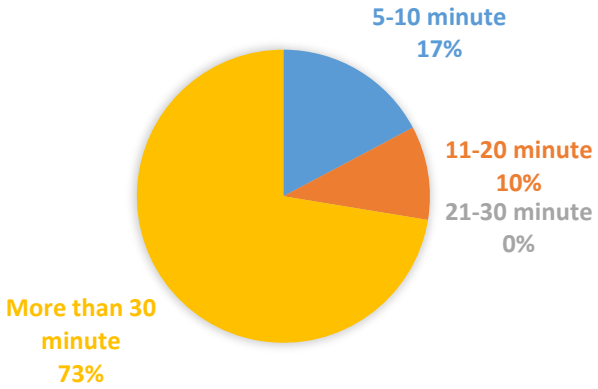


Figure 3.13: Duration to stand while working.

Table 3.13: Frequency and Percentage for Question 8.

Workplace	Frequency	Percentage (%)
5-10 minute	5	17
11-20 minute	4	10
21-30 minute	0	0
More than 30 minute	21	73

Results for duration to stand while working shows in Figure 3.13 and Table 3.13, out of 30 respondents, they are 5 respondents (17%) that choose 5-10 minute, 4 respopondents (10%) choose 11-20 minute, 0 respondents (0%) choose 21-30 minute and 21 respondents (73%) choose more than 30 minute.

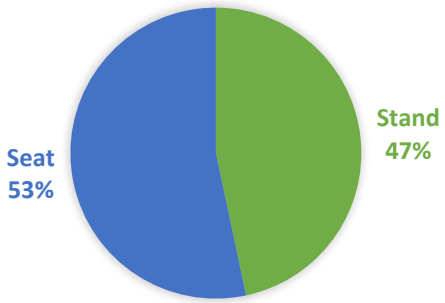


Figure 3.14: Position during working.

Table 3.14: Frequency and Percentage for Question 9.

Workplace	Frequency	Percentage (%)
Seat	16	53
Stand	14	47

There are two common positon while working, there are stand and seat. Based on Figure 3.14 and Table 3.14. Out of 30 respondents, they are 16 respondents (53%) that choose Seat and 14 respopondents (47%) choose Stand.

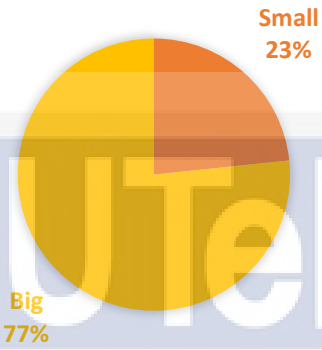


Figure 3.15: Size of checkout station.

Table 3.15: Frequency and Percentage for Question 11.

Workplace	Frequency	Percentage (%)
Big	23	77
Small	7	23

Varience size of checkout station wheather small or big. Based on Figure 3.14 and Table 3.15, out of 30 respondents, they are 23 respondents (77%) that choose Big and 7 respopondents (23%) choose Small.

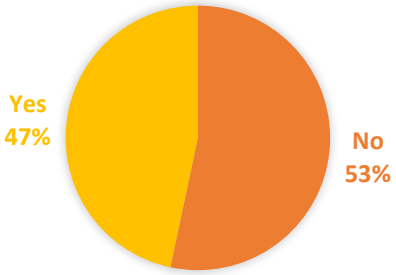


Figure 3.16: Ergonomics.

Table 3.16: Frequency and Percentage for Question 12.

Workplace	Frequency	Percentage (%)
Yes	14	47
No	16	53

Ergonomics is one of the important element in designing chekcout station, based on Figure 3.15 and Table 3.16, out of 30 respondents, they are 14 respondents (47%) that choose Yes and 16 respopondents (53%) choose No.

3.5.2 Subjective Question

For this section, it consist only 1 questions and respondents can give any answer that relate to the question. The results for each question are as follows;

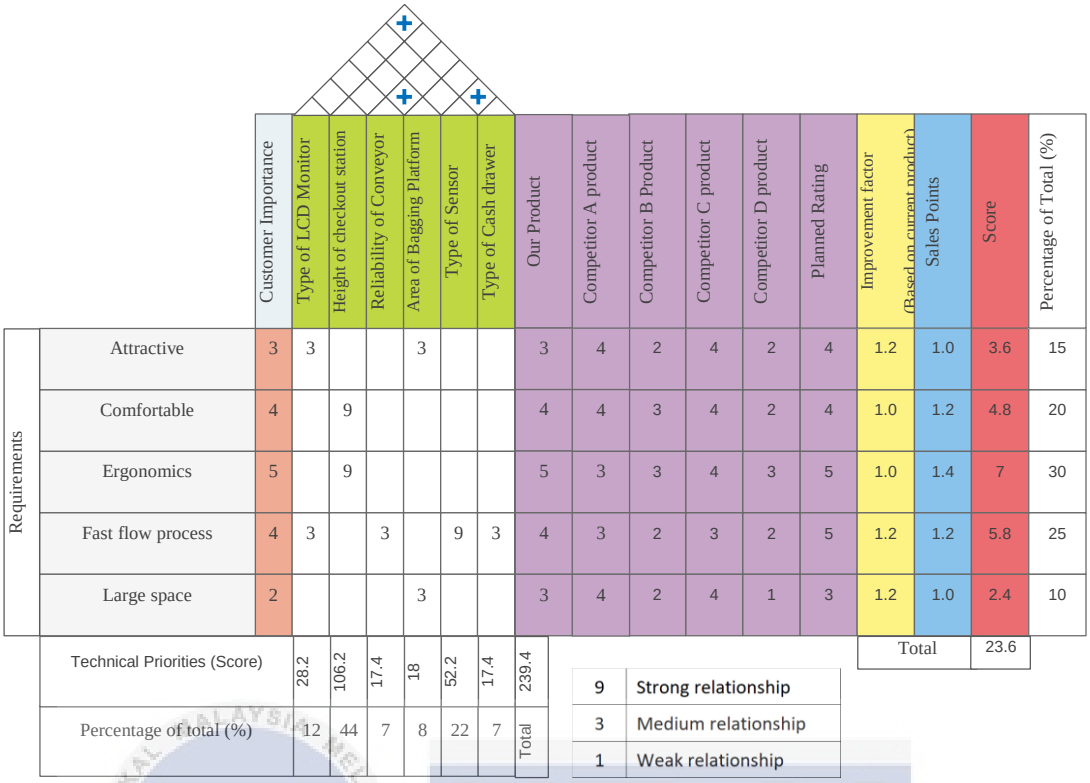
Regarding to this question, the resercher get 3 common answer there are backpain, leg pain and no pain. From this awnser, leg pain is the major pain that cashier facing during the working.

3.6 Quality Function Deployment (QFD)

House of quality is part of Quality Function Deployment (QFD) and uses a planning matrix to relate the requirements of the customer and how a producer will meet those requirements. It can store a lot of information and compare big amounts of data used to define the connection between the client requirement and the capacities of the product.

In addition, HOQ was initially created in 1966 by Dr. Shigeru Mizuno and Dr. Yoji Akao and the basis of HOQ's belief that products should be intended to represent the wish and taste of the customer (Zairi & A. Youssef, 2006). Therefore, marketing individuals, design technicians and manufacturing employees must operate carefully to follow the customer's needs in producing the item. On the other hand, HOQ is a kind of conceptual map that offers the means to create a product for inter-functional planning and communication (Cristiano, Liker, & White, 2000).

The basic structure in HOQ table is with “Whats” as the labels on the left and “Hows” across the top. While the diagonal roof matrix of “Hows vs. Hows” and the body of the house is a matrix of “Whats vs. Hows”. The indication fills the two matrices whether the specific item's interaction is a strong positive, a strong negative, or somewhere in between. In HOQ there are five rooms to complete they are customer requirement, engineering characteristics, correlation matrix, relationship matrix and importance ranking of engineering characteristics.



Requirements	Customer Importance	Type of LCD Monitor	Height of checkout station	Reliability of Conveyor	Area of Bagging Platform	Type of Sensor	Type of Cash drawer	Our Product	Competitor A product	Competitor B Product	Competitor C product	Competitor D product	Planned Rating	Improvement factor (Based on current product)	Sales Points	Score	Percentage of Total (%)
Attractive	3	3			3			3	4	2	4	2	4	1.2	1.0	3.6	15
Comfortable	4		9					4	4	3	4	2	4	1.0	1.2	4.8	20
Ergonomics	5		9					5	3	3	4	3	5	1.0	1.4	7	30
Fast flow process	4	3		3		9	3	4	3	2	3	2	5	1.2	1.2	5.8	25
Large space	2				3			3	4	2	4	1	3	1.2	1.0	2.4	10
														Total		23.6	
Technical Priorities (Score)		28.2	106.2	17.4	18	52.2	17.4	239.4									
Percentage of total (%)		12	44	7	8	22	7	Total									

9	Strong relationship
3	Medium relationship
1	Weak relationship

Figure 3.17: House of quality

Figure 3.17 shows the house of quality that planning to what the customer wants and how the producer to produce the product by customer requirement. The left of HOQ is customer requirement which is attractive, comfortable, ergonomics, fast flow process and large space. From this requirement, ergonomics get the highest number because it is the most importance to the customer and the cashier. While large space gets the least number which is 2. It is because the ready checkout station most of them already got large space in order the cashier to move freely and easier for them to take a rest when there is no customer.

Next is the purple box, it is a planning matrix. This represents the customer competitive assessment to provide customers views on existing products. For this product, there is 4 competitors, there are competitor A is Mydin, competitor B is Aeon, competitor C is Tesco and competitor D is Family Store. Each of the competitor have been graded

by designer when doing observation. Therefore, all the sales point is increases because the designer design has meet the customer needed.

Finally, the green box shows the technical requirement for checkout station, there are 6 technical requirements that needed in order to make a checkout station. There are, type of LCD monitor, height of checkout station, reliability of conveyor, area of bagging platform, type of sensor and type of cash drawer. All of this technical requirement must relate to the customer requirement in order to make the improvement of the checkout station.

3.7 Product Design Specifications (PDS)

Product design specification (PDS) is used for structural or component analysis, design, manufacture and construction to achieve a specified degree of safety, efficiency, performance or quality as well as a common standard of good design practice. A total of six PDS performance, size, safety of machine, maintenance, ergonomics and customer were considered for the development of the checkout station as in table 3.17.

Table 3.17: Product Design Specification

No	Criteria	Specification
1	Performance	• This product have smooth and fast process flow
2	Size	• This product should be large scale to ensure can do large purchase.
3	Safety of machine	• Don't have any sharp edge. • Safety push button for emergency case.
4	Maintenance	• The conveyor is easy to clean. • Repair and replacement with ease.
5	Ergonomics	• This product is easy to operate.

		• The height of this product is in between high and low.
6	Customer	• Target customer from supermarket industry.

3.8 Morphological Chart

A morphological chart is a visual way of capturing the necessary functionality of the product and exploring alternative ways and combinations of achieving it (Smith, Summers, & Mocko, 2016). There may be a number of feasible alternatives for each product function component. The chart allows for the expression of these solutions and provides a structure for consideration of alternative combinations. This can allow the product ' architecture' to be considered early by generating and considering various' sub-solutions ' combinations that have not been earlier recognized. It can be used properly to promote a user-driven attitude to prospective solution generation. In order to generate a complete range of alterative design solution for a product thorough a systematic analysis of the form or configuration that a product or machine might take, so have to make a morphological chart (Smith et al., 2016).

One morphological chart has been produce, which is morphological chart for checkout station. This is because to follow the customer needed. Every morphological chart will produce three concept design ideas and finally will decide which concept will be selected to be final concept. In the final concept also, the concept design will have improvement in order to archive the customer requirement.

3.8.1 Morphological Chart for Checkout Station

Three different option has been made in order to get 3 concept design for checkout station. Finally, will pick the best concept design and make slightly

improvement to get final design. Below is the morphological chart and concept design of checkout station:

Table 3.18: Morphological chart for checkout station.

Part	Option 1	Option 2	Option 3
Shape	 Rectangular	 L-shape	
Conveyor			
Scanner	 Bi-optic	 Horizontal	
Cash drawer position	 In front of the cashier	 Beside the cashier	
Plastic stand	 Beside the cash drawer	 At the end of the counter	

Monitor	 POS computer	 Touch screen	 Dual screen

The concept design idea is generated and each of them are evaluated to choose the best checkout station design that satisfies the customer requirement.

3.8.2 Concept Design

3.8.2.1 Concept Design A

Based on morphological chart given, the criteria for first design concept shows in Table 3.19:

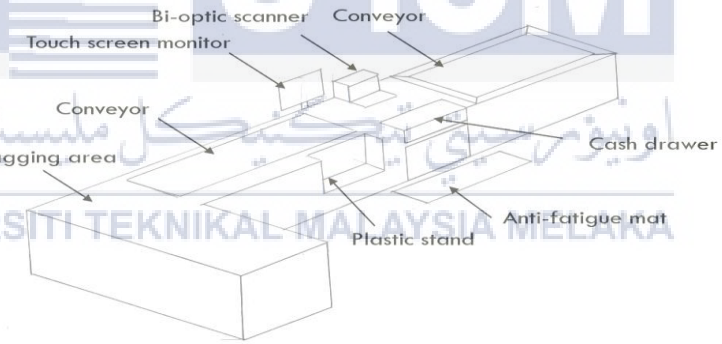


Figure 3.18: Concept design A

Table 3.19: Criteria for design A

Criteria	Option	Criteria	Option
Shape	2	Cash drawer position	1
Conveyor	1	Plastic stand	1
Scanner	1	Monitor	3

For the first concept design, the main shape for this design is L-shape. L-shape is a typical shape that used in supermarket in Melaka. Different with the present design the plastic stand is located beside the cash drawer to easier the cashier to bagging the customer items. On the other hand, the cash drawer for this design is located in front of the cashier and it is easier for cashier to receive the payment from the customer and give the change back to the customer. The monitor used for this design is LCD screen with dual screen. This monitor is useful for the cashier and the customer because the larger the screen for the cashier the faster the job can do and for the customer it easier to monitor the list of their items. The cashier can scan the customer items faster because it uses bi-optic scanner. This scanner has both horizontal and vertical windows that can read barcodes on four or five sides of an items.

3.8.2.2 Concept Design B

Based on morphological chart given, the criteria for first design concept shows in Table 3.20:

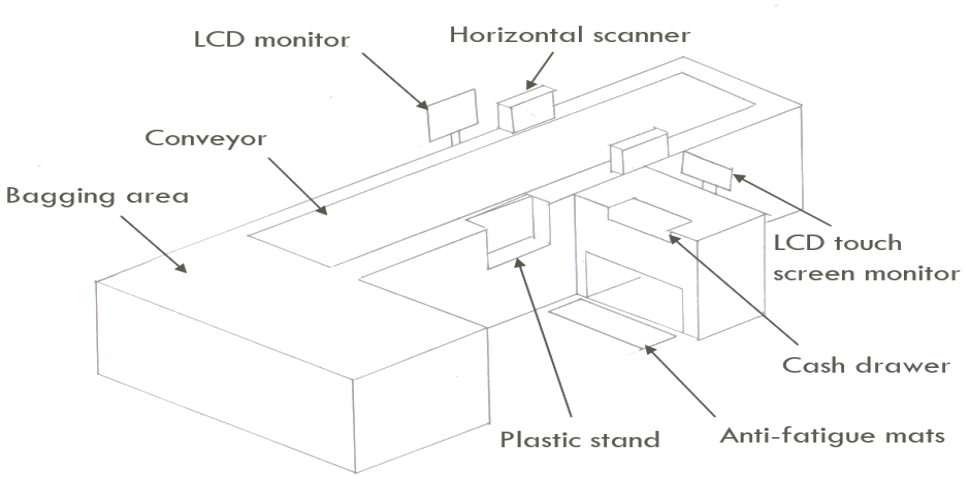


Figure 3.19: Concept design B

Table 3.20: Criteria for design B

Criteria	Option	Criteria	Option
Shape	2	Cash drawer position	2
Conveyor	1	Plastic stand	1
Scanner	2	Monitor	2

For the second concept design, the main shape for this checkout counter is L-shape but the different with the first design is the conveyor. The length of the conveyor is until the beginning of bagging area. The main idea for this concept is where the customer just has to put their items on the conveyor, while the items are moving through when it pass the scanner the item will be scan by itself. Furthermore, for this design it will use two horizontal scanners in order to archive the items scan by itself. For the plastic stand, it will locate at the end of the conveyor for easier the casher to bagging the items then can put all of the items into the bagging area.

The lack of this design is the location of the cash drawer. It is locating at beside the cashier so the cashier need to turn a bit to make a change and receive a payment form the customer. Lastly, the monitor use for this is LCD touch screen monitor that place at the cash drawer and the other one is place in front of the plastic stand where the customer can see the list of their items.

