DESIGN AND FABRICATION OF FOLDABLE WET SHOPPING CART

NUR AIN IZZATI BINTI ZAINUDIN

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

Signature:

Name of Supervisor: EN ROSMAZI B ROSLI

Position: TUTOR

Date:

STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any diploma and is not concurrently submitted for award of other diploma.

Signature:

Name: NUR AIN IZZATI BINTI ZAINUDIN

ID Number: MB07094

Date:

ACKNOWLEDGEMENT

Firstly, I present my thank and gratitude to Allah the Almighty for blessings on me that enable me to continue my studies up to this level and gave me an opportunity to undertake and conducted this project.

Secondly, I present my thanks and gratitude of the help, support and advice of many individuals who have assisted me especially Encik Rosmazi Bin Rosli for his valuable guidance, support, suggestion and most of all for her trust and patience on me during the preparation of this project.

Finally, my sincere thanks are also to the Mechanical Staff of University Malaysia Pahang, for their cooperation while I am conducting this project at the mechanical lab at campus UMP Pekan. Last but not least for my beloved family and all my beloved friends who helped and inspired me to finish this project.

ABSTRACT

This report presents about the Design and Fabrication of Foldable Wet Shopping Cart. The foldable wet shopping cart is device for users to put any groceries while shopping at market. The foldable wet shopping cart is design according to the existing market demand and to fulfill the criteria of customer needs. The design of this folding cart considers durability, easy to use, and ergonomic factor. The concept of the foldable wet shopping cart will be more innovation from the existing product special for Asians user. The selection of suitable materials for this fabrication of folding cart is a loaded material which has minimum weight and can detain heavy load. Materials are proposed for the fabrication of cart is mild steels. This Foldable Wet Shopping Cart is equipped by using all necessary items and methods for instance hollow mild steel, oval hollow steel, round bar, plate bar, elbow pipe, wheels, mosquito net, skills in manufacturing processes, metal inert gas (MIG) welding to join the parts, drilling and also mechanical fasteners. This folding cart would be entirely different from existing shopping cart.

ABSTRAK

Laporan ini membentangkan tentang rekaan dan membentuk sebuah troli lipat untuk kegunaan membeli belah di pasar basah. Troli lipat tersebut adalah alat yang digunakan untuk pengguna meletakkan sesuatu barang semasa membeli belah di pasar. Troli lipat tersebut direka berdasarkan kepada produk yang telah berada dipasaran dan memenuhi kriteria kehendak pengguna. Rekaan troli boleh lipat ini mengambil kira tempoh had masa, senang digunakan, dan faktor ekonomi. Konsep troli lipat akan mempunyai banyak inovasi daripada rekaan yang telah ada untuk keistimewaan pengguna Asia. Pilihan bahan yang sesuai untuk mereka bentuk troli lipat adalah komposisi bahan yang mempunyai berat minimum dan boleh menampung berat. Bahan yang dicadangkan untuk mereka bentuk troli ini adalah keluli lembut. Troli lipat untuk kegunaan basah ini menggunakan semua peralatan dan kaedah yang sesuai iaitu keluli lembut berlubang, keluli berlubang, besi bulat, paip sesiku, tayar, jarring nyamuk, kaedah dalam proses pembuatan, kimpal gas lengai (MIG) untuk bahagian cantuman, alat tebuk lubang, dan juga alat pelekat mekanikal. Troli lipat ini adalah bebeza daripada troli mebeli belah yang sedia ada.

TABLE OF CONTENTS

CHAPTER 2 LITERATURE REVIEW

CHAPTER 3 METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

I	Moment of inertia
b	Width
h	Height
m	Meter
P	Pressure
F	Force
A	Area
Pa	Pascal
M	Moment of force
c	Centre

N	Newton
Kg	kilogram
σ_{ult}	Ultimate stress
σ_{all}	Allowable stress

LIST OF ABBREVIATIONS

CAD Computer-aided design

MIG Metal inert gas

GMAW Gas metal arc welding

DC direct current

EP electro positive

PPE personal protective equipment

ASTM American Society for Testing and Materials

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

This project presents a design and fabrication of a Foldable Wet Shopping Cart that considers durability, easy to use, and ergonomic factor. This cart would be entirely different from existing wet shopping cart. The Diploma final year project allocates the duration of one semester, this large man-hour project requires significant efforts of the student to participate. Basically the entire foldable wet shopping cart project could be divided into three stages, which are concept review and development, designing and fabrication.

The Foldable Wet Shopping Cart is equipped by using all necessary items and methods for instance hollow mild steel, oval hollow steel, round bar, plate bar, elbow pipe, wheels, mosquito net, skills in manufacturing processes metal inert gas (MIG) welding to join the parts, drilling and also mechanical fasteners. The advantages of the proposed foldable wet shopping cart to be developed can be seen that it can be handle easily and smoothly. This foldable wet shopping cart has a height adjustable handle that easy to consumer to handle the cart with different height. The cart can move smoothly

because use the free wheels at the front of the cart. Besides, it has a basket inside the cart to put any small groceries so that the small groceries that the consumer buys are not drop away.

The process of development is initiated from conceptual design stage by considering the function as well simplicity. In order to make friendly environmental-cart, the ergonomic factor is also taken into account. Practical development involves the measurement, cutting the materials into required size and shape and assembly.

1.2 PROBLEM STATEMENT

Consumer are usually facing problem to handle the wet shopping cart. It is because the existing handle of wet shopping cart cannot be adjusted. The height of one people is different from another people. So that, the consumer are facing problem to handle the cart and get a back pain when handle the cart. The existing shopping cart also cannot move smoothly because the wheels that use are not free movement wheels. The consumer needs to lift up the cart a bit when to handle the cart to another place. It is important to further improve the current design of foldable wet shopping cart, so that it more efficient to use.

1.3 OBJECTIVE

Objective means something worked toward or striven or in other words a goal of a project. The specific objectives of this project are:

i) To design and fabricate a foldable wet shopping cart.
ii) To fabricate the folding cart that can be handling easily.

1.4 PROJECT SCOPE

Scope in a project means the area covered by a given task. This project will be limited within the following scopes, which are:

i) The wet shopping cart can be use at market and only to put groceries.
ii) The maximum load for folding cart is 20kg to 25kg

1.5 PROJECT PLANNING

The project begins with meeting the supervisor to define or discuss about the project. After that, define product of foldable wet Shopping cart and built a Gantt chart so that the flow of the project will become smooth.

Do the literature study and research about the title. This is consist a review of the concept of foldable shopping bag, foldable shopping cart with stool, cart with basket and foldable shopping cart and another types of cart available in the market. These tasks have been done through research via internet, books and others relevant academic material related to the title. The literature review is carried out through the project to keep up with the new knowledge about the existing wet shopping cart in the market.

Then, start with the sketching idea. After that the best concept has been choose and consider the measurement of the project then finalized it. The selected idea is then transfer into solid modeling using AutoCAD software.

The next task is doing the methodology study about how to fabricate a foldable wet shopping cart according to the drawing and measurement consideration.

After that, list all the material and select the best materials that are suitable for the foldable wet shopping cart. Then prepare all the material for the fabrication either looking at materials lab store or hardware supplier.

Then, do the preparation of progress presentation and report writing; both of these tasks take two week to be done. Slide have been prepared and double checked if it has mistakes before the midterm presentation.

Using the final drawing and sketching as references for the measurement and the materials needed, the fabrication process is schedule and takes about five weeks include the evaluation process.

