UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATE HAND CRANKED LIFTER FOR CAR ROOF COMPARTMENT

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BACHELOR OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY (AUTOMOTIVE) WITH HONOURS

2022

Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project entitled "Design and Fabricate Hand Cranked Lifter for Car Roof Compartment" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : Mohamad Najmi Bin Mohamad Nor

Date : 16/1/2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree Of Bachelor Of Mechanical And Manufacturing Engineering Technology (Automotive) with honours. The member of supervisor are as follow.

Signature : .....

Supervisor Name : Ir. Mazlan Bin Ahmad Mansor

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DEDICATION

This project and research work is dedicated to all my families for their support and for those who have supported me throughout my education. Not to be forgotten, my project supervisor for his patience, advice and support during this project. And lastly, I am so grateful to ALLAH swt and thank you for the guidance, strength and giving me a healthy life. Also, thank you for giving me inspiration of idea to finish this research.

ABSTRACT

In this era, the advancement in production and management systems has changed the automobile industry very fast. The industry has witnessed the opening up and growth of several emerging markets. The automotive industry is now facing new and pressing challenges. Globalization, digitalization and increasing competition in the market are changing the face of the industry. Due to that, there are many types of cars that have been produced in this present era. Cars type has been classed by car segment. In Asia, the smallest category of car registered as regular cars is known as A-segment. The B-segment is the next larger category of small car. The largest category of small cars is called C-segment or small family car. Most popular car type in Malaysia is MPV or multi-purpose vehicle. This car type become popular because of the variety of seat combinations in the segment, it is the most flexible class among the others. There are MPVs that seat five people and others that accommodate eight people. However, most cars usually have seven seats. Next poular car type in Malaysia is SUV or Sport Utility Vehicles. This car type become popular because SUV offers better cargo capacity. The other reason why people choose SUV is because they want the off-roading capabilities to drive through untamed, unpaved terrain, and wild. The similarities for these two types of cars are they are usually equipped with a roof rack on their roof. Roof rack is an extra cargo storage for SUV and MPV type car. Because of the height of this type of car is taller than others car type, it makes it a little difficult for people to load and unloading their goods on the car roof rack. They need more energy or need more than one person to load and unloading the item on the roof rack. The purpose of this research to design and fabricate a hand cranked lifter to make it easier for people to load and unloading their goods on the car roof rack.

ABSTRAK

Di era ini, kemajuan dalam sistem produksi dan pengurusan telah merevolusikan industri automotif. Industri produksi di Malaysia telah menyaksikan. Industri kita telah menyaksikan pembukaan dan pertumbuhan beberapa pasaran baru. Industri automotif kini menghadapi cabaran baru dan lebih mencabar. Globalisasi, digitalisasi dan peningkatan persaingan di pasaran mengubah perjalanan industri. Oleh kerana itu, terdapat banyak jenis kereta yang telah dihasilkan pada zaman sekarang. Jenis kereta telah dibezakan mengikut segmen kereta. Di Asia, kategori kereta terkecil yang didaftarkan sebagai kereta biasa dikenali sebagai segmen A. Segmen B adalah kategori kereta kecil seterusnya yang lebih besar. Kategori kereta kecil terbesar dipanggil segmen C atau kereta keluarga kecil. Jenis kereta yang paling popular di Malaysia ialah kenderaan MPV atau kenderaan pelbagai guna. Jenis kereta ini menjadi popular kerana pelbagai kombinasi tempat duduk di segmen ini, ia adalah kelas yang paling fleksibel antara lain. Terdapat MPV yang boleh memuatkan lima orang dan juga ada yang boleh memuatkan lapan orang. Walau bagaimanapun, kebanyakan kereta MPV biasanya mempunyai tujuh tempat duduk. Jenis kereta poular seterusnya di Malaysia ialah SUV atau Sport Utility Vehicles. Jenis kereta ini menjadi popular kerana SUV menawarkan kapasiti kargo yang lebih baik. Sebab lain mengapa orang memilih SUV adalah kerana mereka mahukan keupayaan untuk melalui kawasan yang tidak berturap, dan liar. Kesamaan bagi kedua-dua jenis kereta ini ialah biasanya dilengkapi dengan rak atap di bumbung mereka. Rak atap adalah simpanan kargo tambahan untuk kereta jenis SUV dan MPV. Kerana ketinggian jenis kereta ini lebih tinggi daripada jenis kereta lain, ini menyukarkan seseorang untuk memuat dan memunggah barang mereka di rak atap kereta. Mereka memerlukan lebih banyak tenaga atau memerlukan lebih daripada satu orang untuk memuat dan memunggah barang di rak bumbung. Tujuan penyelidikan ini untuk merancang dan membuat alat pengangkat untuk memudahkan orang memuat dan memunggah barang mereka di rak atap kereta.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, praises and thanks to the Allah, the Almighty, for His showers of blessings throughout my research work to complete the research successfully.