3.8.2.3 Concept Design C

Based on morphological chart given, the criteria for first design concept shows in Table 3.21:

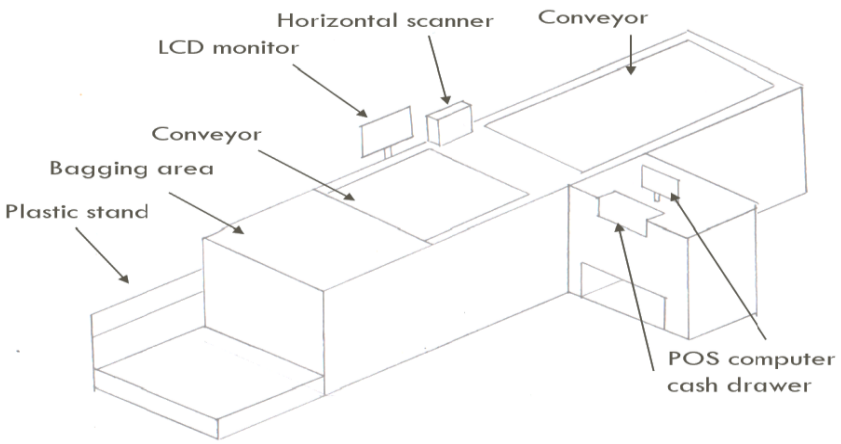


Figure 3.20: Concept design C

Table 3.21: Criteria for design C

Criteria	Option	Criteria	Option
Shape	1	Cash drawer position	2
Conveyor	1	Plastic stand	2
Scanner	2	Monitor	1

For the third and the final concept, the shape for this checkout counter is rectangle shape. It is because the bagging area has been smaller compare to L-shape. The main different of this design is location of plastic stand. The plastic stand has been located at the end of the checkout counter it is because to make the process flow faster where the customer need to involve in this process, the customer need to bagging their items by themselves. Therefore, the cashier job is only to scan the customer item. The scanner that used for this design is horizontal scanner it is because almost impossible to use bi-optic scanner because of the conveyer is all along the checkout counter. On the other hand, the cash drawer is located beside the cashier and the cashier use POS

computer cash drawer which is an old type of cash drawer because this type is still use keyboard instead of touch screen monitor.

3.8.2.4 Concept Design D

Based on morphological chart given, the criteria for fourth design concept shows in Table 3.21:

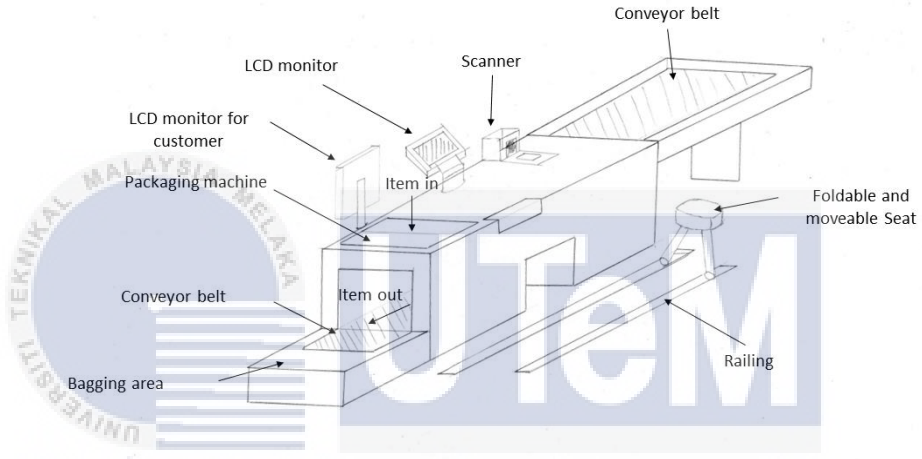


Figure 3.21: Concept design D

Table 3.22: Criteria for design D

Criteria	Option	Criteria	Option
Shape	1	Cash drawer position	1
Conveyor	1	Plastic stand	-
Scanner	1	Monitor	2

For the final concept design, the shape for this checkout counter is rectangular. Compared to other design, this design has packaging machine which will make the packaging processes is fastest compare to other design. Therefore, the cashier only

need to scan the item and just place all the item into the packaging machine and it will package itself. In this design also include foldable chair with railing in order for cashier can seat whenever they feel tired when doing job for long hour. In this design also have in-feed and take-away conveyor belts for easier the item moves toward the cashier and send out to the customer.

3.9 Weight Decision Matrix

A weighted decision method also known as Pugh Method or Pugh Concept Selection. Stuart Pugh invented this method. Weighted decision matrix is a qualitative technique used to rank an option set's multidimensional option. It is an instrument used to compare options with varying degree of significance criteria. In addition, this technique is often used in engineering to make design choice, but it can also be used to rank all the options relative to a "fixed" reference or called a datum and thus generate a partial order for the options.

A weighted decision matrix is a straightforward instrument that can be very helpful in making complex decisions, particularly in instances where there are many options and many different criteria to consider.

Based on weight decision matrix, there are five requirements as criteria form the data survey. For the importance weight column, it is rated form the highest percentage to the lower percentage needed by the customers. Lastly, for the rating column, it is rated based on value 1-5 which is satisfactory, fair, good, very good and excellent as shown in the Table 3.23

Table 3.23: Weight Decision Matrix.

Design criterion	Weight factor	units	Concept A			Concept B			Concept C			Concept D		
			Magnitude	Score	Rating	magnitude	Score	Rating	Magnitude	Score	Rating	Magnitude	Score	Rating
Ergonomics	5	Exp	Excellent	5	25	Satisfactory	1	5	Satisfactory	1	5	Excellent	5	25
Maintenance	3	Rm	500	3	9	300	5	15	350	4	12	1000	2	6
Performance	4	Exp	Satisfactory	1	4	Fair	2	8	Satisfactory	1	4	Excellent	5	20
Safety of machine	2	Exp	Very good	4	8	Good	3	6	Very good	4	8	Good	3	6
Manufacturing cost	1	Rm	1000	3	3	800	4	4	1000	3	3	2000	2	2
Total					49			38			32			59

Table 3.23 shows the weight decision matrix to shows the comparison between four concept design. The best concept design is determine by five design criterion, there are ergonomics, maintenance, performance, safety of machine and manufacturing cost. Every design criterion is rated between 1-5 to shows which of the criteria is important to the customer. The ergonomics shows the highest number of 5 while the manufacturing cost shows 1.

First is ergonomics, for concept A and concept D both shows the magnitude is excellent, follow by the score is 5 with rating of 25. Compare to concept B and concept C, both shows the magnitude is satisfactory, follow by the score is 1 with rating of 5.

Second is maintenance, the highest the number the lower the cost of maintenance. Concept D give the highest number which is 1000. While the score is 2 and the rating is 6. The lowest result shows is concept B. Just only the magnitude of 300 with score of 5 and the magnitude is 15. Give the concept B the highest cost of maintenance.

Third is performance, performance indicate the process of checkout the customer item. Again, concept D is excellent in magnitude score. The score is 5 with the rating of 20. Compare to concept B, concept B only score fair in magnitude and the score is 2 with rating is 8.

Fourth is safety of machine, concept A and concept C both shows the magnitude score is very good. While concept B and concept D shows the magnitude results is good. Finally, is manufacturing cost, manufacturing cost is a cost to produce the checkout station. Concept D shows the highest number is 2000, therefore concept D is expensive compare to concept B. Concept B is the cheapest with score just only 800.

Therefore, concept D gives the total score is 59. Which means the concept D will be choose to be the final design concept. And this final design concept will be analyze in term of ergonomics by using software.

3.9.1 Final Product Design

After the concept designs are presented in concept design, the best design out of the four concept designs is selected. This is done by evaluating the customer requirement in the questionnaire and weight decision matrix before. On the other hand, all of concept designs also evaluating by following guideline for checkout station.

There are 4 main criteria that customers always prefer to buy the product which are, comfortable, ergonomics, fast flow process and large space. First is comfortable, where the cashier can do their job comfortably because the height of this checkout station is not too high or too low for the cashier. Next is ergonomics, the design of this checkout station is ergonomics for the cashier because the design of checkout station is more convenient to work and help to improve productiveness. Third is fast flow process, with the bi-optic scanner this will help the cashier to do work faster and use less energy when scanning the bar code and packaging machine help cashier packaging item faster. Lastly is large space, large space is needed because the cashier can move freely by using the chair that provide at the checkout station.

3.9.1.1 Conclusion of Selected Design

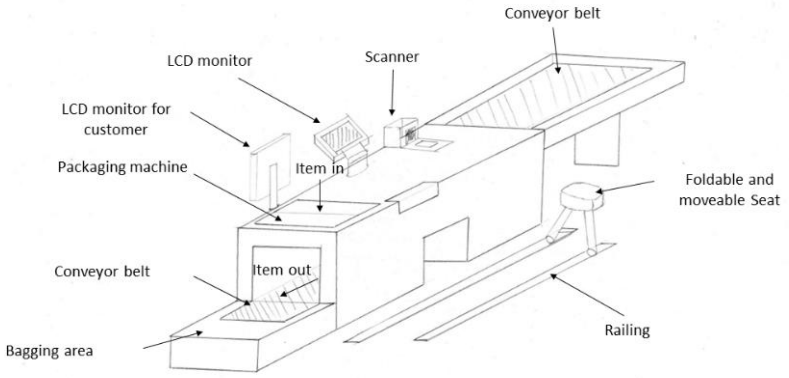


Figure 3.22: Final design for checkout station.

Figure 3.22 shows the final design the reason chooses this design because this design follows all of the guideline given that provide from OSHA. First is the conveyor, there are two conveyors in this design which is in-feed and take-away conveyor belts. The function of this two belts is to bring items to the cashiers to scan the bar code and to move away the items after bagging process. Next, the POS cash drawer and the scanner is place in horizontally in order to easier the cashier to reach. This two need to be place at preferred work zone in order the casher to perform work comfortably. On the other hand, the POS cash drawer used LCD monitor that can adjust by follow the cashier preferences for them to see clearly and comfortable to use. The are two new features in this design which is packaging machine and fordable chair with railing. The function for packaging machine is to shorter the time for to do the packaging and send straight away to the customer. This machine can help to reduce the energy used by the cashier because the cashier only need to focus to scanning the item without need to package the items. Therefore, by having packaging machine it helps reduce number of customer waiting in line during peak hour. Furthermore, this design is completed with foldable chair with railing. With the railing the chair can move to the right or left by and also the chair can be fold and unfold if the cashier want

to use it or not. Sometime, the cashier has to work for a long hour in standing position by providing the foldable chair the can seat whenever the cashier wants as long they can focus doing their job

3.10 Software for Design the Checkout Station.

To design the final concept design CATIA software will used. This software is excellence to design a product for 3D CAD. On the other hand, this software also used to design, simulate and analyze the ergonomics of the checkout station. After finishing the design, the design will be analyzing by using method that include in this software. There are RULA analysis. This method will analyze the biomechanical and postural load requirements of job task that related to upper limb disorders. From this analysis, can know whether the design is ergonomics or not. If no, the design will be improving in order to make the final concept design is ergonomics to use.

3.11 Summary for Chapter 3

In conclusions, this chapter has described and explained about the methodology that has been used in this study. The flow chart shows the starting flow until end of this study. The methods used for this study are observation, questionnaire, quality function deployment (QFD), product design specification (PDS) and morphological chart. From the morphological chart, four design concept has been generated and only one will be choose to be the final concept design. On the other hand, the weight decision matrix helps to determine which concept design will be the final concept design.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

The obtained results from the methods employed in the study was being discussed and analyze in the result and discussion. The purpose of discussion and analysis the design is to provide the better understanding of the finalize design that has been drawn by using software.

In this chapter, discussed about the results of the ergonomics analysis that has been conduct by using CATIA software. The results have been obtained through the RULA analysis was presented in figures in order to provide better understanding. From this chapter, all the collected data was analyzing and make comparison between different kind of design.

4.2 Ergonomics Analysis

The finalize concept design were analyzed using CATIA software in order to get the result for ergonomics analysis The results show the ergonomics posture of cashier when standing and seating at the counter. Both positon that applied the ergonomics analysis divided into several position which are stand still or sit down, placing the item into the packaging machine and pointing towards the LCD monitor. Each CAD drawing concepts will be analyze using RULA Analysis to obtain the

ergonomics result. For this study, analysis on different range of age has different height for better understanding have been made. Table below shows the range of age and height:

Table 4.1: Range of age and height for male worker.

Range of Age	Height (cm)
26-29	166
30-39	165.7
40-49	164.6

Table 4.2: Range of age and height for female worker.

Range of Age	Height (cm)
26-29	154.5
30-39	154.5
40-49	153.2

4.2.1 Existing Design

Figure 4.1 below shows the existing design from company Aeon. In the figure show the size of the counter which is smaller compare to finalize design concept. On the other hand, this design force the cashier working in standing position for a long period.

Meanwhile, the packaging item process is still manual where the cashier need to wrap up by themselves. This process is slow and required more energy and make the

cashier tired faster. This process also need the customer to wait longer if the customer buys a lot of item.

Furthermore, this checkout station did not provide any chair for the cashier. The cashier has to stand to a long period until there is no customer waiting at the line. This will lead to musculoskeletal disorder such as back pain. On the other hand, the bagging area shown in figure is much lower compare to the scanning area. Therefore, the cashier need to bend the body much lower in order to place the wrap up item to bagging area.

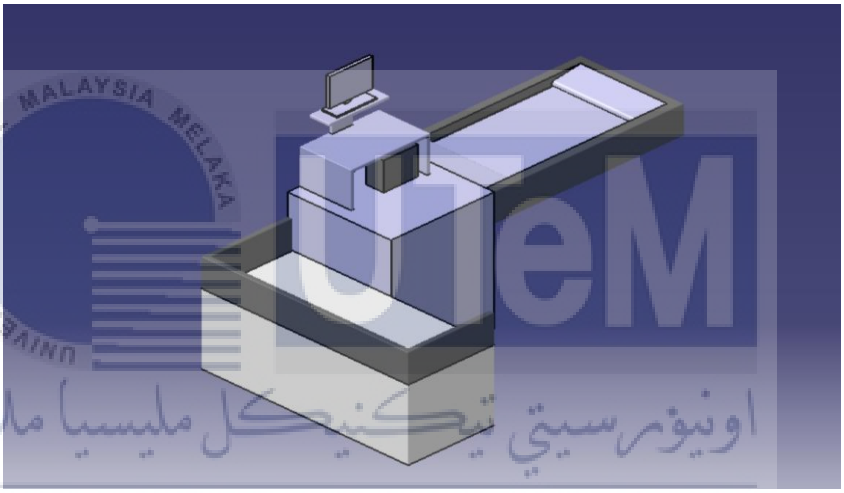


Figure 4.1: Existing checkout station design.

4.2.2 Finalize Design Concept

Regarding to the four concept design proposed, need to decide generate a new conceptual design with new improvement and functionality. Based on the requirement, the design concept is having mechanical component to do the packaging which is to fasten the packaging item process.

Figure 4.2 shows the final concept design. The main structure for this concept design is the packaging machine and moveable/foldable chair. The packaging machine

is a machine that helps the cashier to packaging item faster. This will help to reduce the waiting line for the customer. On the other hand, this packaging machine help to reduce energy used by the cashier by reduce the cashier posture for checkout process.

The movable/foldable chair is a chair that can move to right or left on the workstation. This chair also foldable when not in use. On the other hand, the cashier can change their positon from standing to seating if he or she standing too long. Therefore, this will help to reduce the risk of injured that can happen to the cashier.

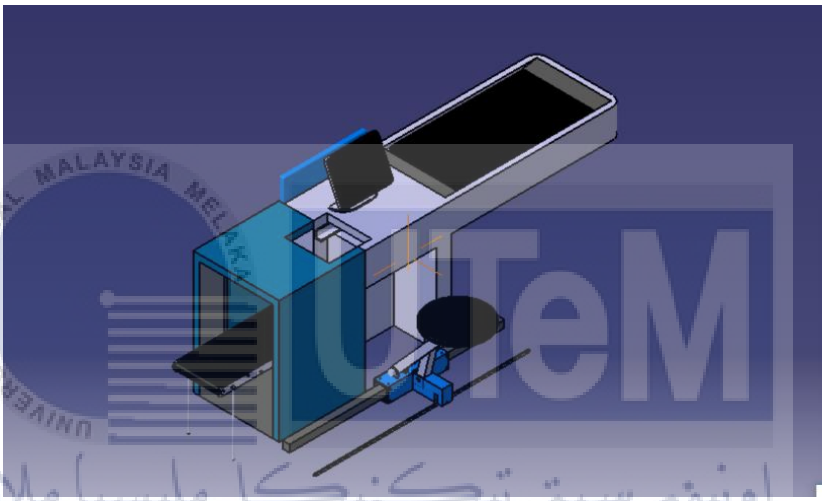


Figure 4.2: Final design concept

4.2.3 Ergonomics Analysis Standing Position for Male Worker

4.2.3.1 Stand Still Position

Figure 4.3 shows the existing design when the cashier in stand still positon without do any work. The result shows the final score is 1 out of 8. From the result, the posture is acceptable and ready to do the job comfortably.