Next task is the final report writing and final presentation preparation. This take about two weeks to accomplished. The report is guided by UMP Thesis writing guided and also the guidance from supervisor. All the task is schedule to take about sixteen weeks overall. The project flow chart is shown in Figure 1.1.

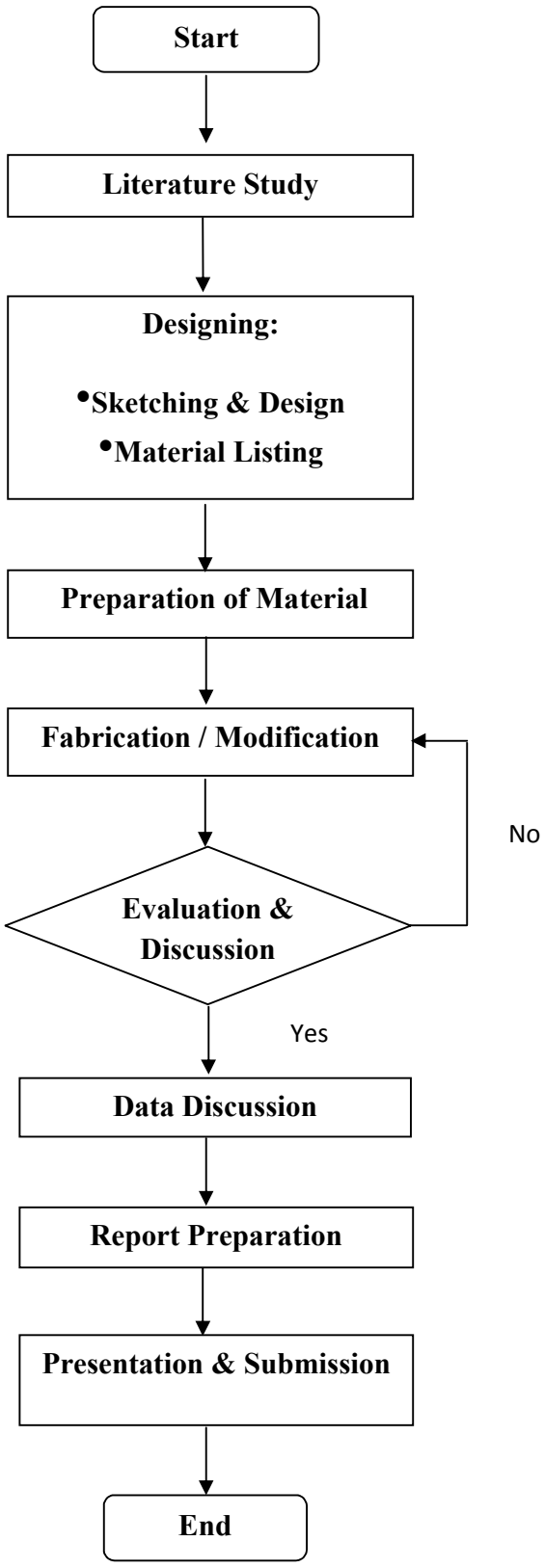


Figure 1.1: Flow Chart

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will explain about research of the project that has been chosen and explained about foldable wet shopping cart features and specification and also tells about the basic part of the project.

2.2 SHOPPING CART

A shopping cart is a cart supplied by a shop, especially a supermarket, for use by customers inside the shop for transport of merchandise to the check-out counter during shopping, and often to the customer's car after paying as well.

The foldable wet shopping cart is design according to the existing market demand and to fulfill the criteria of customer needs. The concept of the foldable wet shopping cart will be more innovation from the existing product special for Asians user.

2.3 TYPES OF SHOPPING CART

Several shopping cart with various function have been found.

i) Foldable Shopping Bag as shown in Figure 2.1

Advantages: -Can be fold in small size

-Light

Disadvantages: -Difficult to handle

Figure 2.1 : Foldable Shopping Bag

ii) Foldable Shopping Cart with Stool as shown in Figure 2.2

Advantages : -With stool

-Can be fold

-Gross weight: 16kg

Disadvantage : -Cannot use to put wet groceries or things.

Figure 2.2 : Foldable Shopping Cart with Stool

iii) Cart with Basket as shown in Figure 2.3

Advantages : -Easy to install to cart

-Loading capacity : 25kg

Disadvantages: -The basket cannot be fold into small size.

Figure 2.3 : Cart with Basket

iv) Foldable Shopping Cart as shown in Figure 2.4

Advantages : -Can be fold

-Practical

-Portable

Disadvantages : -No height adjustable handle

-Cannot move smoothly.

Figure 2.4 : Foldable Wet Shopping Cart

2.3 BASIC PART

2.3.1 **Wheel**: Usually made from rubber that joined together with the bolt and nut with steel frame to ensure strength.

2.3.2 **Body**: Requires full strength of body to support the whole cart.

2.3.4 **Handle**: Usually all the shopping cart must have handled to provide less effort while using the cart due to heavy it's loading.

2.4 JOINING METHOD

Joining involves in assembly stage. Commonly used method to join metal part is Metal Inert Gas (MIG) welding.

2.4.1 Metal Inert Gas (MIG) Welding

Figure 2.5 illustrated of schematic MIG method. An arc is struck between a consumable electrode and the sheet metal to be welded. The consumable electrode is in the form of continuous filler metal. An inert gas surrounds the arc and shields it from the ambient to prevent oxidation. Carbon steels, low alloys steels, stainless steels, most aluminum alloys, zinc based copper alloys can be welded using this process.

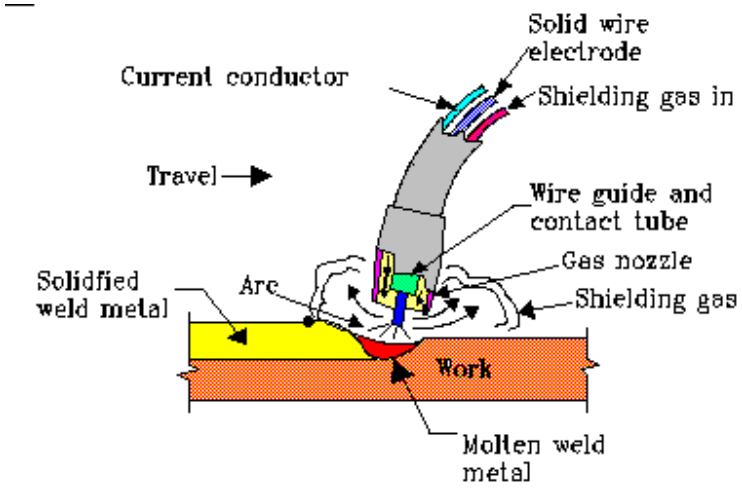


Figure 2.5: Schematic of Metal Inert Gas (MIG) welding

Figure 2.6: A GMAW wire feed unit

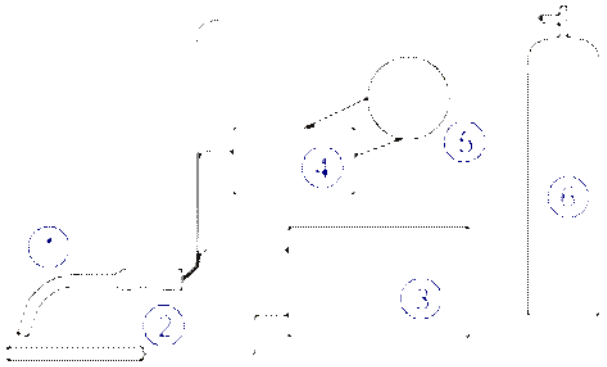


Figure 2.7: Basic component used in MIG operations. **(1)** Gun, **(2)** Workpiece, **(3)** Welding machine, **(4)** Control system, **(5)** Wire, **(6)** Shielding-gas source