I would like to express my deep and sincere gratitude to my research supervisor, Ir. Mazlan Bin Ahmad Mansor, Faculty of Mechanical and Manufacturing Engineering Technology, Universiti Teknikal Malaysia Melaka (UTeM) for giving me the opportunity to do research and providing invaluable guidance throughout this research and also for his support, advice, and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered.

Finally, I am thankful to my loving parents, who were the cornerstone of the strength in my venture, from the very bottom of my heart. My eternal love for patience and understanding to all my siblings as well for showing an aspiration to complete this thesis successfully.

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LIST OF SYMBOLS AND ABBREVIATIONS

Φ	-	Pressure Angle
A	-	Addendum
aG	-	Addendum of Gear
aP	-	Addendum of Pinion
b	-	Dedendum
c	-	Clearance
C	-	Center Distance
D	-	Pitch Diameter
DG	-	Pitch Diameter of Gear
DP	-	Pitch Diameter of Pinion
DB	-	Base Circle Diameter
DO	-	Outside Diameter
DR	-	Root Diameter
F	-	Face Width
Hk	-	Working Depth of Tooth
Ht	-	Whole Depth of Tooth
mG	-	Gear Ratio
N	-	Number of Teeth
NG	-	Number of Teeth in Gear
NP	-	Number of Teeth in Pinion
p	-	Circular Pitch
P	-	Diametral Pitch

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CHAPTER 1

INTRODUCTION

1.1 Background

The automotive industry has been involved in the production of automobiles, including their components technology, such as engines and electronic component, but omitting tires, batteries, and fuel. Passenger cars and light trucks, such as pickups, vans, and sport utility vehicles, are the mainstays of the sector. Commercial vehicles (such as delivery trucks and huge transport trucks, commonly referred to as semis) are secondary in importance to the sector. The articles automobile, truck, bus, and motorcycle explore the design of modern automobiles, while gasoline engine and diesel engine describe automotive engines. The automobile was invented in Europe in the late 1800s.

The automotive industry in Malaysia began during the British colonial period. With its inception in Singapore in 1926, Ford Malaya became Southeast Asia's first automobile assembly facility. Malaysia's post-independence automotive sector was founded in 1967 to promote national industrialization.

Proton Holdings Berhad was the first Malaysian automotive manufacturer (PROTON). PROTON was founded in 1983, providing the groundwork for the automotive industry's national pride. 1985 was a watershed point in Malaysian history. The Proton Saga, the country's first national car, was released to the public. For most countries, this is an elusive dream, but PROTON made it a reality for Malaysia.

Malaysia's second national vehicle company, Perusahaan Otomobil Kedua Sendirian Berhad (PERODUA), was founded in 1992. In August 1994, PERODUA released their first car, the Perodua Kancil. Perodua initially focused on producing minicars segment A car, with no models competing with Proton in the same market sectors. However, in recent years, its target market sectors have begun to pass with Proton's market, particularly in the super small segment (A segment and B segment), where the Perodua Myvi has defeated the Proton Savvy and currently competes against the Proton Iriz.