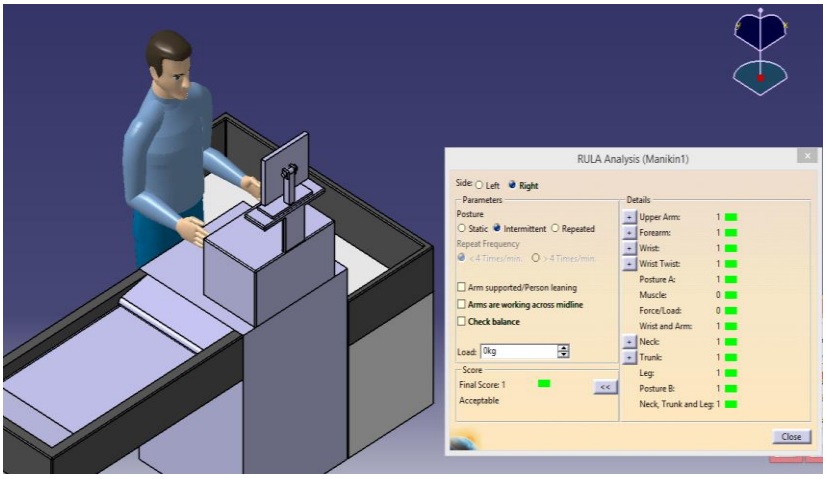


Figure 4.3: Stand Still position for existing design.

Figure 4.4 shows the ergonomics result for new design with the height of the cashier is 166cm in stand still position. The result shows the final score is 2 out of 8, From the result, the cashier posture is acceptable and comfort to do the job. Less stress occurs at the whole body because in this action show the standing still positon without do any work.

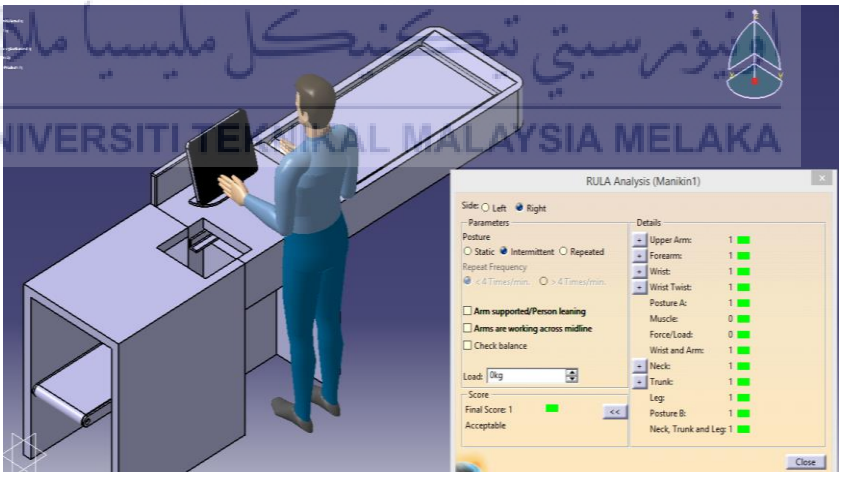


Figure 4.4: Stand still position for height of 166 cm.

The ergonomics result for the cashier with height of 165.7 cm in stand still position at the checkout counter shows the final score of 2 out of 8 in the Figure 4.5 below. From the results, the cashier posture is acceptable and comfort to do the job.

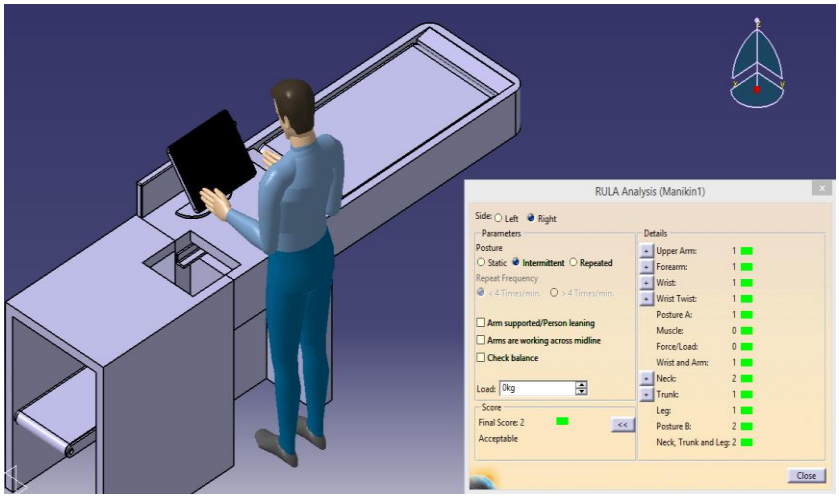


Figure 4.5: Stand still position for height of 165.7 cm.

Figure 4.6 below shows the ergonomics result for height of 164.6 cm in stand still position with final result of 2 out of 8. From the result, the cashier posture is acceptable and comfort to do the work.

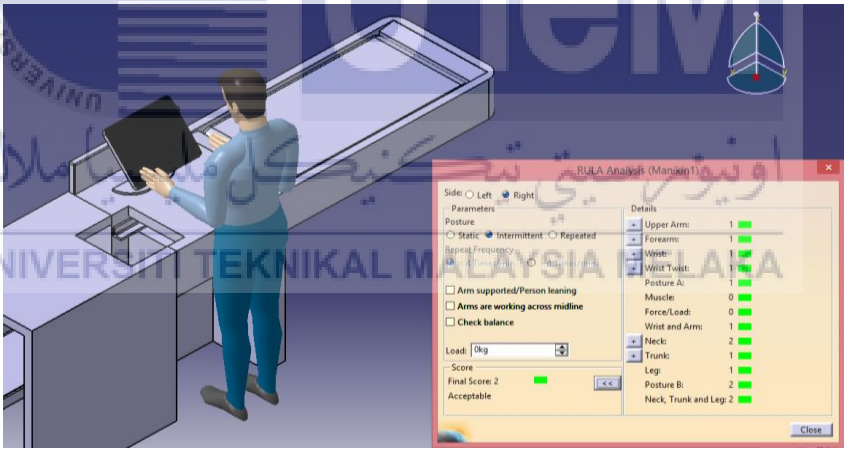


Figure 4.6: Stand still position for height of 164.6 cm.

4.2.3.2 Placing Item into Bagging Area and Packaging Machine

The results show the existing design of the right side of cashier when placing item into bagging are shown in the Figure 4.7 below. The result shows the final score of 4. From the result, the cashier posture need to investigate further in more detail. The

cashier`s body that affected most in this design are hand wrist, forearm, trunk, neck and leg. This is because the design of bagging area is too low. Therefore, the right side of the cashier used more energy and need to bend their body more in order to place item to bagging area.

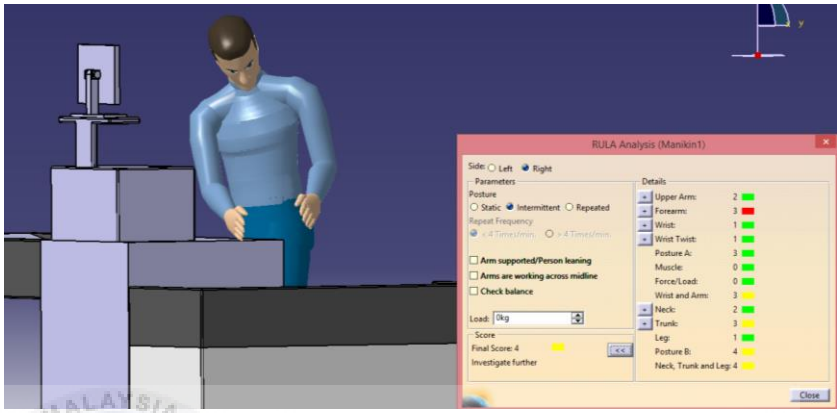


Figure 4.7: Placing item into bagging area for existing design (right).

Figure 4.8 below shows left side ergonomics result of the cashier when place item to bagging area. The result shows final score of 3 out of 8. From the results, the trunk, neck and leg had affected most and need to investigate further to get best ergonomics result. This is because the left side need to support more and required more energy when placing item which will lead to back pain and other musculoskeletal disorder.

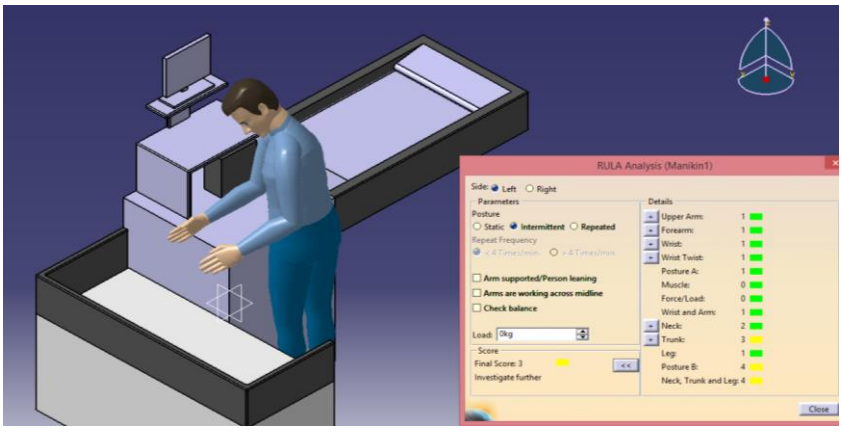


Figure 4.8: Placing item into bagging area for existing design (left).

Figure 4.9 shows the left side and Figure 4.10 shows the right side ergonomics result for new design with height of the cashier is 166cm when put item into the packaging machine. For the left side, the result shows final score of 2 out of 8. From the results, the left side of the cashier have the best posture compare to the right side because the left side use less energy compare to the right site. While the right side shows the final score of 3 out of 8. From the results, the cashier posture should be further reviewed to get the best ergonomics result. The cashier`s body effected is at the cashier hand wrist and forearm because cashier used more energy to lift item to put to the packaging machine.

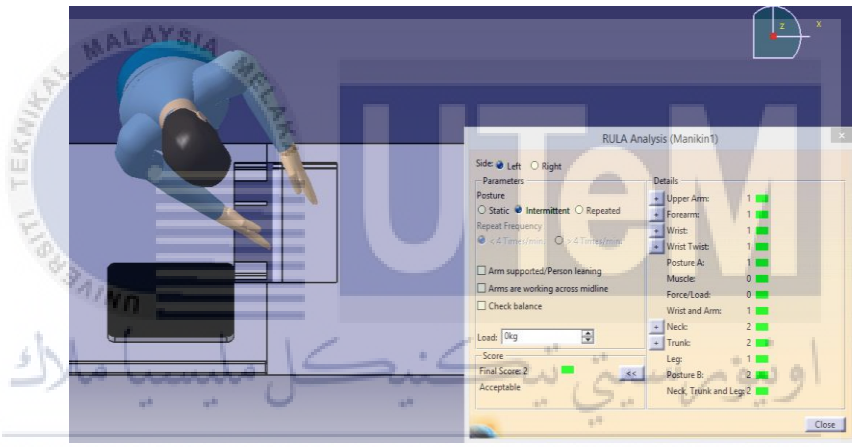


Figure 4.9: Place item into the packaging machine for height of 166 cm (left).

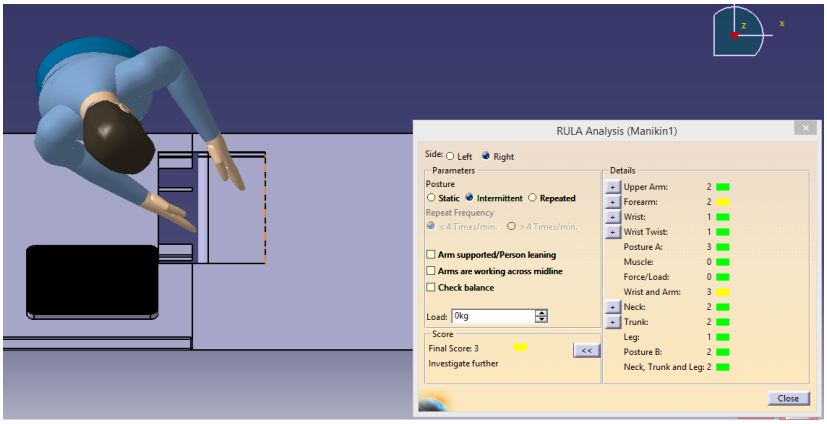


Figure 4.10: Place item into the packaging machine for height of 166 cm (right).

Figure 4.11 show the result for right hand side while doing the work. The results show the forearm used more energy in the process. In this posture, the casher required to do the job repeatedly in order to place all the item into the packaging machine, this will make the arm fatigue faster.

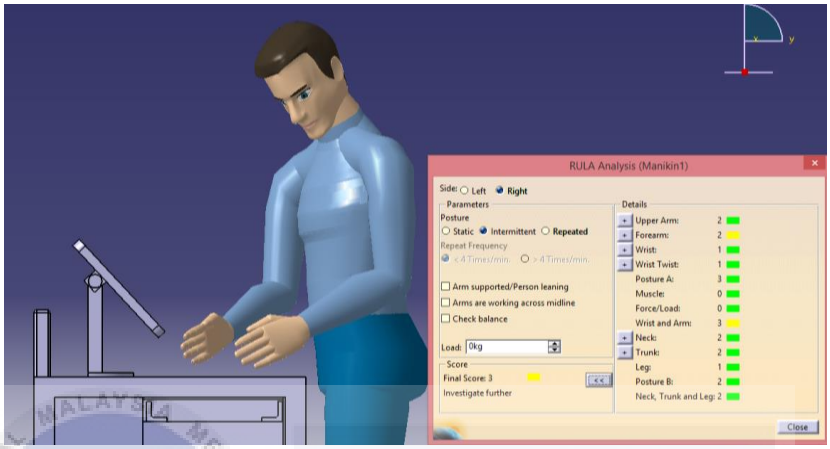


Figure 4.11: Posture of the right hand for height of 166 cm.

In order to make the posture is ergonomics is by changing the angle of the arm. The arm need to lift a bit to achieved the result of 2 out of 8. Therefore, the Figure 4.12 shows the best posture for the right hand of the cashier.

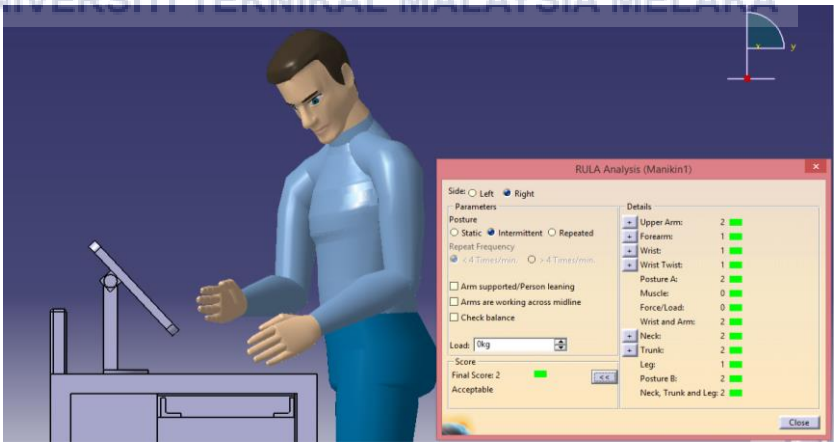


Figure 4.12: The correct posture for the right hand for height of 166 cm.

The results for the cashier with height of 165.7 cm for the left side and right side of cashier when placing item to the packaging machine shown in the Figure 4.13

and Figure 4.14 below. The final score for the left side is 2 out of 8. From the results, cashier posture is the best posture when standing. Therefore, the posture is acceptable and ready to do the job. While on the right side, the final score is 3 out of 8. From the results, the right hand of the cashier should be further reviewd to get the best ergonomics results. The cashier`s body effected is at the hand wrist and forearm because cashier used more energy to put item to the packaging machine.

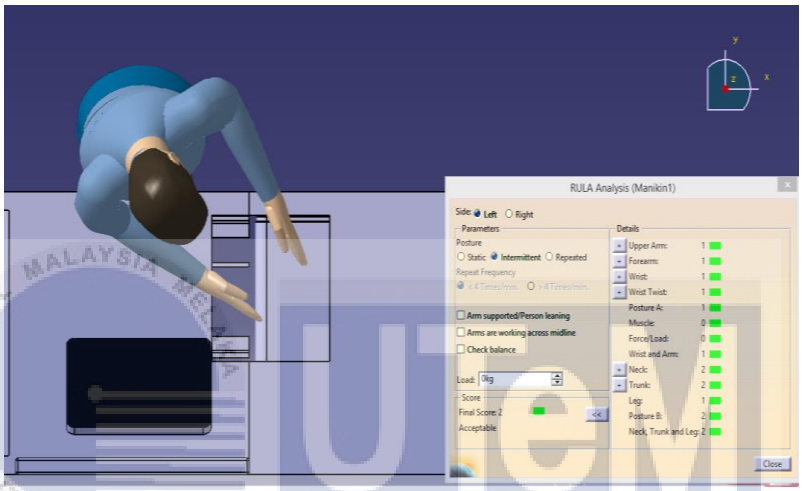


Figure 4.13: Placing item into packaging machine for height of 165.7 cm (left)

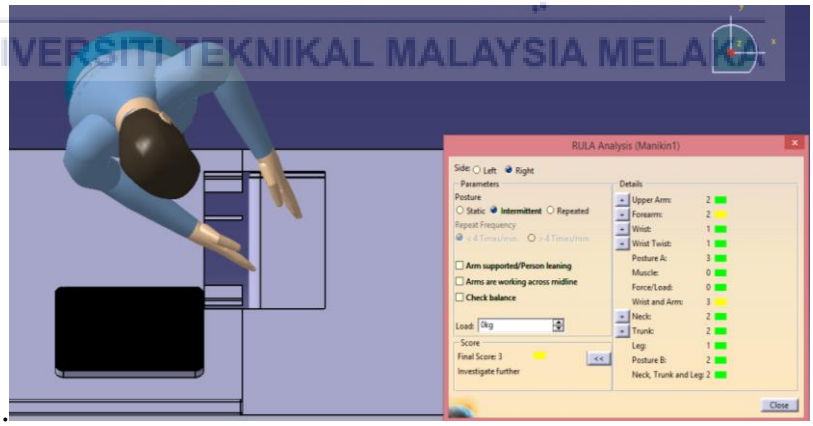


Figure 4.14: Placing item into packaging machine for height of 165.7 cm (right).