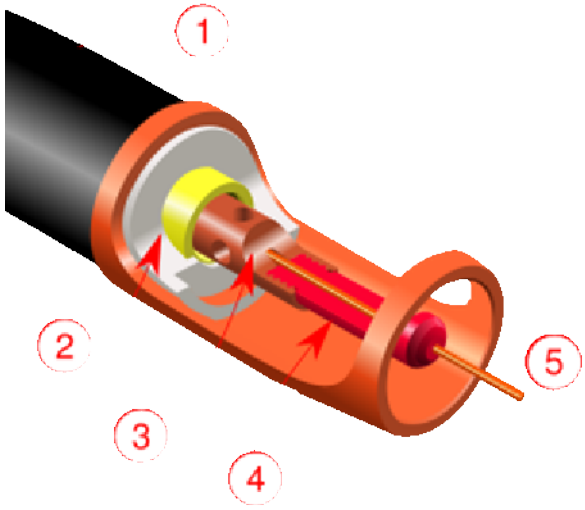


Figure 2.8: GMAW torch nozzle cutaway image. **(1)** Torch handle, **(2)** Molded phenol dielectric (shown in white) and threaded metal nut insert (yellow), **(3)** Shielding gas nozzle, **(4)** Contact tip, **(5)** Nozzle output face

MIG (Metal Inert Gas) or as it even is called GMAW (Gas Metal Arc Welding) uses an aluminum alloy wire as a combined electrode and filler material. The filler metal is added continuously and welding without filler-material is therefore not possible. Since all welding parameters are controlled by the welding machine, the process is also called semi-automatic welding.

The MIG-process uses a direct current power source, with the electrode positive (DC, EP). By using a positive electrode, the oxide layer is efficiently removed from the aluminum surface, which is essential for avoiding lack of fusion and oxide inclusions. The metal is transferred from the filler wire to the weld bead by magnetic forces as small droplets, spray transfer. This gives a deep penetration capability of the process and makes it possible to weld in all positions. It is important for the quality of the weld that the spray transfer is obtained.

There is a different MIG-welding process, conventional MIG and pulsed MIG. Conventional MIG uses a constant voltage DC power source. Since the spray transfer is limited to a certain range of arc current, the conventional MIG process has a lower limit of arc current, or heat input. This also limits the application of conventional MIG to weld material thicknesses above 4 mm. Below 6 mm it is recommended that backing is used to control the weld bead.

2.4.2 Mechanical Fasteners

A fastener is a hardware device that mechanically joins or affixes two or more objects together. Fasteners can also be used to close a container such as a bag, a box, or they may involve keeping together the sides of an opening of flexible material, attaching a lid to a container. There are also special purposes closing devices, such as bread clip. Fasteners used in these manners are often temporary, in that they may be fastened and unfastened repeatedly.

The most common method of mechanical fastening is by use of bolts, nuts, screws, pins and a variety of other fasteners. These operations are known also as mechanical assembly. Mechanical fastening generally requires that the components have holes through which the fasteners are inserted. These joints may be subjected to both shear and tensile stressed and should be designed to resist these forces.

Figure 2.9: Mechanical Fasteners

2.5 DRILLING

Drilling is the cutting process of using a drill bit in a drill to cut or enlarge holes in solid materials, such as metal. Different tools and methods are used for drilling depending on the type of material, the size of the hole, the number of holes, and the time to complete the operation. As the drill is rotated and advanced into the workpiece, material is removed in the form of chips that move along the fluted shank of the drill.

On most workpieces it is vitally important that the hole be drilled precisely in reference to the x, y, and z axes. When drill a hole should be located perpendicular to the workpiece surface. This is due to the large length-to-diameter ratio which causes the drill bit to be easily deflected which can cause the hole to be misplaced, or the drill bit to break or fatigue. There are so many types of production operations that involve making a variety of holes in countless different materials.

Figure 2.10: Drill press machine

2.6 GRINDING

Grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material.

In grinding, an abrasive material rubs against the metal part and removes tiny pieces of material. The abrasive material is typically on the surface of a wheel and abrades material in a way similar to sand paper. On a microscopic scale, the chip formation in grinding is the same as that found in other machining processes.

Figure 2.11: Portable hand grinder

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Project methodology is a body of practices, procedures and rules used by those who work in a discipline or engage in an inquiry and a set of working methods. In this chapter, will explain about the process that involved during the fabrication process and about the design that had been chosen to be as the final idea to be producing or fabricate. All the fabrication process in this project is going to be explained in details. Project methodology for design and fabrication for foldable wet shopping cart is shown by flow chart in Figure 3.1.

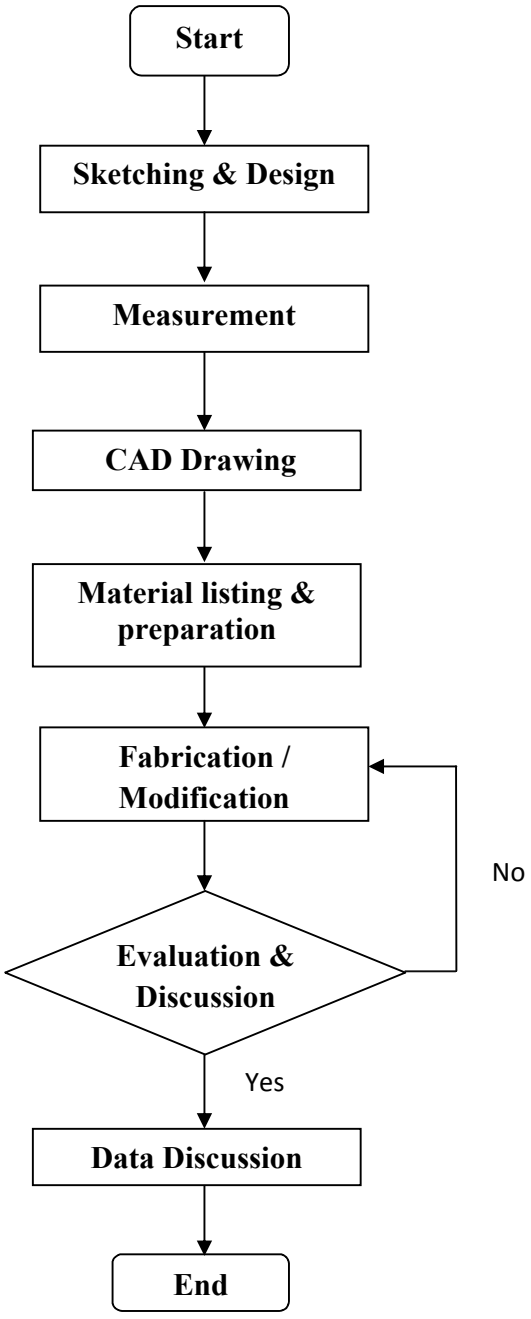


Figure 3.1: Project Flow Chart

Figure 3.1 show the flow chart of methodology. After gathering all the relevant information, the project undergoes with sketching and design process. In this step, the knowledge gather by the review is used to make a sketch design that suitable for the project. After several design sketched, design consideration have been made and one design have been chosen. The measurements for the foldable wet shopping cart are listed. The final design selected, then transfer to solid modeling and engineering drawing using AutoCAD software. Then, materials are listed to make sure that all the material to use for the fabrication are enough.

Next, after the needed material is listed, acquisition and preparation of materials step take places. There are a lot of materials that need to buy such as hollow pipe steel, plate bar, elbow pipe, screw and wheels.