There are numerous automotive companies in Malaysia nowadays, including Toyota, Honda, Mitsubishi, Suzuki, Volvo, Peugeot, BMW, Mercedes, and others. From a sector to a luxury segment, this corporation provides a wide range of automotive models. In Malaysia, the MPV class is the most popular. This is due to the fact that MPVs sacrifice style for functionality. Many MPV manufacturers construct automobiles with spacious, flexible cabins rather than sleek lines and aerodynamic curves. These cabins are frequently described as large boxes with sharp corners. This is exactly what MPV owners, many of whom are outdoor enthusiasts, are searching for. The bare-bones home is impenetrable to filthy camping gear. Aside from that, the boxy cabins offer for more functional seating and better flexibility. Most MPVs comfortably accommodate five or more people. It's also possible that where and how those passengers seat in the car will change. Many variants allow drivers to remove seats to make room for additional luggage, as well as slide from one side of the car to the other.

Malaysians prefer SUV cars since the country offers a diverse range of road conditions. Another reason Malaysians adore this class is that it offers Off-Roading capability. People who live near the forest love to buy this car segment since Malaysia has tropical rainforest habitats.

1.2 Problem statement

The MPV and SUV automobile segments are the two most popular car segments among Malaysians. Typically, cars in this sector come with a roof rack mounted on the car's roof. A roof rack is a set of bars that are attached to the roof of a vehicle. It's used to transport large objects like bags, bicycles, canoes, kayaks, skis, and other carriers and containers. This car segment has a higher height than other car segments, ranging from 1.8m to 2m.

Because of its height, this item makes loading and unloading items from a car roof rack difficult. Loading and unloading items requires two or more people. They must exert additional force in order to raise the item and load it onto the roof rack.

Muscle strains or ligament sprains in the lower back can result from this condition. When weak muscles are overstretched or damaged, a muscular strain results. Both strains and sprains, despite appearing to be minor injuries, can result in severe lower back pain.

1.3 Project objectives

The goal of this project is to design and build a hand-cranked lifter for the roof compartment of MPVs and SUVs. This can lessen the amount of energy and force required to load or unload items from a car roof rack. The following are the precise goals:

a) To design a hand cranked lifter

b) To fabricate and innovate a hand cranked lifter using kinetic energy.

c) To reduce the conservation of human force and energy to lift goods.

1.4 Scope of project

The scope of this research are as follows:

a) To invent a lifter by using gear and pulley concepts using CATIA V5 software.

b) The factors that affect the rotational kinetic energy generated of the lifter.

c) The type of material and component use to produce a durable hand cranked lifter.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

This chapter review cranked lifter mechanism and types of material used. CATIA and Altair Hyperworks are used for design and simulation of the product. This chapter also briefs the description of type of car segment, material strength, product design specification (PDS) and types of back pain. These days, car is one of the most essential needed for every individual contrast with public transport. Now days, most car has roof rack on the top of the car roof especially SUV and MPV car segment.

Cars with roof rack has been a popular concept since 1950s and 1960s. 1950s to1960s isthe era of smallpickup truck. It was fairly simple to attach rack-type devices securely with the brace and support of the rain gutters in place. Commonly SUV and MPV car segment has this roof rack installed by the manufactured. This make a car with a roof rack have an extra storage space to carry more large items such as big luggage, big tent, kayaks and large container. The disadvantages of this features is a user has to lift an item higher to store it on the roof rack than the car boot which is less high. When we lift item higher than our height, this will make the muscles in your back will be strained beyond what they can handle. This could lead to a back pain problem.