Figure 4.15 below shows the final score of 2 out of 8. From the results, the best posture of the right hand is about 45° from the upper arm. But, this posture is hard for

the cashier to put item to the packaging machine. Therefore, the cashier need to increases the degree of the forearm in oder to place item to the packaging machine.

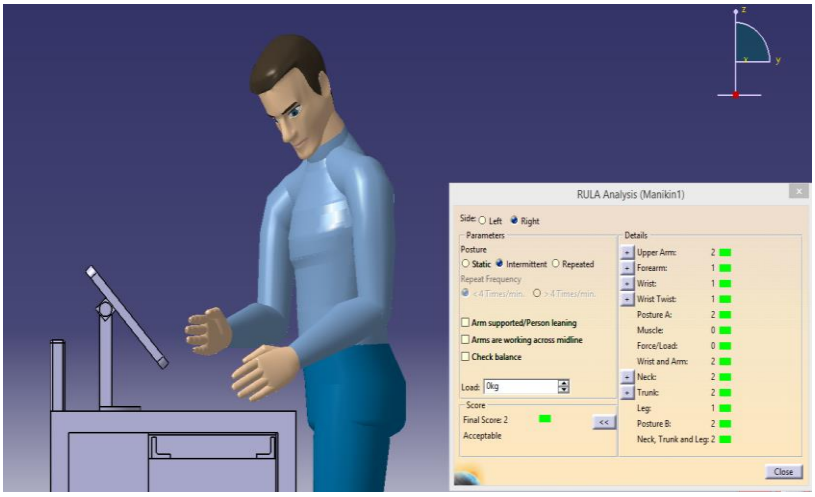


Figure 4.15: The correct posture for the right hand for height of 165.7 cm.

The result shows the right side of the cashier and the left side of the cashier with height of 164.6 cm when placing item into the packaging machine in the Figure 4.16 and Figure 4.17 below. From the right side, the cashier posture give result of 3 out of 8, while the left side give result of 2 out of 8. From the result, the right hand posture should be further reviewed to get the best ergonomics result. The hand wrist and forearm have the most affected the cashier body. On the other hand, the posture on the left side is acceptable and comfortable to do work.

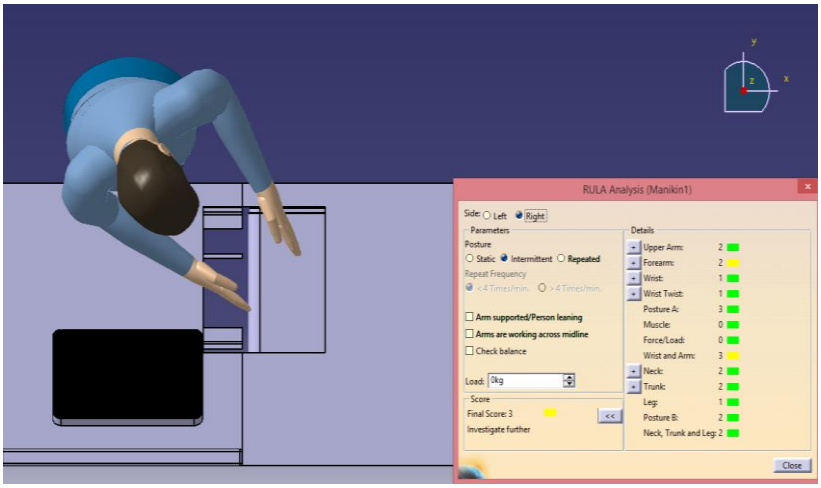


Figure 4.16: Placing item into packaging machine for height of 164.6 cm (right).

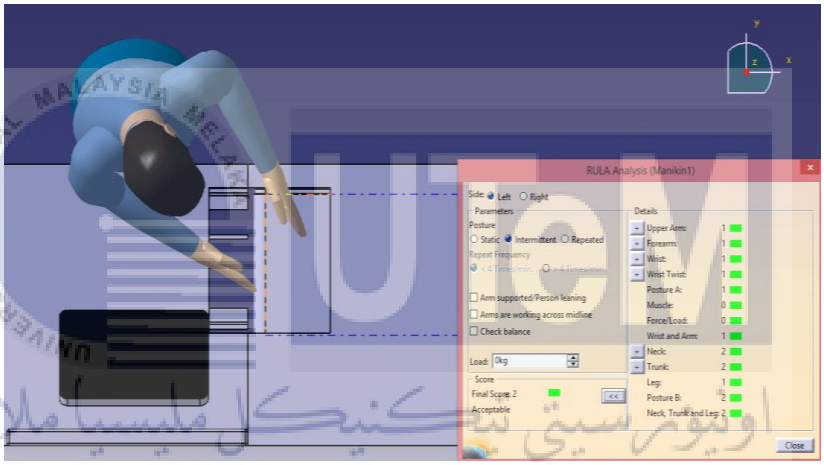


Figure 4.17: Placing item into packaging machine for height of 164.6 cm (left).

To get the best ergonomics for the right hand side, the cashier hand need to lift a bit in order to get better ergonomics result show in Figure 4.18. From the results, the right hand posture gives 2 out of 8. Eventually, this posture is hard for the cashier to place the item to the packaging machine because the right hand it too high to place the item.

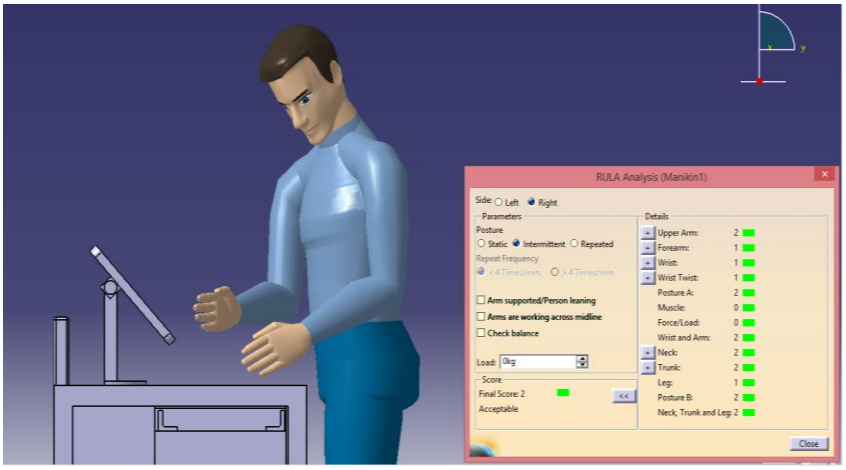


Figure 4.18: The correct posture for right hand for height of 164.6 cm.

4.2.3.3 Hand Pointing the Keyboard and LCD Monitor

The results show the existing design for right hand of cashier when pointing the keyboard shown in Figure 4.19 below. The final score is 2 out of 8. From the results, the cashier posture is acceptable and comfort for the cashier to use.

Figure 4.19: Hand pointing the keyboard for existing design.

The results shows the new design with the height of cashier is 166 cm for right side of cashier when pointing the LCD monitor shown in the Figure 4.20 below. The

final score is 2 out of 8. From the results, the cashier posture is acceptable and can be used. Less stress occurs at the right hand because in this action less force needed.

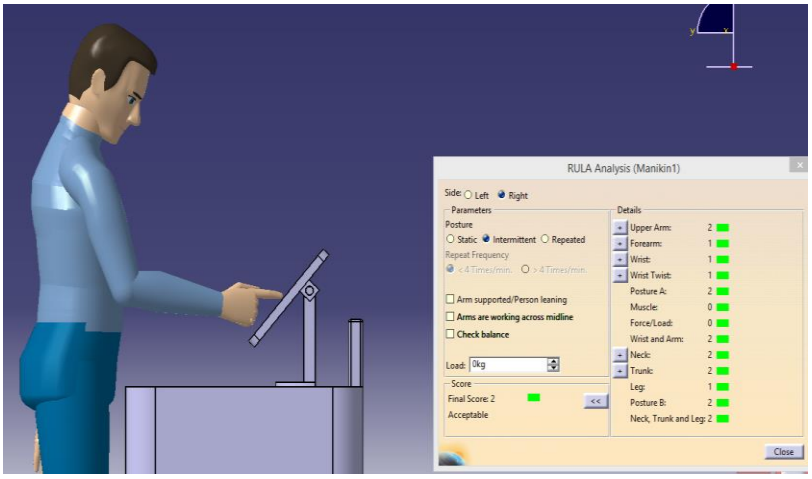


Figure 4.20:Pointing toward the LCD monitor for height of 166 cm.

The ergonomics result for the right side of cashier with height of 165.7 cm when pointing towards the LCD monitor showed in the Figure 4.21 below. The final results shows the score of 2 out of 8. From the results, the posture of the right hand is acceptable and easy for the cashier to touch the LCD monitor.

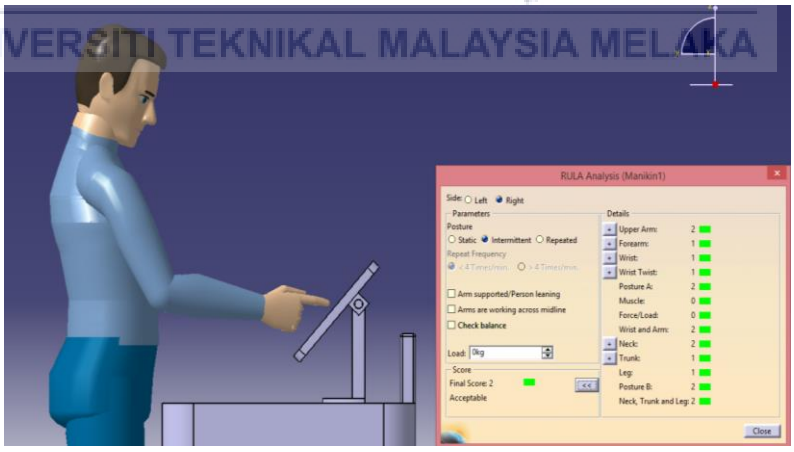


Figure 4.21: Pointing towards the LCD monitor for height of 165.7 cm.

The results for right side of cashier with height of 164.6 cm when pointing the LCD monitor shown in the Figure 4.22 below. The final score is 2 out of 8. Less stress occurs at the right hand because in this action less force is needed.

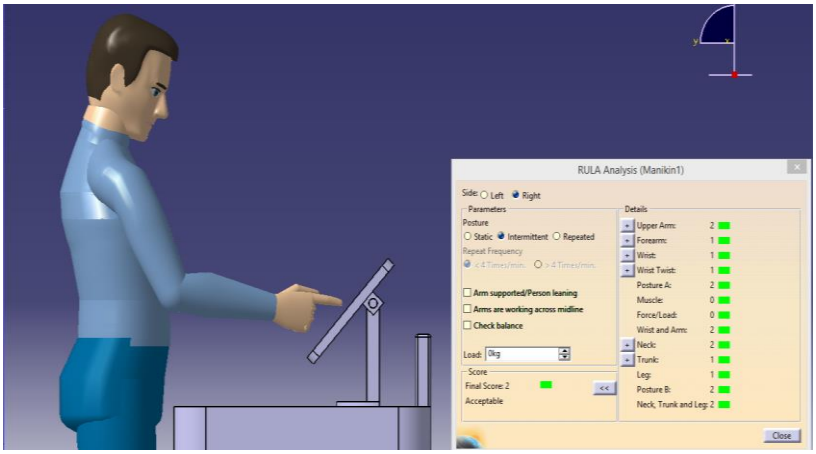


Figure 4.22: Pointing towards the LCD monitor for height of 164.6 cm.

4.2.4 Ergonomics Analysis Design for Standing Position for Female Worker

4.2.4.1 Stand Still Posture

In the Figure 4.23 shows the existing design information of the ergonomics result when cashier in standing positon. The ergonomics result get from the analysis is 1. From the results, clearly the cashier posture is acceptable and comfort to do a job.

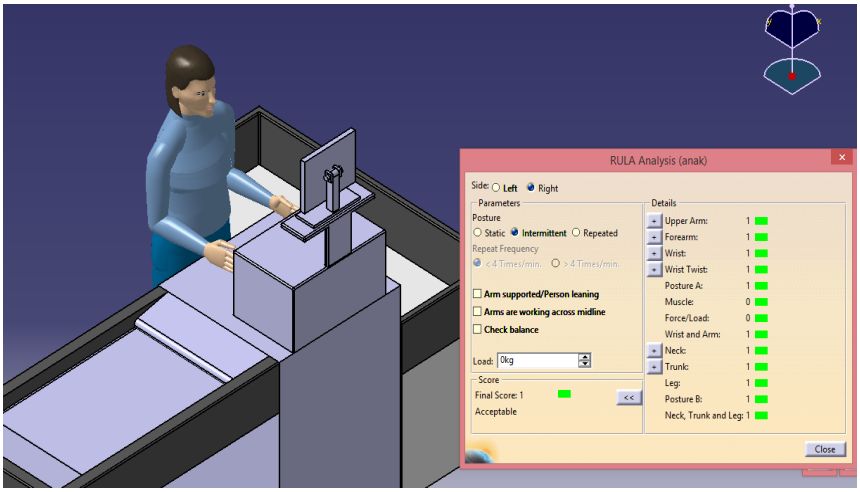


Figure 4.23: Standing posture for existing design.

The ergonomics result for new design with the height of cashier is 154.5 cm for left and right side of cashier when stand still at the checkout counter is shown in the Figure 4.24 below. Both results show the final score which is 1 out of 8. The posture of the cashier is acceptable and comfort to do the job.

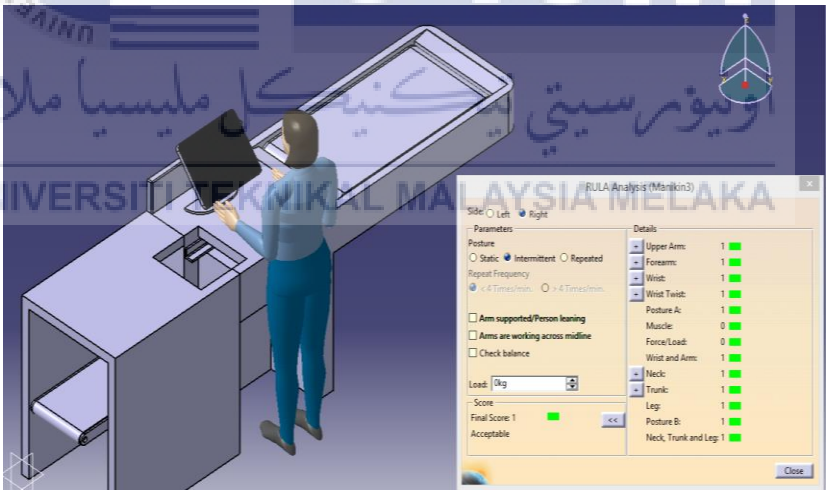


Figure 4.24: Stand still posture for height of 154.5 cm.

Figure 4.25 shows the ergonomics with height of cashier is 154.2 cm result for stand still position. The result shows the final score is 1 out of 8. From the result, the cashier posture is acceptable. Less stress occurs at the whole body.

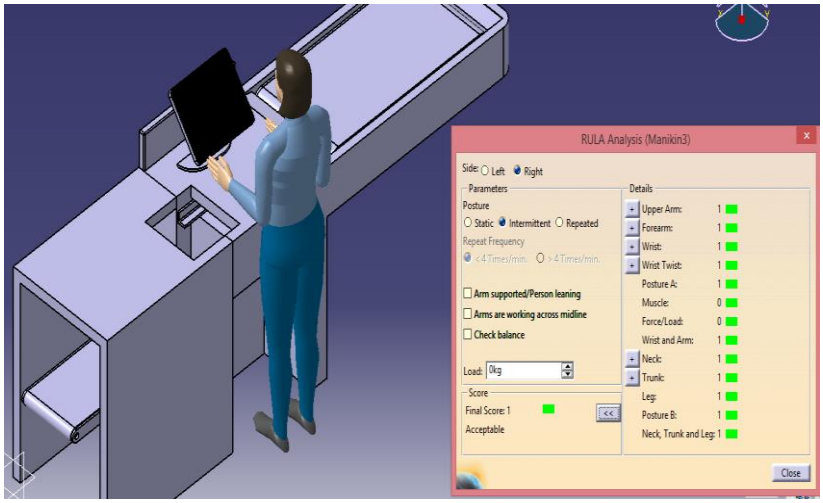


Figure 4.25: Stand still posture for height of 154.2 cm.