After all the parts needed had been gathered, the project proceeds to next step that is fabrication process. The drawing is used as a reference by following the measurement and type of materials needed. The fabrication process involved measuring and marking, cutting, drilling, joining, finishing and painting. After all the process was finished, the parts are checked to make sure that the output of the process obeys the product requirement.

The parts are joined together to produce full-scaled of foldable wet shopping cart. Then the product was tested by do the evaluation process. The cart was test to see if it fulfills the requirement such as safety, smoothly movement, and also consider the ergonomic aspect. During the testing, if problem occur such as malfunction or unstable cart, the product will be improved or modified to fix the error. Then finalize the process by doing some finishing and painting.

The last phase of the process is data discussion. In data discussion, the draft report is hand over to the supervisor for error checking. The final product will be compared with the report to make sure that there is no mistake on both project and report. The final report was submitted after the project presentation.

3.2 DESIGN

The Design of the foldable wet shopping cart must be compliance to several aspects. The design consideration must be done carefully so the design can be fabricated and the parts are all functioning. The aspects that must be considered in designing the cart are:

3.2.1 **Strength**: Must have certain strength to ensure that it can load groceries.

3.2.2 **Ergonomic Factors**: Cart must be user friendly as easy and convenience.

3.2.3 **Suit to environment**: The foldable cart must be suitable to be use at market area

3.3 DRAWING

The drawings are divided into two categories, which are:

3.3.1 **Sketching**: All the ideas for the cart fabrication are sketched on the paper first to ensure that idea selection can be made after this

3.3.2 **CAD Drawing**: The final idea is drawn using AutoCAD software with details features.

3.4 DESIGN SPECIFICATION

The design of the foldable wet shopping cart must be considered that it can endure several specifications, which are:

3.4.1 The cart will have a maximum height of adjustable handle to 0.3m.

3.4.2 The maximum load of this cart is 20kg to 25kg.

3.5 SKETCHING AND DRAWING SELECTION

From the existing ideas, three sketching that had been considered and compared as shown in Figure 3.2 to Figure 3.5.

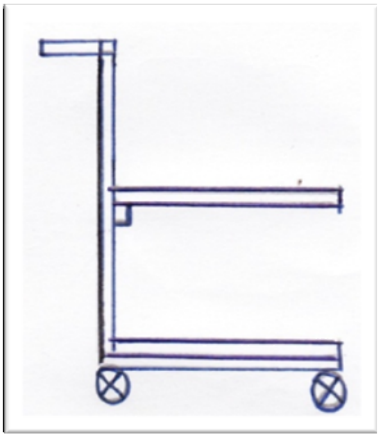


Figure 3.2: Sketching 1

Figure 3.3: Sketching 2

Figure 3.4: Sketching 3

3.6 FINALIZED DESIGN

After comparing the above design and extracting good features, the design is finalized as shown in Figure 3.5.

.

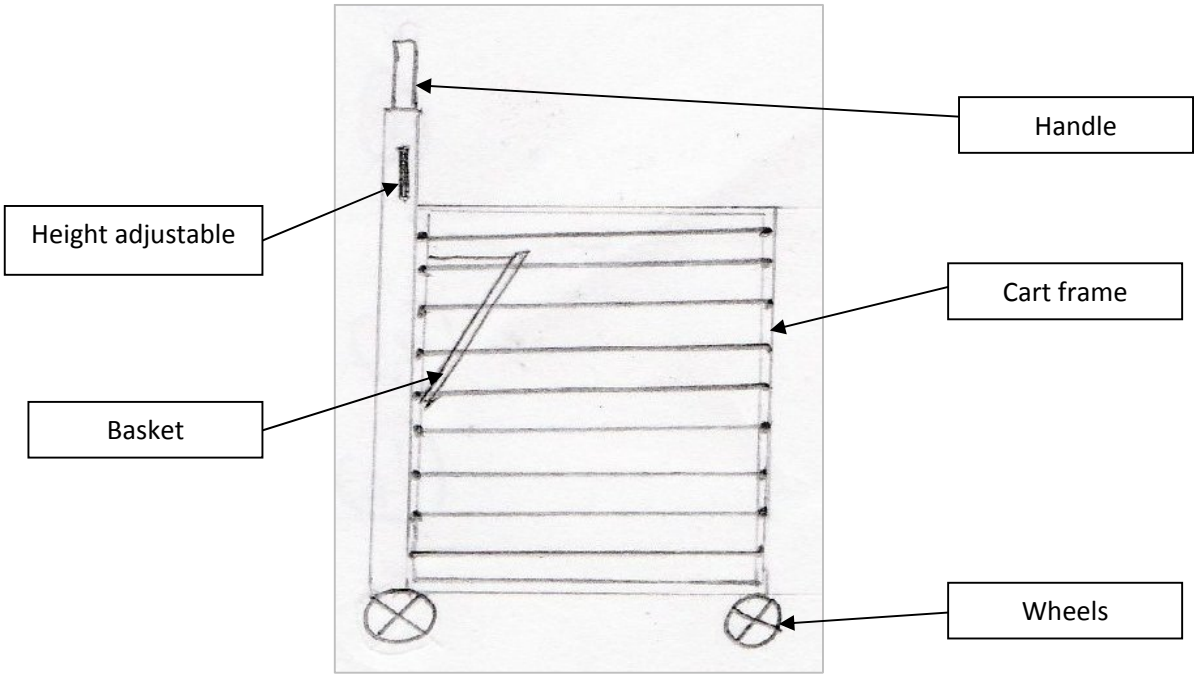


Figure 3.5: Final Concept

The design is chosen in such a way that consistent with the objective. It is easy to handle because the handle can be adjust. The safety and functioning also influence the design.

3.7 COMPUTER AIDED DESIGN DRAWING

After a design has been selected, the next step in the designing process is dimensioning. The dimensioning is base on relevant dimensions and also referring to the existence foldable cart so that the design is fit into others part.

After dimensioning, the engineering drawing of the design is drawn using AutoCAD software, at this stage solid modeling method is used. Part by part solid modeling created according to the dimension done before, after all part created, the 3D model is assembled with each other base on the design.

3.8 OVERALL VIEW OF THE DESIGN

Figure 3.6: CAD Drawing

Figure 3.6 and Figure 3.7 show the final idea of a Foldable Wet Shopping Cart. Additional base for wheels also were added to make sure that the shopping cart can be easily to move and the handle can be adjust to achieve the ergonomic aspect.