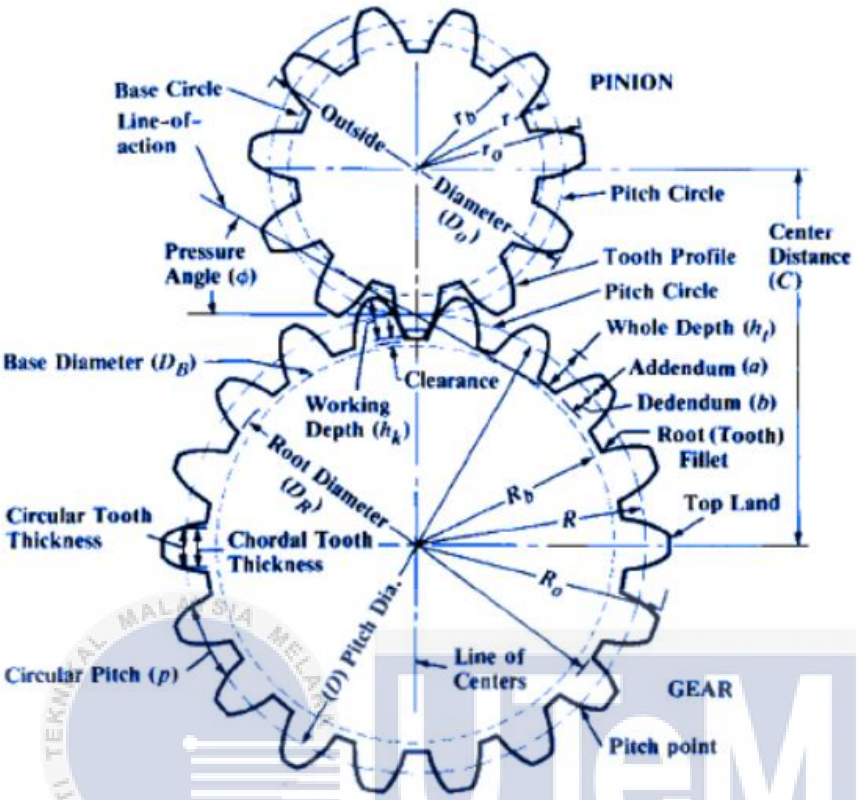
2.2 Hand Crank Winches

Winches have been utilised for millennia in a variety of applications, ranging from building construction to transporting military vehicles. Many of the original winches had to be operated by hand, and we now have a wide range of advanced winch technology, including electric and hydraulic winches. Hand crank winch has been invented for the first time during the Ancient Persian Empire.

It is a mechanical device that is used to lift and move large and heavy items. It winds wire rope around a drum (or a spool) and holds it firm until it has to be changed. This type of winch is operated by turning the ratcheting crank/lever to lift or pull a load. Hand crank winches are available in a variety of sizes and can pull weights ranging from 180kg to 1800kg.

Figure 2.1 Hand cranked winch

2.2.1 Gear Equation



Where:

φ = Pressure Angle

a = Addendum

aG = Addendum of Gear

aP = Addendum of Pinion

b = Dedendum

c = Clearance

C = Center Distance

D = Pitch Diameter

DG = Pitch Diameter of Gear

DP = Pitch Diameter of Pinion

DB = Base Circle Diameter

DO = Outside Diameter

DR = Root Diameter

F = Face Width

hk = Working Depth of Tooth

ht = Whole Depth of Tooth

mG = Gear Ratio

N = Number of Teeth

NG = Number of Teeth in Gear

NP = Number of Teeth in Pinion

p = Circular Pitch

P= Diametric Pitch

To Find	Equation
Base Circle Pitch	$D_B = D \cos\varphi$
Circular Pitch	$p = (\pi D)/ N$ $p = \pi / P$
Center Distance	$C = N_p (m_G + 1) / 2P$ $C = (D_p + D_G) / 2$ $C = (N_G + N_p) / 2P$ $C = (N_G + N_p) p / 2P$ $C = (N_G + N_p) p / 6.2832$
Diametral Pitch	$P = \pi / p$ $P = N / D$ $P = [N_p (m_G + 1)] / 2C$
Gear Ratio	$m_G = N_G / N_p$
Number of Teeth	$N = P D$ $N = (\pi D) / p$
Outside Diameter (Full Depth Teeth)	$D_O = (N + 2) / P$ $D_O = [(N + 2) p] / \pi$
Outside Diameter (American Standard Stub Teeth)	$D_O = (N + 1.6) / P$ $D_O = [(N + 1.6) p] / \pi$
Outside Diameter	$D_O = D + 2a$
Pitch Diameter	$D = N / P$ $D = (N p) / \pi$
Root Diameter	$D_R = D - 2b$
Whole Depth	$a + b$
Working Depth	$a_G + a_p$

Figure 2.2 Equation of gear

2.3 Steel

Steel alloyed with elements such as copper, tungsten, sulfur, vanadium, silicon, and boron is known as alloy steel. Strength, hardness, wear resistance, and toughness are all improved by adding these alloying elements. The proportions of alloying components might range from 1 to 50%. Alloy steels can contain a wide range of elements, each of which improves the material's mechanical, thermal, and corrosion resistant qualities. Low-concentration elements (less than 5 wt%) tend to improve mechanical qualities, such as hardenability and strength, whereas higher-concentration elements (up to 20 wt%) boost corrosion resistance and stability at high and low temperatures.