4.2.4.2 Placing Item into Bagging Area and Packaging Machine

Figure 4.26 shows the left side and Figure 4.27 shows the existing design for right side ergonomics result of the cashier when placing item to bagging area. Both figure show the same final score of 4 out of 8. From the result, the cashier posture should be further reviewed to get best ergonomics result. On the other hand, both figure shows the same result of which part of the cashier body affected most. There are upper arm, forearm, hand wrist, trunk, neck and leg.

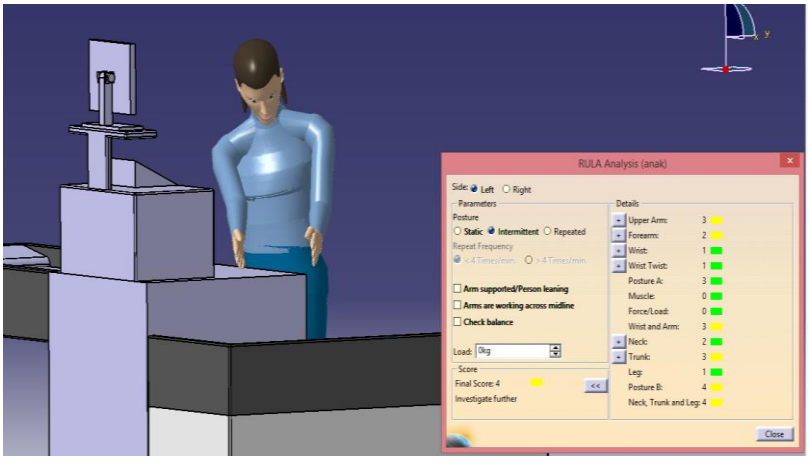


Figure 4.26: Placing item into bagging area for existing design (left).

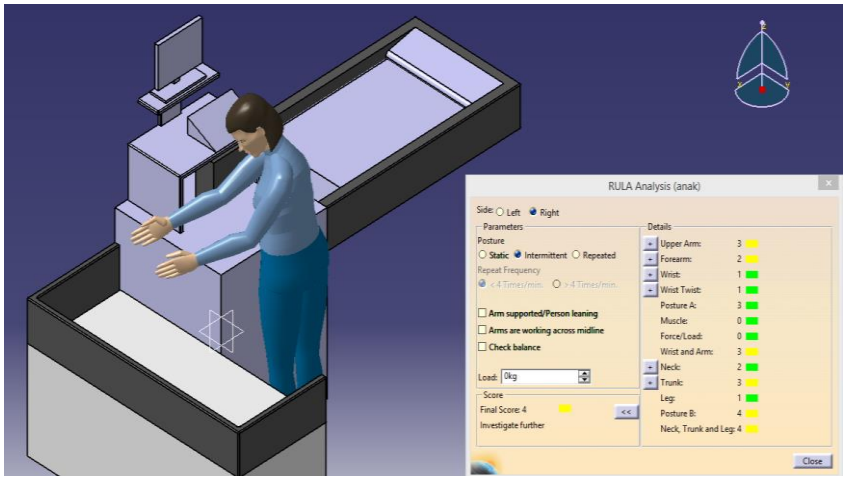


Figure 4.27: Placing item into bagging area for existing design (right).

Figure 4.28 shows the left side and Figure 4.29 shows the new design with height of the cashier is 154.5 cm for right side ergonomics result of the cashier when put item to the packaging machine. Both give the same final result is 2 out of 8. From the result, it is clearly the posture is acceptable and the cashier comfortable to do the placing item to packaging machine.

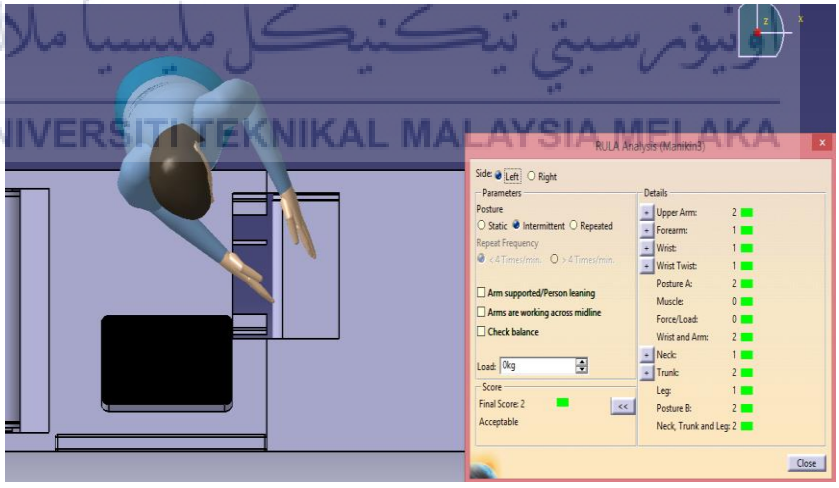


Figure 4.28: Placing item into packaging machine for height of 154.5 cm (left).

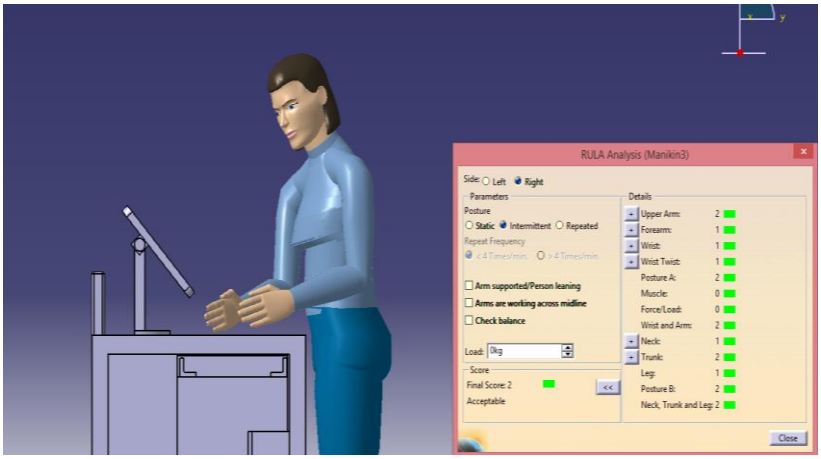


Figure 4.29: Placing item into packaging for height of 154.5 cm (right).

Both side give the same final result which is 2 out of 8 and shown in Figure 4.30 and Figure 4.31 with the height of the cashier is 153.2 cm. From the results, both side have the best posture when placing item to packaging machine. In figure shown how close the hand can be move in order to place item to packaging machine.

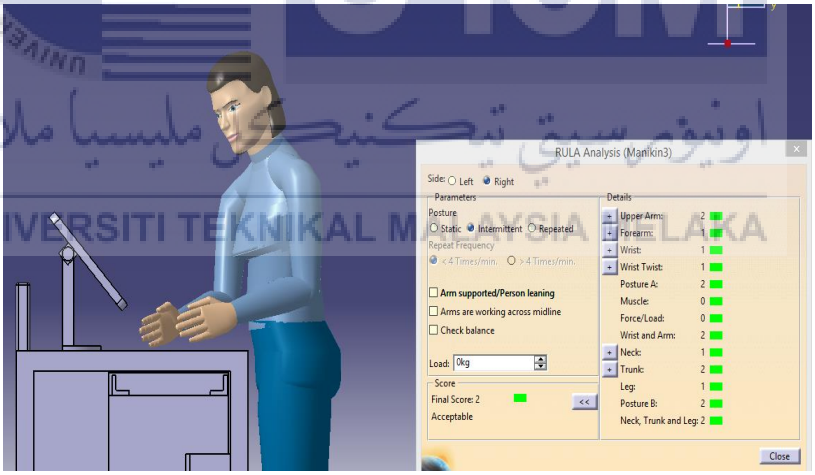


Figure 4.30: Placing item into packaging machine for height of 153.2 cm (right)

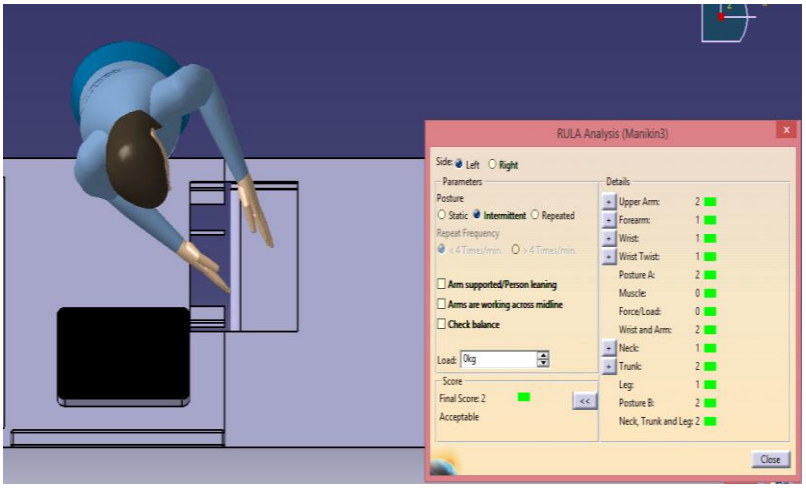


Figure 4.31: Placing item into packaging machine for height of 153.2 cm (left).

4.2.4.3 Pointing Towards the Keyboard and LCD Monitor

The results show the existing design for the right side of cashier when pointing the keyboard shown in the Figure 4.32 below. The final score is 3 out of 8. From the figure, the hand wrist and arm affected most to the cashier. This is probably due cause on twisting the hand wrist frequently.

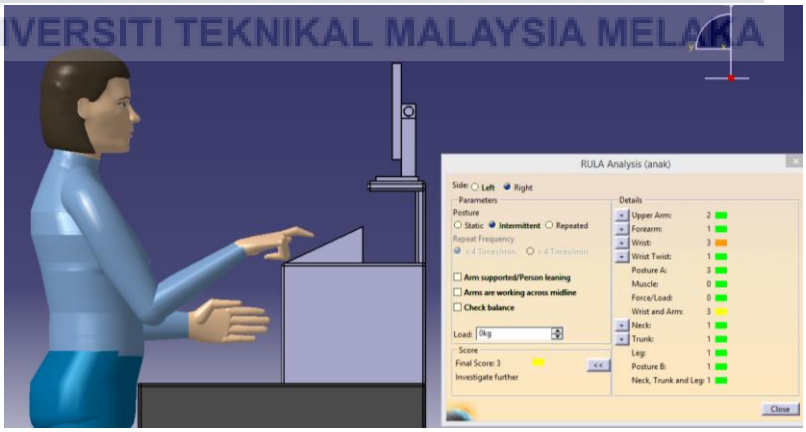


Figure 4.32: Hand pointing to the keyboard for existing design.

The results show the new design with the height of cashier is 154.5cm for the right side when reaching the LCD monitor shown in the Figure 4.33 below. The final

score is 3 out of 8. From the results, the posture need to investigate further in more detail get the best ergonomics result. The cashier`s body affected most in this design is hand wrist. After investigate further, the LCD monitor need to get closer to the cashier to get ergonomics posture shown in Figure 4.34 below. About 200 mm from the edge of the counter, the LCD need to adjust for the cashier is easy to use the LCD monitor and the final result is 2 out of 8.

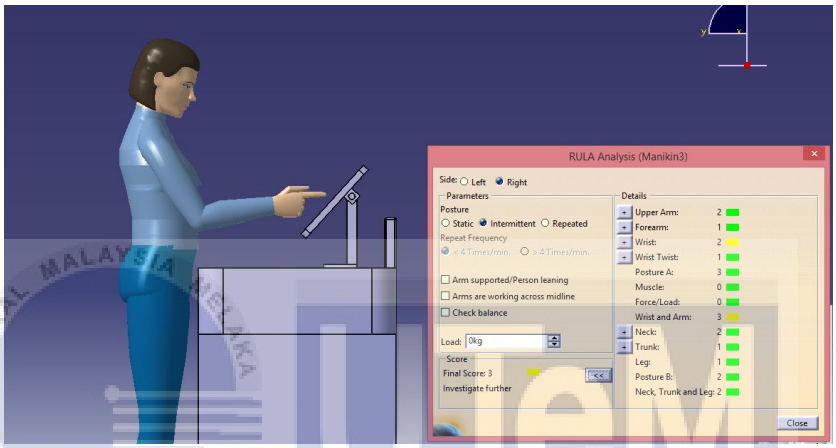


Figure 4.33: The LCD monitor at the origin place for height of 154.5 cm.

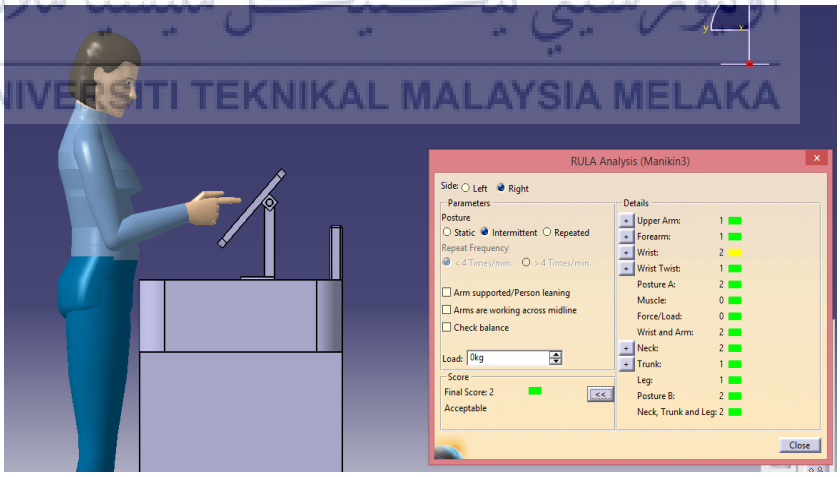


Figure 4.34: The LCD monitor closer to the cashier for height of 154.5 cm.

Information in the Figure 4.35 below is about the ergonomics result when cashier pointing the LCD monitor with height of 153.2 cm and the result from the

analysis is 3. From the results, cashier suffer the hand wrist and arm problem if do the posture repeatedly.

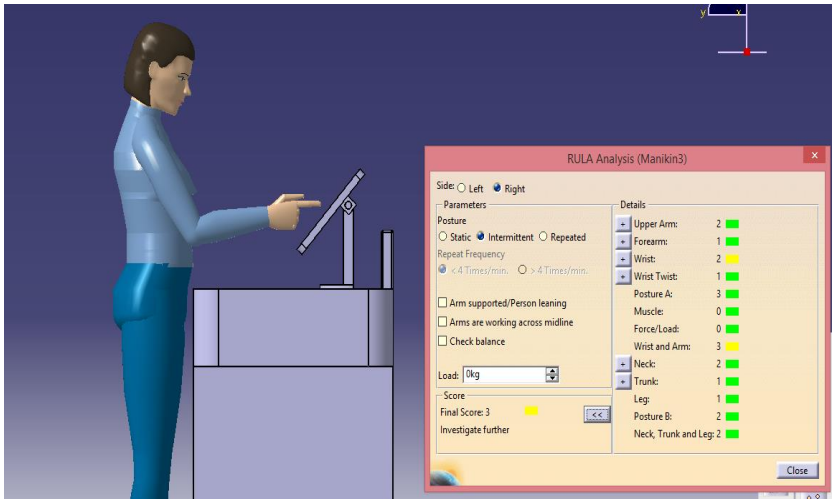


Figure 4.35: The LCD monitor at the origin place for height of 153.2 cm.

The LCD need to adjust in order to get the ergonomics posture. The LCD have been move towards the cashier about 200 mm from the edge of the counter. For the results, the ergonomics result gets from this changes are 2 out of 8.

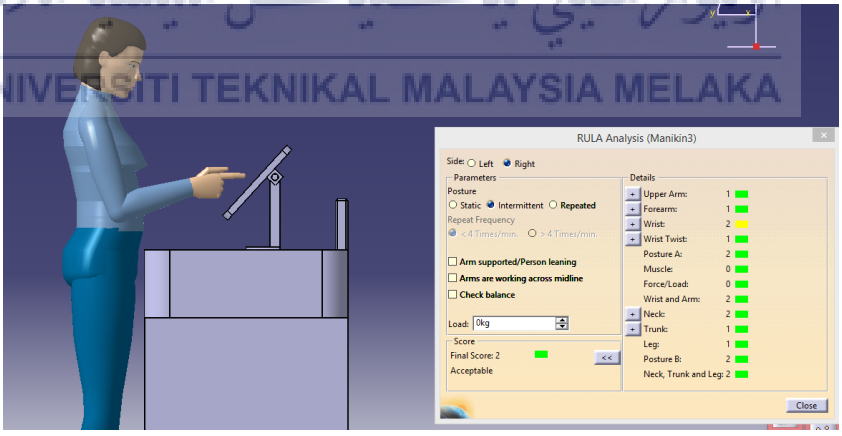


Figure 4.36: The LCD monitor closer to the cashier for height of 153.2 cm.