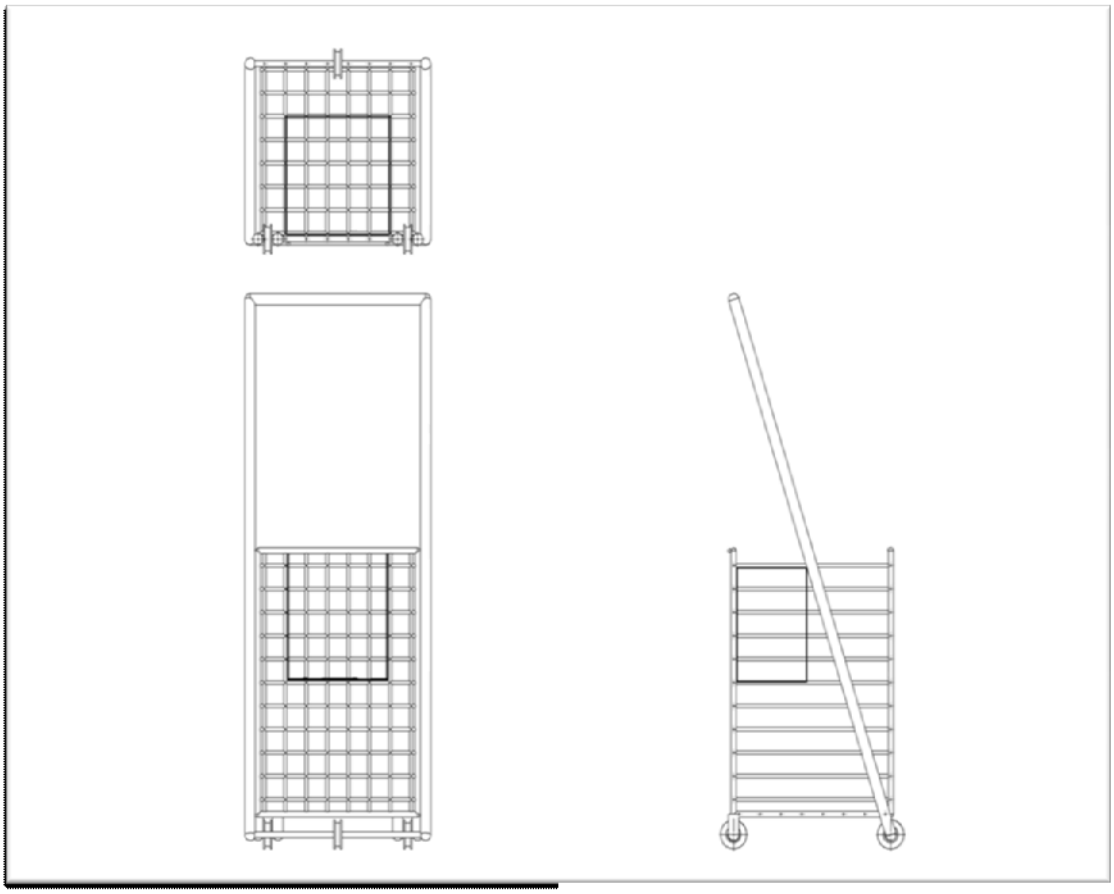


Figure 3.7: Isometric View

3.9 MATERIALS

Table 3.1 shows all the type of materials for the design needed:

Type	Size(mm)	Quantity
Hollow pipe steel	280 X 15 X 2	2
Hollow pipe steel	350 X 20 X 2	3
Plate bar	95 X 4 X 18	2
Plate bar	100 X 4 X 18	2
Oval hollow steel	300 X 20 X 20	2
Oval hollow steel	460 X 20X 20	4
Elbow pipe	Hollow =20mm	2
Wheels	Back=120	2
	Front= 50	1

Table 3.1: List of Materials

3.10 FABRICATION PROCESS

After designing phase, comes fabrication process. These processes are about using the material selection and fabricate the product base on the design and also according to the dimension. Many methods can be used to fabricate the product, like welding, fastening, cutting, drilling and many more method. Fabrication process is difference from manufacturing process in term of production quantity. Fabrication process is a process to make only one product rather then manufacturing process that focus to large scale production. In the project fabrication process needed to make the

base, cart handle, and the important is the frame of the cart. Fabrication process was include part by part fabrication until assembly to the others component.

3.10.1 Process Involve

In order to make the design come to reality, fabrication process needs to be done first. The fabrication process starts from dimensioning the raw material until it is finish as a desired product. The processes that involved are:

- **Measuring**: Measuring the materials into dimension needed.
- **Marking**: All measured materials need to be marked to give precise dimension.
- **Cutting**: Cutting the materials into parts according to dimension needed.
- **Joining**: Materials joined by the method of welding and using bolt nuts.
- **Drilling**: Marked holes are then drilled to make holes for bolts.
- **Finishing**: Any rough surface cause by welding spark were grind to give smooth and safe surface.
- **Painting:** Paint the cart to avoid corrosion and look properly.

3.10.2 Fabrication Procedure

The fabrication process was started with measuring the material into the required dimension. The material were used to be measuring are hollow pipe steel, oval hollow steel, and plate bar. All the measuring and marking process is done using measuring tape and steel marker. Firstly, do a measurement process to all the materials that will be cutting or drill to make sure the efficiency cutting. All the measuring and marking process is done using measuring tape and steel marker as shown in Figure 3.8.

Then, after several quantities of material had been marked, the next step is to cut the material into its desired length. This process is done using the floor cutter disc as shown in Figure 3.9. Before proceed the process, safety measurement had been carried out by wearing Personal Protective Equipment (PPE) such as goggle and gloves. These safety measurements are so important in order to prevent the projectile spatter from the process. During this process, Engineering Square is used in order to make sure the dimension of the material length is correct and precise.

All the material that had been cut is grinded to give smooth surface to make sure that joining process can be done precisely as shown Figure 3.10. Then all the material was arranged into joining position.

Then, several locations were drilled to make holes for bolts and nuts for the support bar. Press drilling machine is used as shown in Figure 3.11 to make a hole at the hollow pipe steel of the cart handle and at a solid steel to screw the back wheels of the cart and.

The joining process was carried out by using Gas Metal Arc Welding or formerly known as Metal Inert Gas as shown in Figure 3.12. First, the welding machine is set up to make sure that the output of the process will satisfy. Head-shield, gloves, goggle and other PPE equipment are not to be forgotten. Then, all the materials were weld together. During this process, a minor movement of the materials will give bad effect to the joint and to the framework. It is because the hollow tube will expand and twist a little due to the temperature changes.

After finishing welding, the entire welded placed will be grinded to make sure that the entire joint surface was smooth from any spatters or sharp as shown in Figure 3.13.

After all the process had been done, then continue the next process which is painting process in Figure 3.14. Before that the whole product must be brush by using sand paper to ensure it from dirt and rust. The black paint color is used for the whole product.

Figure 3.8: Measuring and marking process

Figure 3.9: Cutting process

Figure 3.10: Grinding process

Figure 3.11: Drilling process

Figure 3.12: Joining process

Figure 3.13: Finishing Process

Figure 3.14: Painting process

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter will discuss about the results of the project fabrication. It consists of the bending moment analysis and stress analysis when a minimum and maximum load are assume to the folding cart. With all the analysis result, the suitable materials for the fabrication of the foldable wet shopping cart will know.

In the last phase, the discussions are come out with the survey from respondent to get some comment for the fabrication so that some improvement for the foldable cart can be done in the future fabrication.

4.2 BENDING MOMENT ANALYSIS

A bending moment exists in a structural element when a moment is not applied to the element so that the element bends. Moments and torques are measured as a force

multiplied by a distance. Failure in bending will occur when the bending moment is sufficient to induce tensile stresses greater than the yield stress of the material.

The values of bending are calculated with a minimum and maximum load. The values of the minimum and maximum load are 20kg and 25 kg. The values are calculated to determine the materials that selected using for the folding cart fabrication are safe when a load is given.