The table below summarizes the effects of adding various elements to steel, as well as the normal weight fractions.

Table 2.1 Table effects of adding various elements to steel

Element	Symbol	wt. %	Function
Aluminium	Al	0.95–1.30	Alloying element in nitriding steels
Bismuth	Bi	–	Improves machinability
Boron	B	0.001–0.003	Improves hardenability
Chromium	Cr	0.5–2.0	Improves hardenability
		4–18	Corrosion resistance
Copper	Cu	0.1–0.4	Corrosion resistance
Lead	Pb	–	Improves machinability
Manganese	Mn	0.25–0.40	Prevents brittleness in combination with sulfur
		>1	Increases hardenability
Molybdenum	Mo	0.2–0.5	Inhibits grain growth
Nickel	Ni	2–5 12–20	Increases toughness Improves corrosion resistance
Silicon	Si	0.2–0.7	Increases strength and hardenability
		2	Increases yield strength (spring steel)
		Higher %	Increases magnetic properties
Sulfur	S	0.08–0.15	Improves machinability (free-machining steel properties)
Titanium	Ti	–	Reduces martensitic hardness in Cr steels
Tungsten	W	–	Increases hardness at high temperatures
Vanadium	V	0.15	Increases strength while maintaining ductility, promotes fine grain structure

2.3.1 Low Alloy Steel

Due to their great strength and cost-effectiveness, low alloy steels are employed in a wide range of industries. Military vehicles, construction equipment, ships, pipelines, pressure vessels, oil drilling platforms, and structural components are all examples of where they can be found. HY80 and HY100 are two examples.

2.3.2 High Alloy Steel

Manufacturing and processing high-alloy steels can be costly and time-consuming. Their high hardness, toughness, and corrosion resistance, on the other hand, make them excellent for structural components, automotive applications, chemical processing, and power generation equipment. The grades HE, HF, HH, HI, HK, and HL are examples of high-alloy steels.

2.3.3 Stainless steel

As with carbon steel, there is a wide variety of grades of stainless steel, generated through variation in chemical composition and heat treatment. These may be classified into five main groups according to their metallurgical structure, namely austenitic, ferritic, duplex (austenitic–ferritic), matensitic and precipitation hardening. In addition to the minimum of 10.5% chromium (Cr) required to give stainless steel its corrosion resistance, a number of other alloying elements may be present. These include carbon (C), nickel (Ni), manganese (Mn), molybdenum (Mo), copper (Cu), silicon (Si), sulphur (S), phosphorus (P) and nitrogen (N). The chemical compositions (% by mass of alloying elements) associated with the different grades are defined in the European Standard, EN 10088–1[3]. The most common grades for structural applications are the austenitic and duplex grades. These will

be discussed in more detail. Austenitic stainless steels typically contain 17–18% chromium and 8–11% nickel, offer very good corrosion resistance and have an austenitic microstructure. Duplex stainless steels typically contain 22–23% chromium and 4–5% nickel and have a mixed austenitic–ferritic microstructure. The duplex stainless steels offer higher strength, wear resistance and generally corrosion resistance than the austenitics, but at greater expense. In addition to the high number of grades of stainless steel, there are also a number of different stainless steel designation systems. The system adopted in the remainder of this paper will be that given in EN 10088-1. For each standard stainless steel grade, EN 10088-1 defines a steel name and a steel number. It is the steel number that will be referred to herein. Equivalent designations, including those to the German (DIN) and the US (AISI) systems are provided elsewhere. Chemical compositions for three grades of stainless steel commonly adopted in structures, two austenitic, EN 1.4301 and EN 1.4401 and one duplex, EN 1.4462 are provided in Table 1. Equivalent designations for grades EN 1.4301, EN 1.4401, EN 1.4462 according to the popular AISI system are AISI 304, 316 and 2205, respectively. Further information relating to stainless steel material properties and material selection is available.