4.2.5 Ergonomics Analysis for Seating Position for Male Worker

4.2.5.1 Seating Posture

Figure 4.37 and Figure 4.38 below shows the ergonomics result for new design with the height of the cashier is 166cm when seating after stand for a long time or starting their job. The result shows final score of 2. From the result, the cashier posture is acceptable and comfort to do the job. No stress occures at the whole body because the action shows the cashier seatwithout do any work.

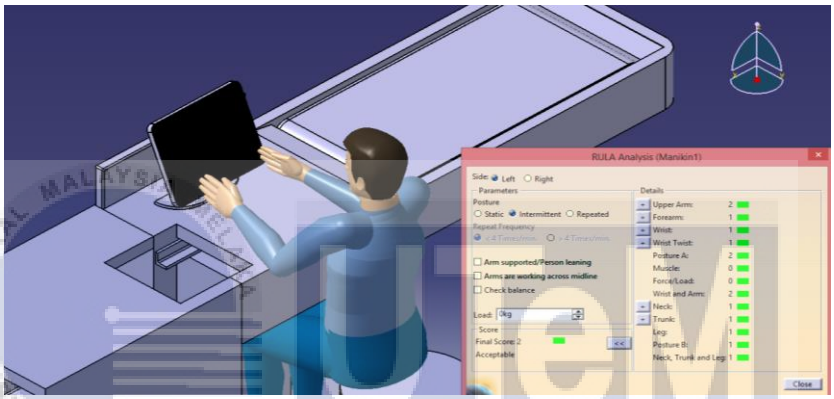


Figure 4.37: Seating posture from back view for height of 166 cm.

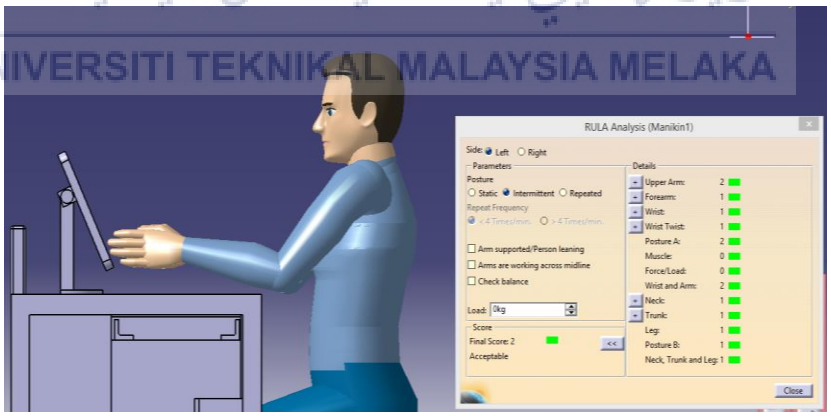


Figure 4.38: Seating posture from side view for height of 166 cm.

Figure 4.39 and Figure 4.40 shows result of ergonomics analysis with the height of cashier is 165.7 cm when cashier at the seating position. The result get from the analysis is 2 out of 8. From the results, the seating position is acceptable and ready to

do any work. At this point, less stress occurs at the whole body because the body is more relax compare to stand still position.

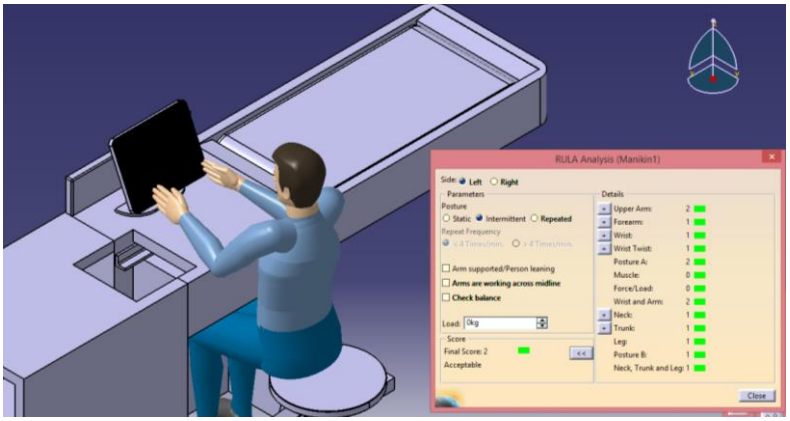


Figure 4.39: Seating posture from isometric view for height of 165.7 cm.

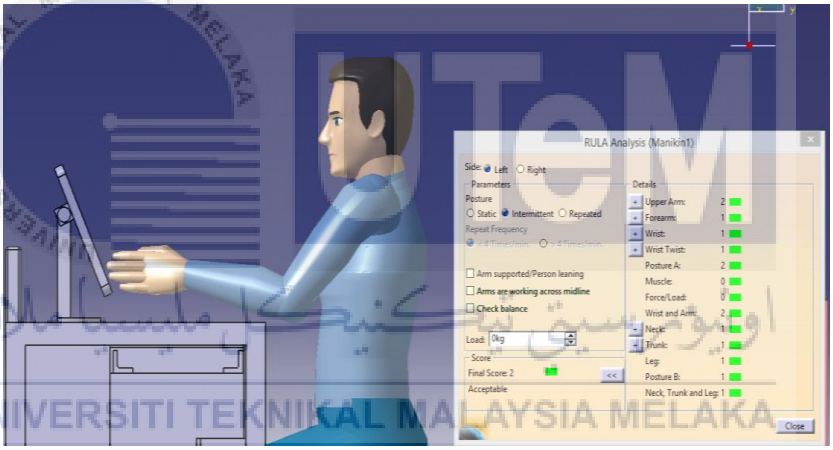


Figure 4.40: Seating posture form the side view for height of 165.7 cm.

Ergonomics result when cashier in seating position with height of 164.6 cm shown in Figure 4.41 below. The result of the final score is 2 out of 3. From the results, cashier posture is the best posture and comfortable for the cashier to do work.

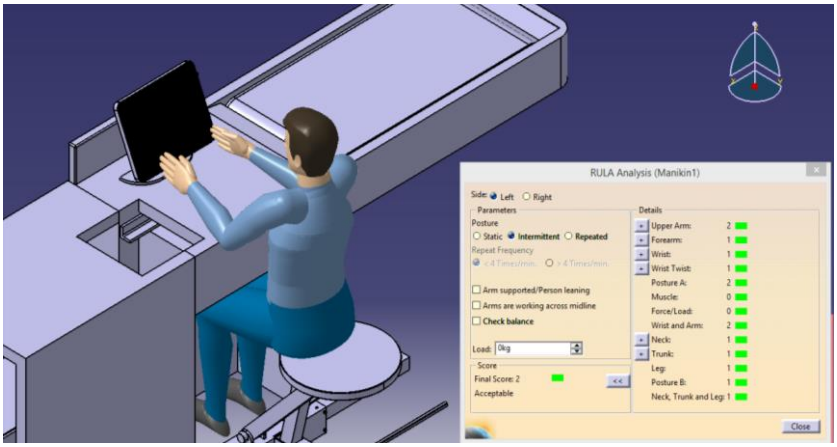


Figure 4.41: Seating posture from isometric view for height of 164.6 cm.

4.2.5.2 Placing Item Into Packaging Machine

Figure 4.42 shows the left side from top angle, Figure 4.43 show the left side from side angle and Figure 4.44 shows the right side from top angle ergonomics result the new design with height of the cashier is 166 cm when sitting and place item to packaging machine. The final score of 2 out of 8. From the results, the cashier is acceptable and comfort to do the job. This is because the sitting position give different kind of posture compare to standing position which more relax and used less energy.

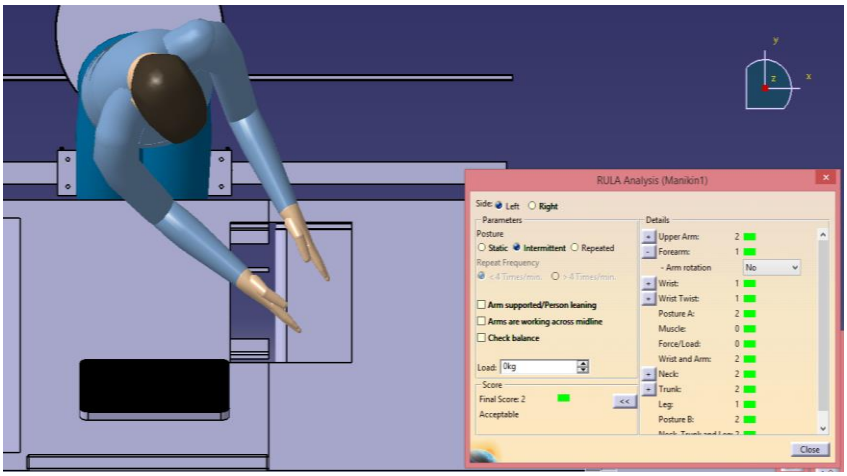


Figure 4.42: Placing item into packaging machine for height of 166 cm (left).

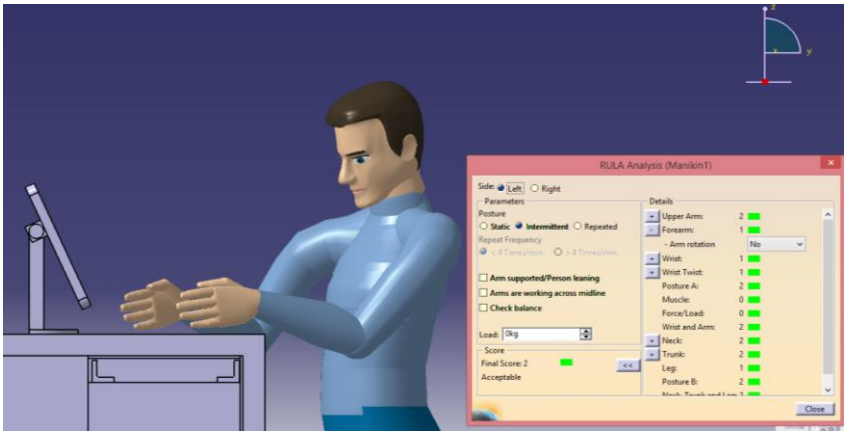


Figure 4.43: Placing item to packaging machine for height of 166 cm (left).

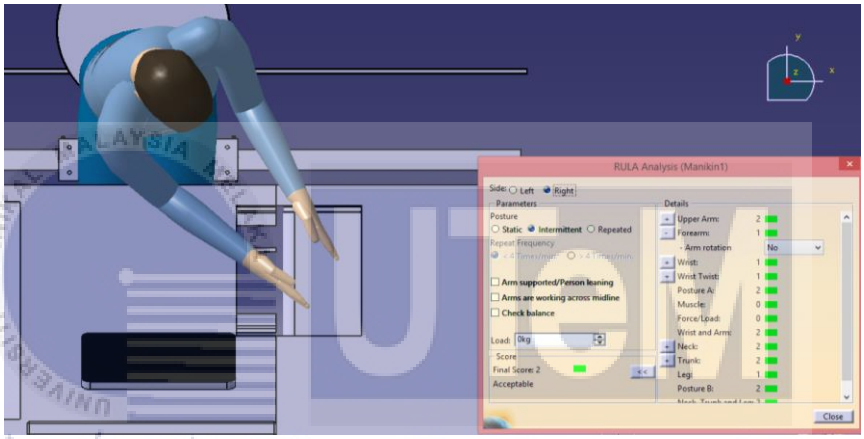


Figure 4.44: Placing item to packaging machine for height of 166 cm (right).

Figure 4.45 shows the right side and Figure 4.46 shows the lef side ergonomics result of the cashier with height of 165.7 cm when sitting and place item to packaging machine. Both show the final score of 2 out of 8. From the result, the posture is acceptable and ergonomics if the job repateadly less than 4 times per minute.

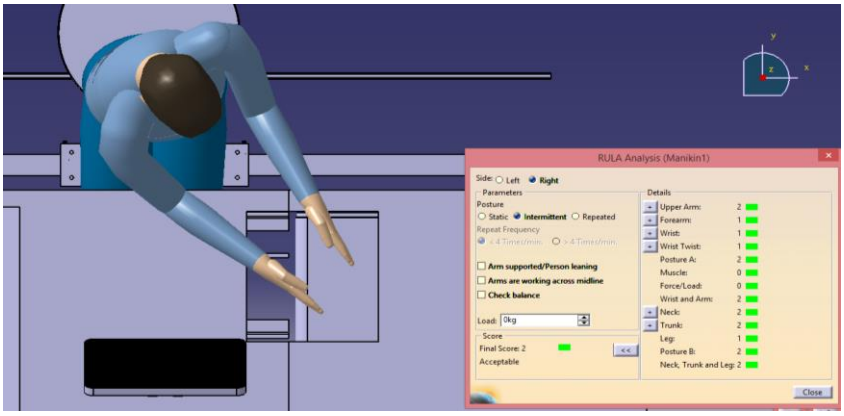


Figure 4.45: Placing item into the packaging machine for height of 165.7 cm (right)

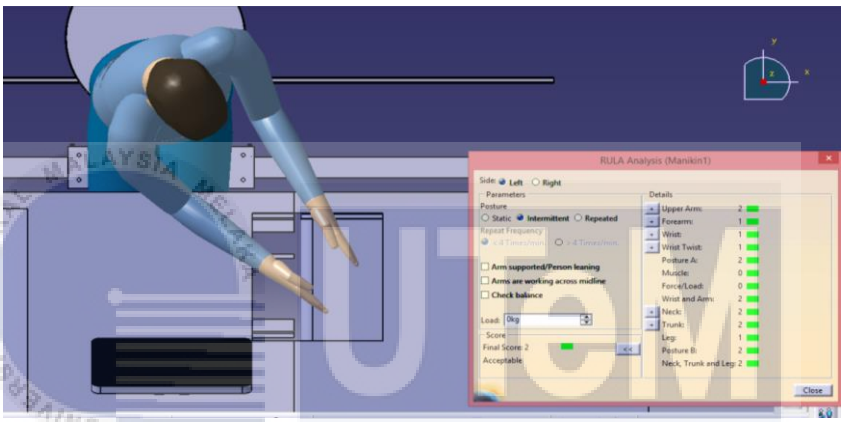


Figure 4.46: Plasing item into the packaging machine for height of 165.7 cm (left).

Both shows the same ergonomics result of the cashier with height of 164.6 cm when sitting and placing item to packaging machine in Figure 4.47 and Figure 4.48. The final result for both figure is 2 out of 8. From the result, the cashier is comfortable to do repeatedly placing item to packaging machine because the ergonomics posture is acceptable.

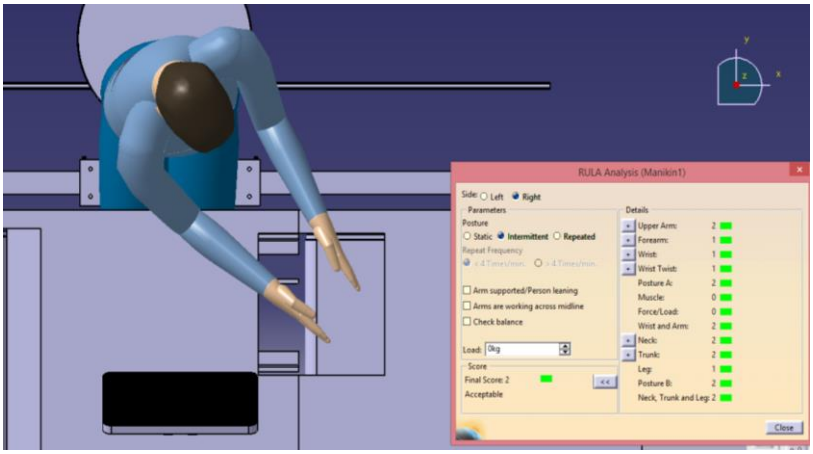


Figure 4.47: Placing item into packaging machine for height of 164.6 cm (right)

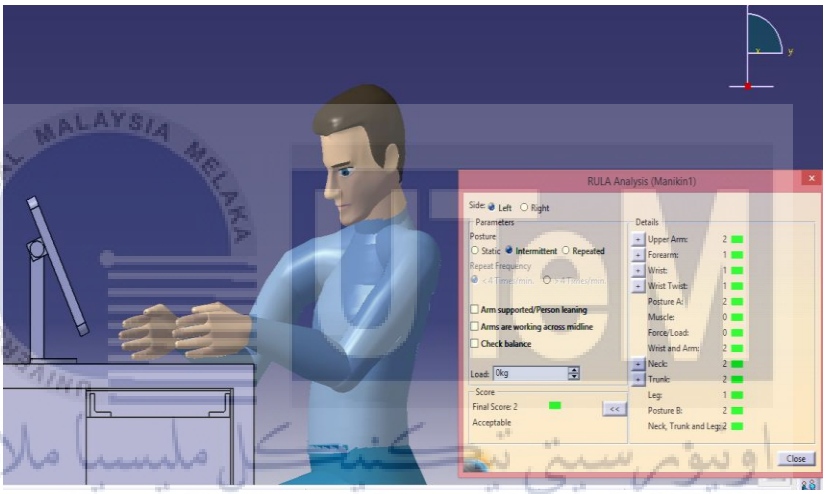


Figure 4.48: Placing item into packaging machine for height of 164.6 cm (left side).