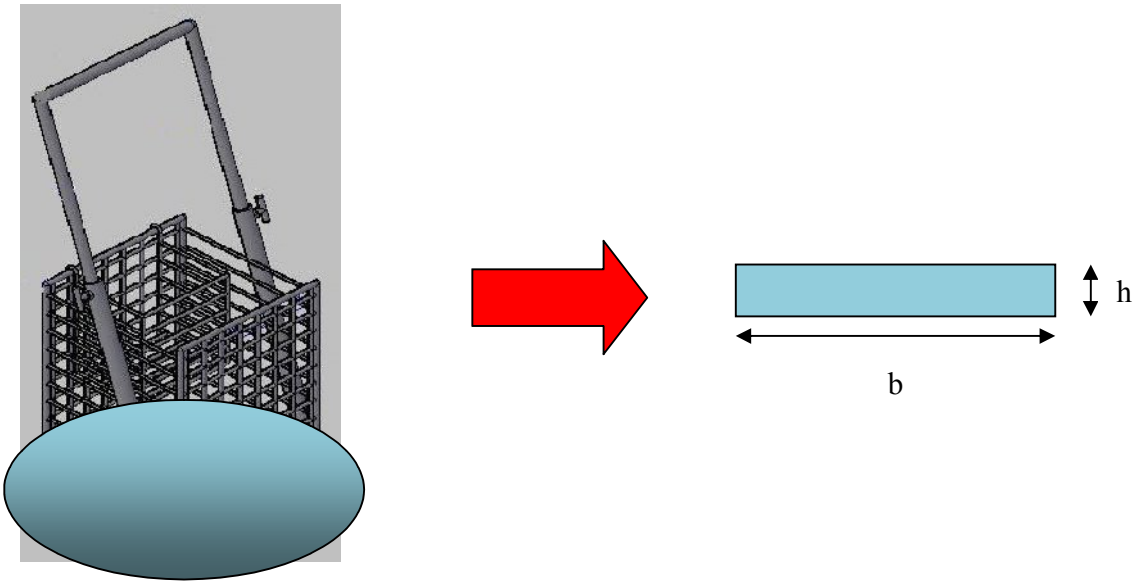


Figure 4.1: Part of the bending moment

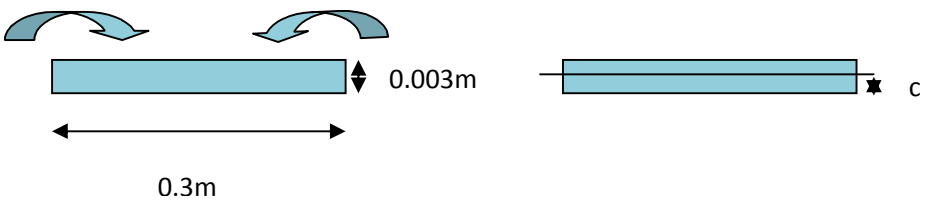


Figure 4.2: Bending moment

4.2.1 Bending moment analysis for minimum load, 20kg

$$I = \frac{1}{12} bh^3$$

$$= \frac{1}{12} (0.3)(0.003)^3$$

$$= 6.75\,x\,10^{-10}\,m^4$$

$$P = F = ma$$

$$= 20x9.81$$

$$= 196.2N$$

$$\sigma_m = \frac{p}{A}$$

$$= \frac{196.2}{0.3\,x\,0.003}$$

$$= 218kPa$$

$$M = \frac{I}{c}\sigma_m$$

$$= \frac{6.75x10^{-10}m^4}{1.5x10^{-3}}(218x10^3)$$

$$= 0.0981Nm$$

The base of the cart is safe for 20kg load.

4.2.2 Bending moment analysis for maximum load, 25 kg

$$I = \frac{1}{12}bh^3$$

$$= \frac{1}{12}(0.3)(0.003)^3$$

$$= 6.75x10^{-10}m^4$$

$$P = F = ma$$

$$= 25x9.81$$

$$= 245.25N$$

$$\sigma_m = \frac{P}{A}$$

$$= \frac{245.25}{0.3x0.003}$$

$$= 272.5kPa$$

$$M = \frac{I}{c}\sigma_m$$

$$= \frac{6.75\,x10^{-10}\,m^4}{1.5\text{x}10^{-3}}(272.5x10^3)$$

$$= 0.123\,Nm$$

The base of the cart is safe for 25kg load.

4.2.3 Design of safety

Design of safety, n_s = ultimate stress / allowable stress

$$= \frac{\sigma ult}{\sigma all}$$

$$2.5 = \frac{\sigma ult}{272.5kPa}$$

$$\sigma ult = 681.25kPa$$

The 25kg is the maximum load for the folding cart.

4.3 STRESS ANALYSIS

Stress analysis is an engineering discipline that determines the stress in materials and structures subjected to static or dynamic forces or loads. The aim of the analysis is usually to determine whether the structure of the folding cart can safely withstand the specified forces.

This is achieved when the determined stress from the applied force is less than the ultimate tensile strength, ultimate compressive strength or fatigue strength.

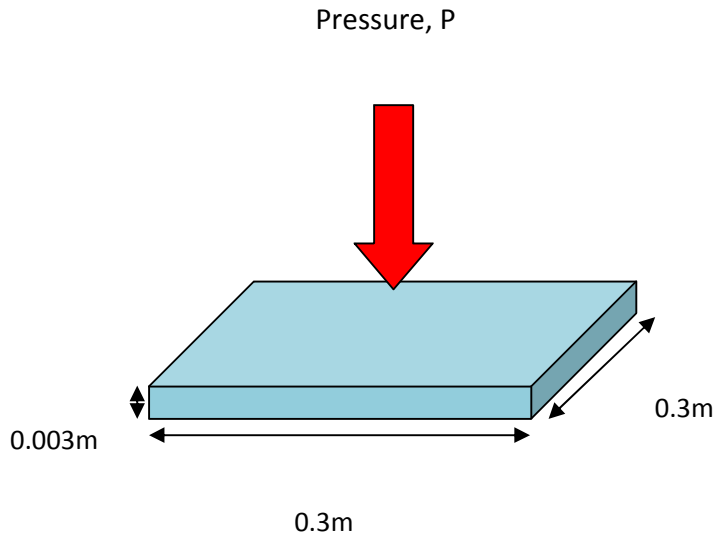


Figure 4.3: Stress analysis for the base of the folding cart

4.3.1 Stress analysis for minimum load, 20kg

$$P = F = ma$$

$$= 20x9.81$$

$$= 196.2N$$

$$\sigma cal = \frac{P}{A}$$

$$= \frac{196.2}{0.3x0.3}$$

$$= 2180Pa$$

$$\sigma ult(cal) < \sigma y(propertytable)$$

4.3.2 Stress analysis for maximum load, 25kg

$$P = F = ma$$

$$= 25x9.81$$

$$= 245.25N$$

$$\sigma cal = \frac{P}{A}$$

$$= \frac{245.25}{0.3x0.3}$$

$$= 2725Pa$$

$$\sigma ult(cal) < \sigma y(propertytable)$$

4.3.3 Design of safety

Design of safety, n_s = ultimate stress / allowable stress

$$= \frac{\sigma ult}{\sigma all}$$

$$2.5 = \frac{\sigma ult}{2725Pa}$$

$$\sigma ult = 6812.5Pa$$

The folding cart are safely stable when reach the maximum load of the cart.

4.4 PROCDUCT DEMONSTRATION

The foldable wet shopping cart is fabricated to use at market to put any groceries at a maximum load. The folding cart can be handling easily. Its mean that the folding cart is fabricated using free movement wheels at the front of the cart. So that users are not having a problem to move the cart to another place because the existing folding carts are a bit difficult to move.

Users normally have a different height so that this folding cart is also fabricated that the handle can be adjusted. So that users are also not having a back pain when handle this folding cart because the handle can be adjusted to a maximum height of the handle. Besides that, the small basket inside the cart is fabricated to easy for users to put any small groceries to prevent the small things are drop away. The materials using for

the fabrication are strength because when the users put at a maximum load the cart is still stable.

The demonstration of the product are shown in Figure 4.4.1, Figure 4.4.2, Figure 4.4.3, Figure 4.4.4, Figure 4.4.5, Figure 4.4.5, and Figure 4.4.6.