2.4 Back Pain

Back pain can strike people of all ages for a variety of causes. Because of factors such as prior profession and degenerative disc disease, the risk of experiencing lower back discomfort increases as people get older. The bony lumbar spine, discs between the vertebrae, ligaments around the spine and discs, spinal cord and nerves, lower back muscles, abdominal and pelvic internal organs, and the skin around the lumbar area are all possible causes of lower back pain. Back discomfort due by improper posture or lifting technique is

the most common cause of back discomfort when lifting weights. Back rounding is a frequent issue, and it can cause your hips to be at an odd angle, putting stress on the ligaments around your spine. Lifting item too high to put on the car roof rack with wrong technique can also cause back pain example on figure 2.3.

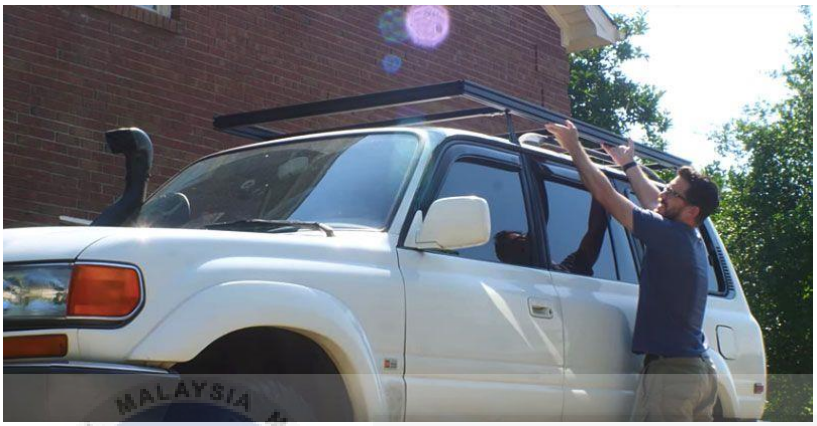


Figure 2.3 Example of wrong position when lifting item to high area

2.5 Car Segment

Government agencies frequently construct classification schemes in order to tax or regulate vehicle usage. Some countries may base car taxes on environmental considerations like the user pays principle. This is one of the reason why car are divided into several segment according to the positioning, pricing and dimensions of the vehicle.

2.5.1 MPV (Multi-Purpose Vehicle) Segment

Despite the number of seats, MPVs are noted for having a low roof. Because of the variety of seat arrangements available, it is the most adaptable of the three classes. There are MPVs that seat five people and others that accommodate eight people. Most cars, on the other hand, have seven seats. They resemble a minivan in appearance, with the exception

that MPVs are smaller in size. MPVs also have rear swinging doors rather than sliding doors, unlike minivans.

Figure 2.4 Example ofMPV car's segment

2.5.2 SUV (Sport Utility Vehicle) Car Segment

Off-road capabilities is one noticeable feature of the SUV that sets it apart from the other MPV body types. SUVs are built for one goal above all others, to act as a truck while delivering improved cabin comfort. SUV usually come with a greater price. SUVs are also designed on the same ladder frame as pickup trucks, allowing them to traverse even the most difficult terrain. It's also worth mentioning that SUVs have significantly higher power output and suspension systems. Don't forget about models with a specific 4x4 drivetrain, which is necessary for off-roading.

Figure 2.5 Example of SUV Car Segment

2.6 Welding

Welding is a fabrication method that joins two or more materials, most commonly metals and thermoplastics, by melting the components together using high heat and electric current, and then cooling them. Fusion is the name of the procedure.

A filler material will be introduced to the joint in addition to melting the material, forming a lump of molten material that will cool to produce a strong joint. In order to make a weld, pressure can be combined with heat. The edges of the weld parts are curved into an appropriate welding groove, such as a V groove, before welding begins. The arc melts the groove and filler edges together as the welding advances, forming a molten weld pool.

The molten weld pool must be shielded from oxygenation and the impacts of the surrounding air, for example, with shielding gases or slag, in order for the weld to be durable. The welding torch is used to feed the shielding gas into the molten weld pool. Over the molten weld pool, the welding electrode is coated with a substance that produces shielding gas and slag.

Metals like copper, mild steel, and stainless steel are the most typically welded materials. Plastics can also be welded. The heat source for plastic welding is either hot air or an electric resistor.