4.2.5.3 Pointing Towards the LCD Monitor

Information in the Figure 4.49 is about the ergonomics result when cashier reach the LCD monitor in the right side with height of 166 cm. The ergonomics result get from the analysis is 2. From the results, cashier posture is accaptable and comfort to do the job but it is hard to reach the monitor in this positon. Therefore, the Figure 4.50 show the positon of the LCD monitor is move about 80 mm closer to the cashier for the cashier to do the job comfortably.

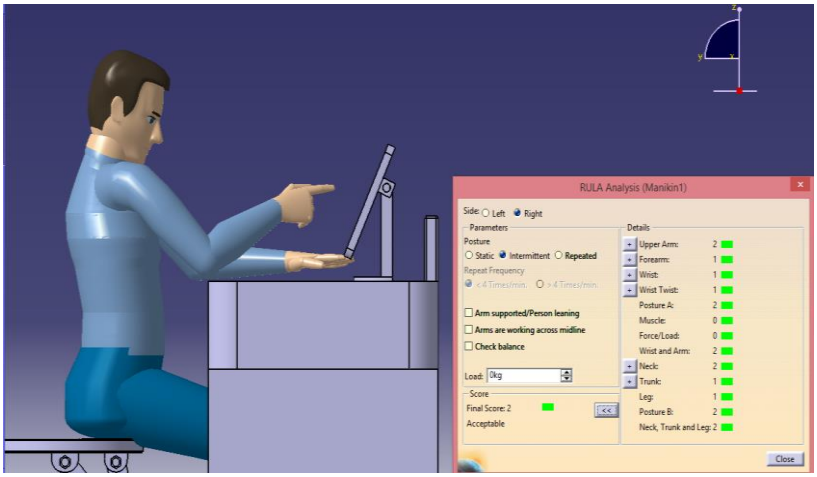


Figure 4.49: Position of LCD at origin place for height of 166 cm.

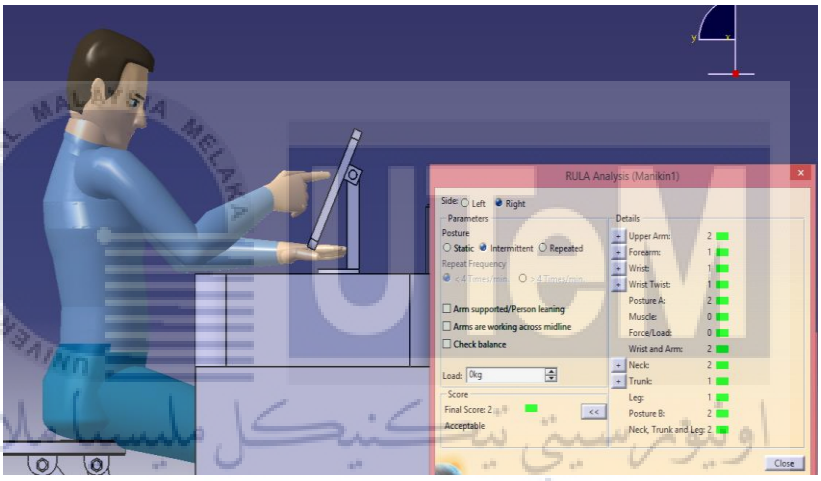


Figure 4.50: Postion of LCD monitor after adjust for height of 166 cm.

Information in the Figure 4.51 is about the ergonomics result when the cashier pointing towards the LCD monitor with height of 165.7 cm. The ergonomics result get from the analysis is 2. From the results, the right hand posture is acceptable. Even thought, the right hand posture is acceptable, it is hand for the cashier to reach the LCD monitor. Therefore, the cashier need to extend their hand to touch the LCD monitor.

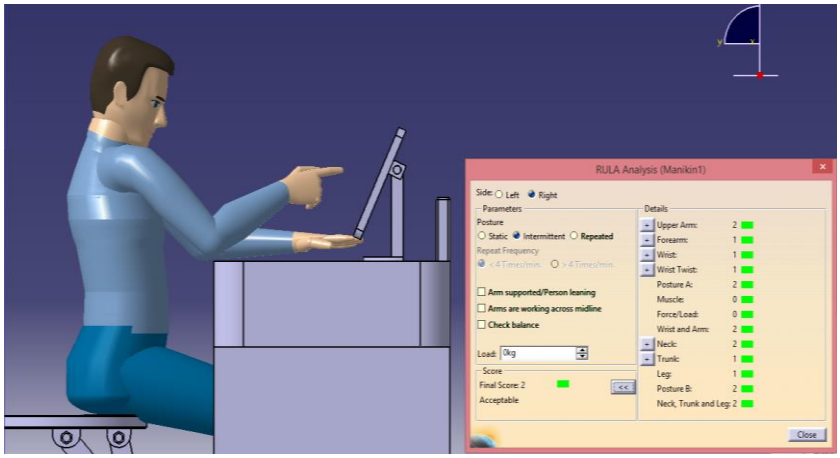


Figure 4.51: The LCD position at the origin place for height of 165.7 cm.

To make sure the cashier to do the job easily, the LCD monitor need to get closer to the cashier. Therefore, about 80 mm need to adjust in order the cashier is easy to reach the LCD monitor shows in Figure 4.52.

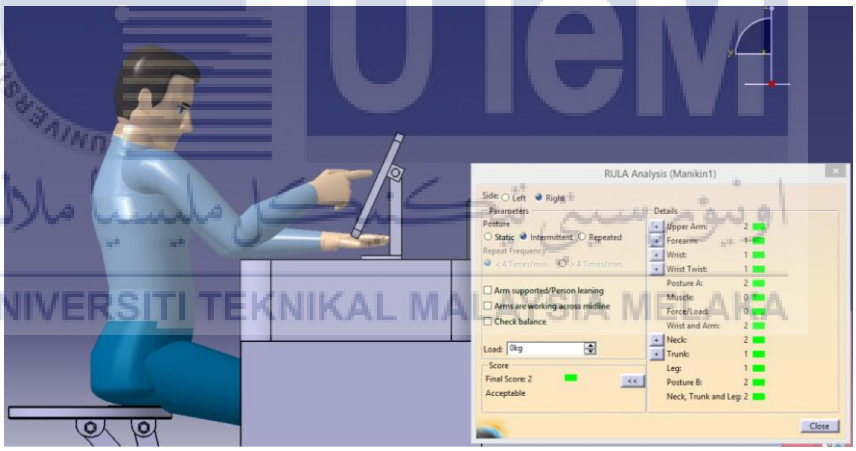


Figure 4.52: Position of LCD monitor after adjust for height of 165.7 cm.

Figure 4.53 shows the right side ergonomics result when the LCD at the origin. While Figure 4.54 shows the right side ergonomics result when the LCD move closer to the cashier with height of 164.6 cm. Both shows the final score 2 out of 8. The different is, the cashier cannot reach the LCD monitor in the ergonomics posture because the LCD is to far too reach. Therefore, the LCD monitor need to get closer to

the cashier to easier the cashier does the job. Almost 200 mm from the edge of the counter need to adjust for the LCD get closer to the cashier.

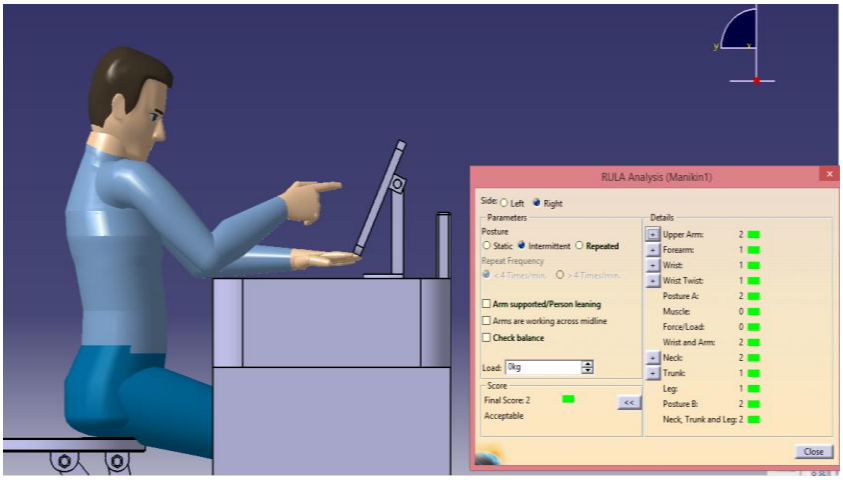


Figure 4.53: The LCD monitor at the origin place for height of 164.6 cm.

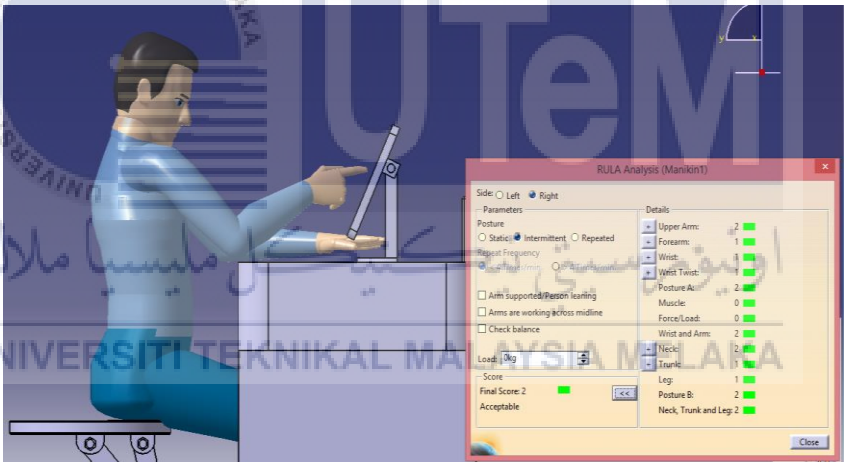


Figure 4.54: Postion of LCD monitor after adjust for height of 164.6 cm.

4.2.6 Ergonomics Analysis for Seating Position for Female

4.2.6.1 Seating Posture

Figure 4.55 below shows the ergonomics results of the cashier with height of 154.5 cm went seating after stand for a long time or starting their job. The result shows final score of 2. Form the result, the cashier posture is acceptable.

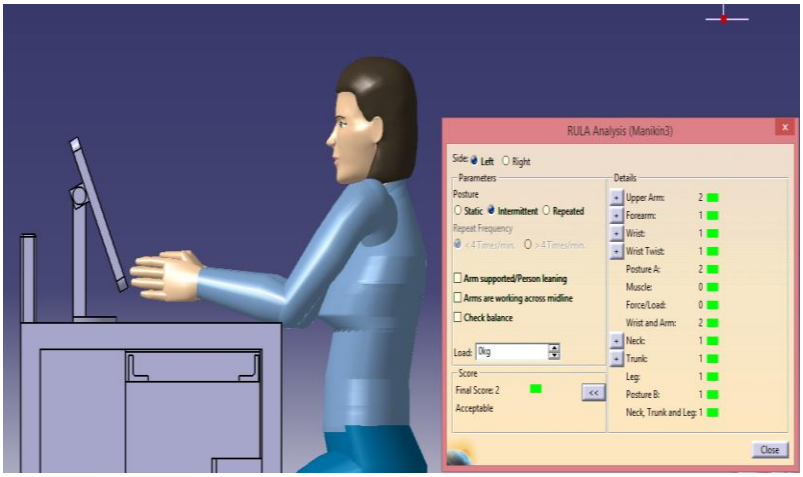


Figure 4.55: Seating posture for height of 154.5 cm.

The ergonomics result shows with height of the cashier is 153.2 cm in the Figure 4.56 for seating position when ready to do work. The result shows the final score is 2 out of 8. From the result, the seating posture in the figure is acceptable and comfort to do the job.

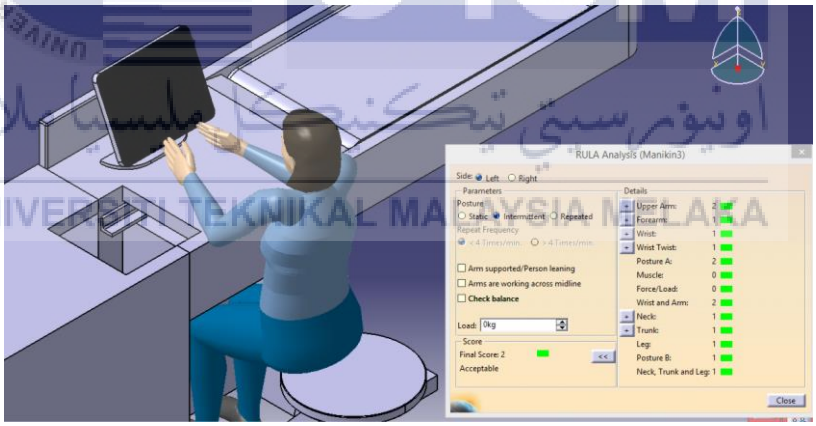


Figure 4.56: Seating posture for height of 154.5 cm.

4.2.6.2 Placing Item into Packaging Machine

Figure 4.57 shows the left side and Figure 4.58 show the right side ergonomics result of the cashier with height of 154.5 cm when placing item to packaging machine.

Both show the final score of 2. Therefore, the posture is acceptable when do the repeatedly placing item to packaging machine.

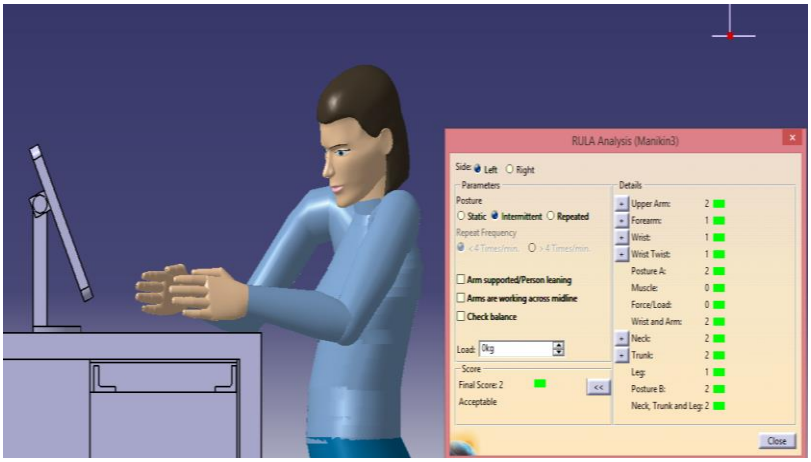


Figure 4.57: Placing item into packaging machine for height of 154.5 cm (left).

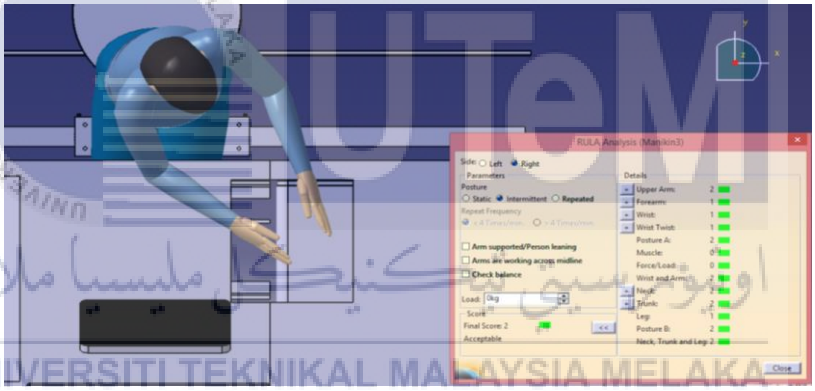


Figure 4.58: Placing item into packaging machine for height of 154.5 cm (right).

In Figure 4.59 and Figure 4.60 shows the result of ergonomics for placing item to the packaging machine with height of the cashier is 153.2 cm. The final score for both left and right side is 2 out of 8. Therefore, this posture is comfortable to do the placing item to packaging machine. High stress will occur at the whole body if the posture repeatedly for more than 4 times per minute.

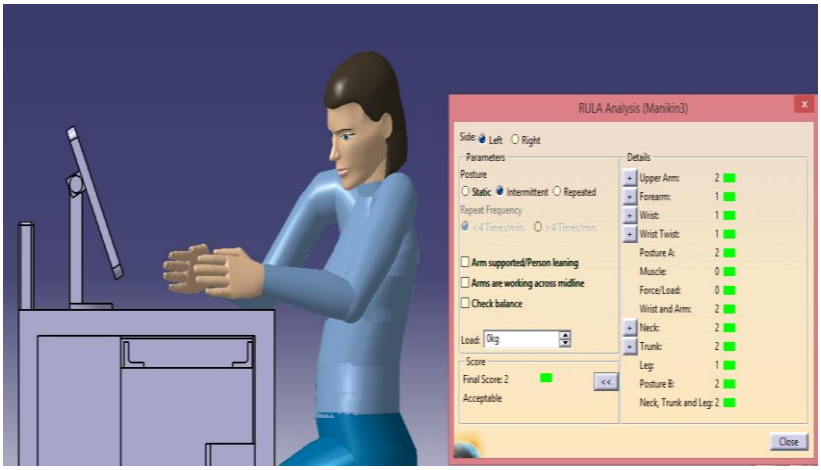


Figure 4.59: Placing item into packaging machine for height of 153.2 cm (left).