Figure 4.4.1: Handling the folding cart

Figure 4.4.2: Folding the cart

Figure 4.4.3: Small basket inside the cart

Figure 4.4.4: Height adjustable handle

Figure 4.4.5: Free movement wheel at the front of the cart

Figure 4.4.6: The Foldable Wet Shopping Cart

4.5 TESTING AND EVALUATION

The testing and evaluation are done by five respondent student of University Malaysia Pahang. First, they are needs to test the product, and then give some responds according to the question that already given in an evaluation form. All the responds are below:

4.5.1 Question 1

The question is about the respondent feel any back pain when handling the cart. All the respondents give the no answer. It is mean that the folding cart is friendly to user and achieved the ergonomic factor.

4.5.2 Question 2

The question asks that if the respondent having a problem when move the cart. All the respondents also give the no answer. The cart is easy to move because the free movement wheel is use at the front of the cart. So that the cart is not difficult but have smoothly movement.

4.5.3 Question 3

The question asks the respondent that the foldable cart is suitable use at market to put groceries. All the respondent give the yes answer because the cart is design and fabricated using a cord steel. It is because when users put the wet groceries, all the less of water are not float in the cart. Besides that, the small basket also can put the smaller things to prevent it from drop away.

4.5.4 Question 4

The question asks if the respondent are recommend the product to other users. 1 respondent no comment and 4 respondents give the yes answers. It is because the folding cart is safely to use and not have dangerous factors that can effects the user.

4.5.5 Question 5

The question asks if any suggestions from the respondent to improve the quality of the foldable wet shopping cart. All the respond are:

4.5.5.1 Respondent 1

The materials for the fabrication should use the lightweight materials. So that the users are not feels heavy when put a load in the cart.

4.5.5.2 Respondent 2

The height adjustable handle should design with more efficient in order that the handle is easy to be adjusted.

4.5.5.3 Respondent 3

The cart should be design that the folding cart can be fold into the small size. So that it can reduce the space when to store the cart.

4.5.5.4 Respondent 4

The small basket inside the cart should be design that can be fold as the cart using the cord materials.

4.5.5.5 Respondent 5

Improve the cart to more function such as have a seat at the back of the cart that can be fold together with the cart. Users can have a sit when tired after shopping.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter covers the summary of overall results of this project. In this chapter will discuss mainly about the conclusion of the project, concluding all the process that involved in the fabrication of a foldable wet shopping cart. Besides that, this chapter also includes a few recommendations to increase the quality of the folding cart.

5.2 RECOMMENDATION

Throughout the project, lot of things have been learnt and discovered a lot of materials that can be added to enhanced product. Due to the time constraint and unavailability, the enhancement is not included. From the evaluation process, some recommendations are get to improve the fabrication of the shopping cart to produce the better product in the future. Here are the suggestions of enhancement for future development:

5.3.1 Improve the foldable wet shopping cart to more function

5.3.2 The handle need to some improvement to a better height adjustable handle

5.3.3 The foldable cart can be fold into a small size to reduce the space when store the cart

5.3. 4 The small basket in the cart can be fold with the cart

5.3.5 Use the lightweight materials to fabricate the folding cart

5.3 CONCLUSION

Overall, this fabrication has been achieved the objective which are to design and fabricate a foldable wet shopping cart and to fabricate the cart that can be handle easily. However, a few aspects still need some improvement in order to increase the quality of the folding cart. The quality improvement such as use the lightweight materials in the fabrication process so that the folding cart is not too heavy and easy to handle besides considering the ergonomic aspect. Based on the survey, the foldable wet shopping cart is suitable use at wet market and very friendly to users. By that, can be concludes here, that all the objective of this project has been achieved.

REFERENCES

1. http://en.wikipedia.org/wiki/Gas_metal_arc_welding , dated on July 13th, 2009
2. http://www.juliantrubin.com/encyclopedia/engineering/tensile_strength.html, dated on July 13th, 2009
3. http://en.wikipedia.org/wiki/Shopping_cart, dated on July 13th, 2009
4. http://www.efunda.com/processes/machining/grind.cfm, dated on July 18th, 2009
5. http://en.wikipedia.org/wiki/Stress_analysis, dated on July 20th, 2009
6. http://en.wikipedia.org/wiki/Drilling, dated on July 25th, 2009
7. http://en.wikipedia.org/wiki/Bending_moment, dated on August 4th, 2009
8. http://en.wikipedia.org/wiki/Fasteners, dated on August 4th, 2009
9. Kalpakjian, S, Schmid, S.R. and Musa, H. (2000), *Manufacturing Engineering and Technology.*

APPENDICES A

Typical Tensile Strength

Material	Yield strength (MPa)	Ultimate strength (MPa)	Density (g/cm³)
Structural steel ASTM A36 steel	250	400	7.8
Steel, API 5L X65 (Fikret Mert Veral)	448	531	7.8
Steel, high strength alloy ASTM A514	690	760	7.8
Steel, prestressing strands	1650	1860	7.8
Steel Wire			7.8
Steel (AISI 1060 0.6% carbon) Piano wire	2200-2482 MPa		7.8
High density polyethylene (HDPE)	26-33	37	0.95
Polypropylene	12-43	19.7-80	0.91
Stainless steel AISI 302 - Cold-rolled	520	860	
Cast iron 4.5% C, ASTM A-48	276	200	
Titanium Alloy (6% Al, 4% V)	830	900	4.51
Aluminum Alloy 2014-T6	400	455	2.7
Copper 99.9% Cu	70	220	8.92
Cupronickel 10% Ni, 1.6% Fe, 1% Mn, balance Cu	130	350	8.94
Brass	approx. 200+	550	5.3
Tungsten		1510	19.25
Glass		50 (in compression)	2.53
E-Glass	N/A	3450	2.57

S-Glass	N/A	4710	2.48
Basalt fiber	N/A	4840	2.7
Marble	N/A	15	
Concrete	N/A	3	
Carbon Fiber	N/A	5650	1.75
Spider silk	1150	1200	
Silkworm silk	500		
Aramid (Kevlar or Twaron)	3620		1.44
UHMWPE	23	46	0.97
UHMWPE fibers (Dyneema or Spectra)		2300-3500	0.97
Vectran		2850-3340	
Pine Wood (parallel to grain)		40	
Bone (limb)	104-121	130	
Nylon, type 6/6	45	75	
Rubber	-	15	
Boron	N/A	3100	2.46
Silicon, monocrystalline (m-Si)	N/A	7000	2.33
Silicon carbide (SiC)	N/A	3440	
Sapphire (Al_2O_3)	N/A	1900	3.9-4.1
Carbon nanotube (see note above)	N/A	62000	1.34

Source: A.M. Howatson, P.G. Lund and J.D. Todd, "Engineering Tables and Data" p41

APPENDICES B

Evaluation Form

This evaluation form is a respond for the product that is Foldable Wet Shopping Cart. All the respondent must test the folding cart first before fill the below question.

NAME: _____

DATE: _____

1. Do you feel any back pain while handle the cart?

   ☐ Yes ☐ No

2. Are the cart is easy to move?

   ☐ Yes ☐ No

3. Do you agree the foldable cart is suitable use at market to put any groceries?

   ☐ Yes ☐ Maybe ☐ No

4. Do you recommend this product to other users? If no please state a reason.

   _____

   _____

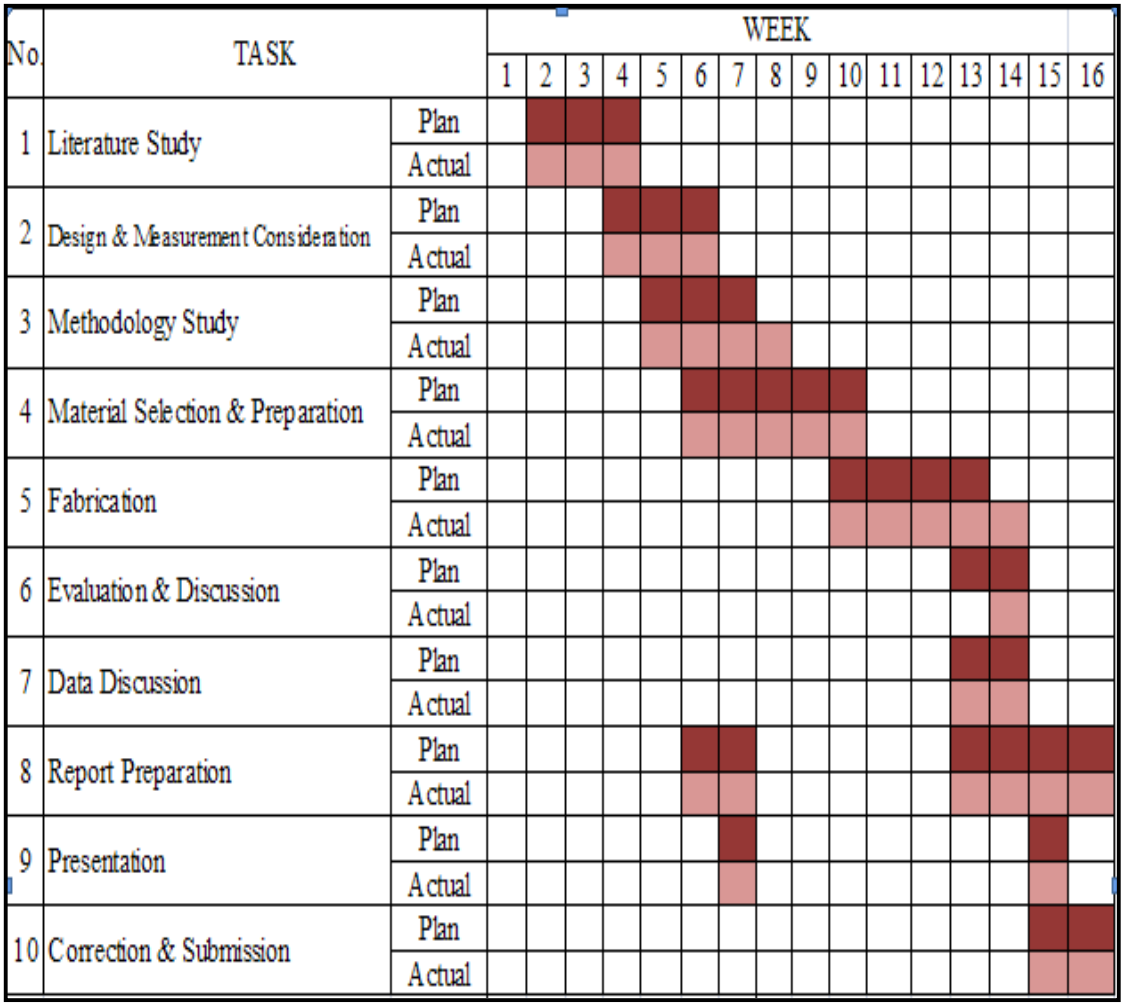
5. Do you have any suggestion to improve the quality of the folding cart?

   _____

   _____

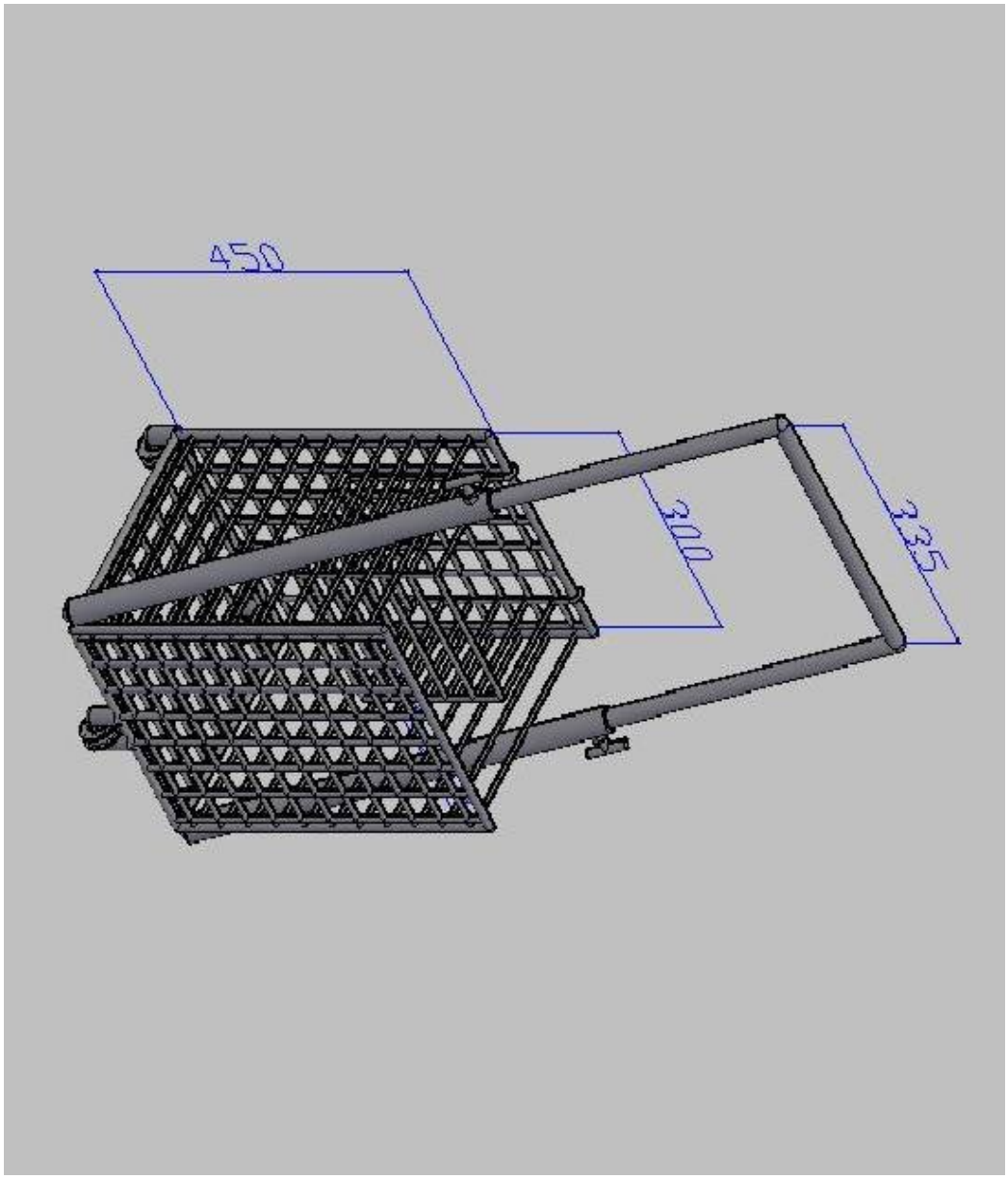
APPENDICES C

Gantt Chart



APPENDICES D

CAD Drawing



APPENDICES E

Isometric View