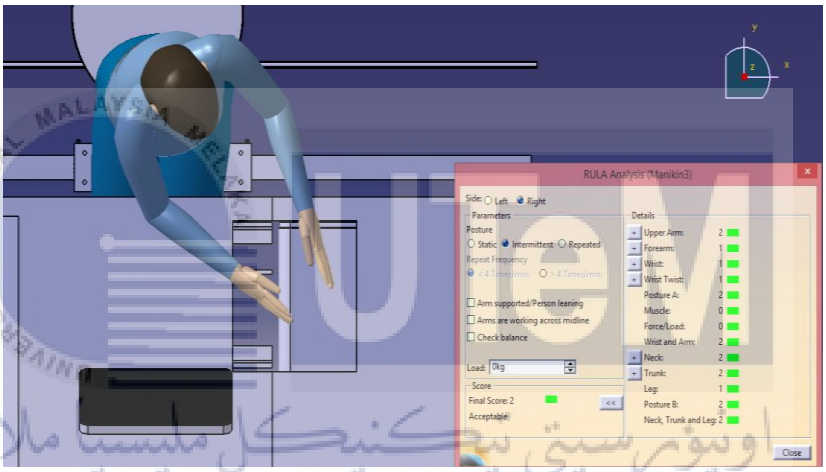


Figure 4.60: Placing item into the packaging machine for height of 153.2 cm (right).

4.2.6.3 Pointing Towards the LCD Monitor

The results show the right side of cashier with height of 154.5 cm when reaching the LCD monitor shown in the Figure 4.62 below. The final score 2 out of 8. From the results, the right hand posture is acceptable and ergonomics. The constraint is the LCD is far away from the cashier, if the cashier wants to reach, the posture of the right hand will be not ergonomics. Therefore, the LCD need to adjust closer to the

cashier and about 200mm need to be adjust the LCD monitor shown in the Figure 4.63 below.

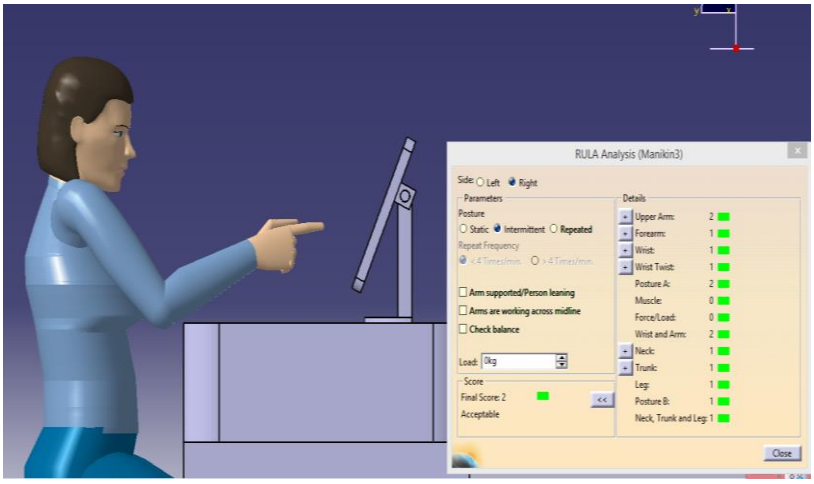


Figure 4.61: The LCD position at the origin place for height of 154.5 cm.

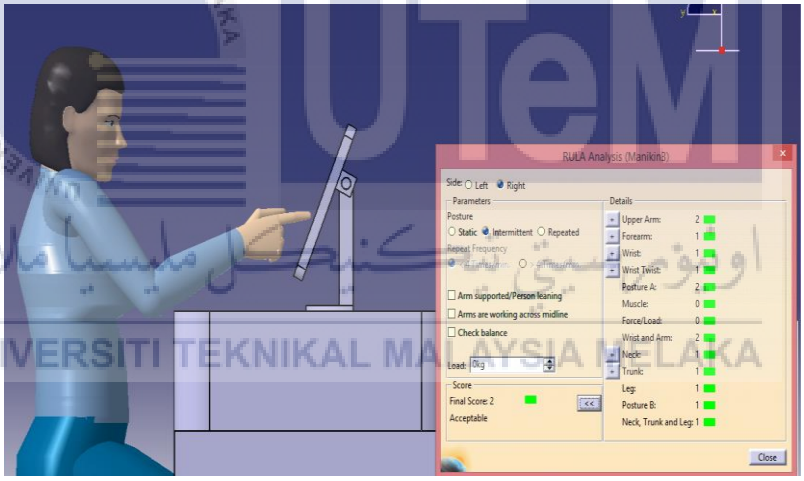


Figure 4.62: Postion of LCD monitor after adjust for height of 154.5 cm.

Figure 4.64 shows the right side the ergonomics result of the cashier pointing towards the LCD monitor with height of 153.2 cm. From the results, when sitting position give the same result as standing position, where the LCD monitor is hard to reach at the ergonomics posture. Therefore, in sitting position also need to adjust the LCD monitor closer to the cashier and the range is the same which is 200mm from the edge of the counter. This results shows in Figure 4.65.

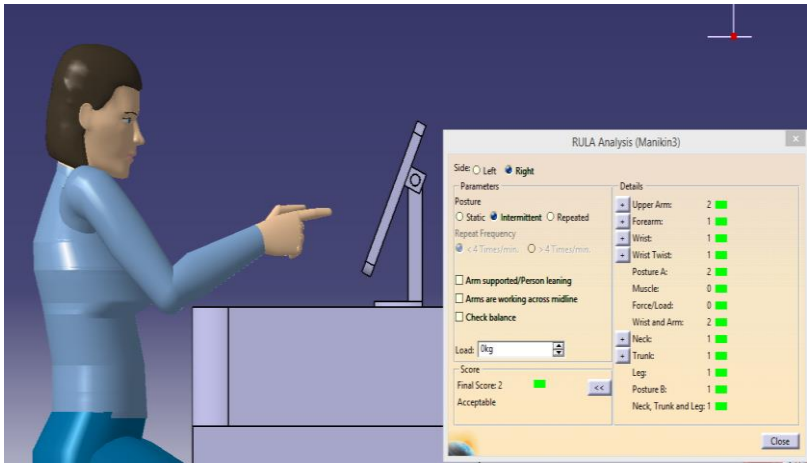


Figure 4.63: The LCD monitor at the origin place for height of 153.2 cm.

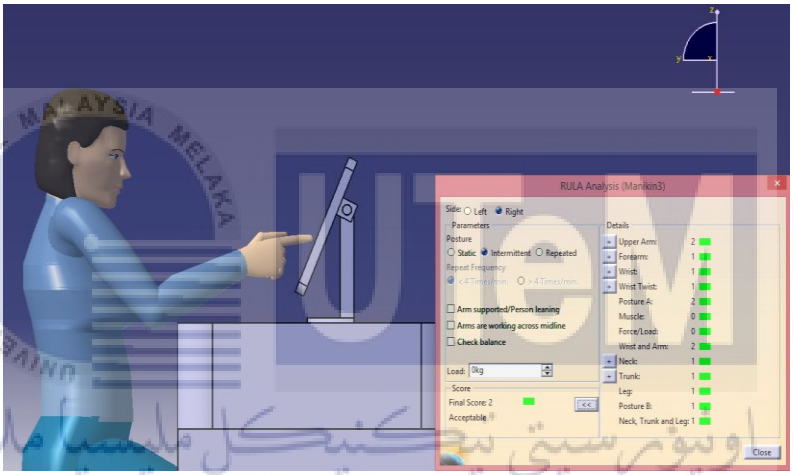


Figure 4.64: Postion of LCD monitor after adjust for height of 153.2 cm.

4.3 Comparison betweem Existing Design and Concept Generations

To recognize distinctions in ergonomic value, the findings of the assessment are evaluated and contrasted between the present existing model and the choice of ideas. If the new design is less ergonomic than the existing ones, to achieve the best ergonomics value it is necessary to re-select the concept.

4.3.1 Comparison on Standing Posture for Male

Table 4.3: Placing Item into Bagging Area and Packaging Machine Analysis Result for Male

Existing Design		**Concept Design**	
Body Part	Score	Body Part	Score
Upper arm	2	Upper arm	1
Forearm	3	Forearm	1
Wrist	1	Wrist	1
Wrist twist	1	Wrist twist	1
Muscle	0	Muscle	0
Wrist and arm	3	Wrist and arm	1
Neck	2	Neck	2
Trunk	3	Trunk	2
Leg	1	Leg	1
Neck, Trunk and Leg	4	Neck, Trunk and Leg	2
Final Score	4	**Final Score**	2

Table 4.3 shows the ergonomically comparable design for the analysis of the Rapid Upper Limb Assessment. Exisitng design shows the final score that is 4 from the result. The result for design is poor ergonomics value, mainly affecting the neck, wirst and arm. While concpet design shows the final score is 2. This shows the concept design have the best ergonomics compare to exisitng design.

4.3.2 Comparison on Seating Posture for Female

Table 4.4: Placing Item into Bagging Area and Packaging Machine Analysis Result for Female

Existing Design		**Concept Design**	
Body Part	Score	Body Part	Score
Upper arm	3	Upper arm	2
Forearm	2	Forearm	1
Wrist	1	Wrist	1

Wrist twist	1	Wrist twist	1
Muscle	0	Muscle	0
Wrist and arm	3	Wrist and arm	2
Neck	2	Neck	1
Trunk	3	Trunk	2
Leg	1	Leg	1
Neck, Trunk and Leg	4	Neck, Trunk and Leg	2
Final Score	4	**Final Score**	2

The comparison between existing and concept design in the cashier body's static posture is explained in Table 4.4. The existing design shows the final score for this analysis is 4. Therefore, the design need to do more research in order to improve the value of ergonomics. While the final design shows the final result of 2. The result shows good ergonomics value.

4.4 Discussion

The study of this project aims to design and perform ergonomics analysis for supermarket checkout station. Checkout station arrangement include scanning/packaging area, cashier chair, LCD monitor and bagging area. The position of cashier posture to do the ergonomics analysis are standing and seating position, placing item to bagging area and pointing towards LCD monitor.

The selected design which is concept 4 of conceptual design has been used and compared with the existing design. Both design had been analyzed using RULA analysis to see either the new design is more ergonomics or not compare with the existing design. To determine the best ergonomics design, RULA analysis is used to determine the best design either existing or new design have the best ergonomics. On the other hand, the human body posture does not reflect to the design of checkout

station. If the design is ergonomics, the cashier posture shows the posture with no risk of injury from the seating or standing posture.

From the comparison, the result shows the new design is more ergonomics compare to the existing design in term of when the cashier in standing posture. When in standing posture the new design shows the cashier no risk of injury when placing item to packaging machine and pointing towards the LCD monitor. Compare to the existing design, the cashier suffers a lot of injury. From the analysis, the results show the right side got high risk of injury compare to the left side. The part of the cashier effected most are forearm, hand wrist, neck trunk and leg. The percentage of the risk of injury will increase if the cashier repeatedly does the process over 4 times per minute. On the other hand, the existing design does not include chair for the cashier. If the cashier standing too long for long period, the chance getting musculoskeletal disorder is higher. Meanwhile, the new design gives another perspective which provide moveable and foldable chair. Therefore, the cashier can do job in seating or standing position. This advantage gives the cashier move comfortable workstation without worry any risk will occur to them. The new design helps to reduce the injury because the design gives ergonomics posture to the cashier.

The new checkout counter design will give large impact for checkout process. It is because the new design provides packaging machine. This packaging machine will help to fasten the packaging process and help to reduce waiting time for the customer.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, the objective of this project had been fulfilled. This project is divided into five chapters which are introduction, literature review, methodology, result and discussion and lastly the conclusion and recommendation.

The design task had been carried out and the best conceptual design is selected. There are four concept design was generated with different components, different scanning process and different type of packaging item for the customer. The best design had been generated following specification of the conceptual design by using the weight decision matrix. Concept 4 was selected as the best concept design.

Meanwhile, the RULA analysis was applied in the existing and new design, in order to see the posture of the cashier when standing or seating at workstation, placing item to packaging machine or bagging area and pointing towards keyboard or LCD monitor. The ergonomics result is used to compare between the existing and new design to see which design is more ergonomics. From the analysis, the result shows the new design is more ergonomics compare with the existing design. The new design can be used in future to develop the new checkout counter. The new design can minimize and prevent musculoskeletal disorder when the checkout process happen.

5.2 Recommendation

During this project, there are several recommendations for the development of the checkout station which are the design of scanner can be change to automatic scan the item when the item go through the conveyor. On the other hand, the design of packaging machine can be change to make the process of hanging the plastic bag smoother and faster. Furthermore, the new design should reduce the posture of the cashier, instead of making the cashier always to turn right or left, place the packaging machine in front of the cashier. Therefore, less energy required to placing item to packaging machine and less stress occur to the whole body.

In addition, from the analysis done in this project, the mini prototype of the checkout station could be fabricating due to show the process, how the packaging machine running and due to the result obtained

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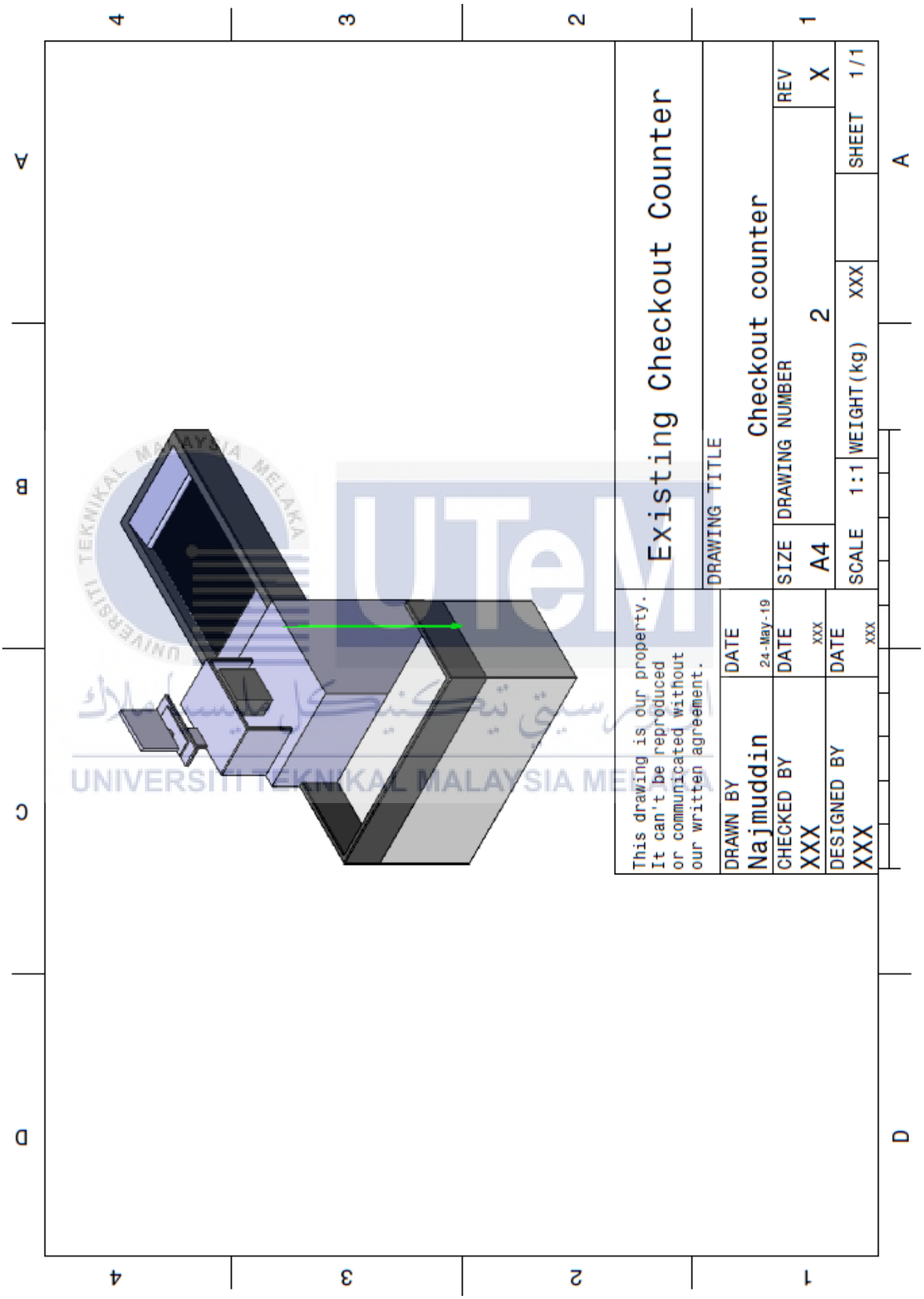
APPENDIX A

Existing Checkout Counter



APPENDIX B

Finalize Design Concept