2.6.1 Welding Types

There are many type of welding that has been evolve, there is several common type of welding this day:

2.6.1.1 Gas Metal Arc Welding (GMAW/MIG)

It warms the two metals to be connected by passing a shielding gas along the wire electrode. This procedure, which comprises plate and large bore pipe, requires a constant voltage and direct-current power source and is the most prevalent industrial welding process.

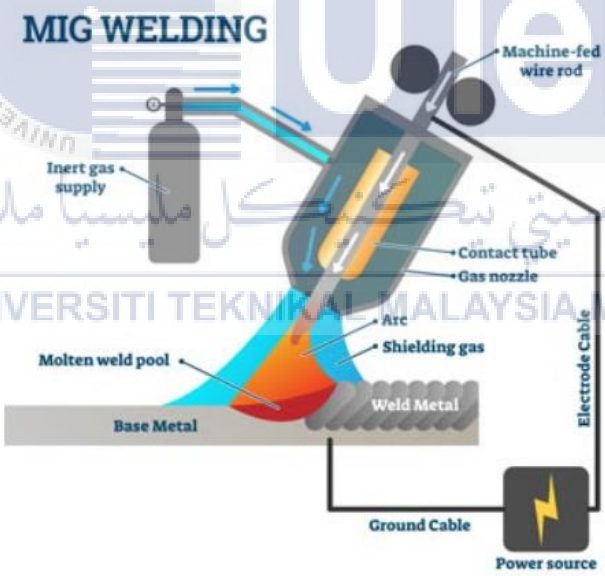


Figure 2.6 GMAW/MIG welding process

2.6.1.2 Gas Tungsten Arc Welding (GTAW/TIG)

This procedure is most commonly used to join thick portions of stainless steel or non-ferrous metals. It is an arc-welding technology that produces a weld with a fixed consumable

tungsten electrode. This method takes much longer than MIG, Stick, or Flux Cored Arc Welding.

Because non-ferrous metals have such a wide range of melting points, it's important to be cautious when determining the base metal's composition. Although both Stainless Steel and Steel contain iron, the metal must have at least 11% Chromium to be termed Stainless Steel. Carbon steel melts at temperatures between 2,600 and 2,800 degrees Fahrenheit.

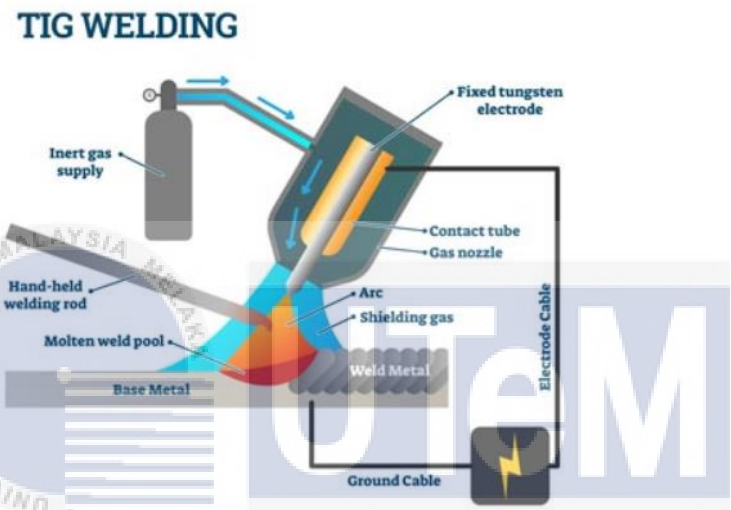


Figure 2.7 GTAW/TIG welding process

2.6.1.3 Shielded Metal Arc Welding (SMAW)

The welder uses a manual stick welding procedure to perform this type of welding. An electric current is used to create an arc between the stick and the metals to be connected.

This is commonly used to joining building steel structure and industrial fabrication to weld iron, steel, and mild steel pipe utilising the open V-Groove.

Welders must be able to weld to a degree where their work can withstand a destructive form of bend test. Shielded metal arc welding is commonly used to join carbon steel, alloyed steels, stainless steel, cast iron, and ductile iron, but it can also be used to join

non-ferrous metals such as titanium and brass. It's a material that's rarely utilized on aluminum.

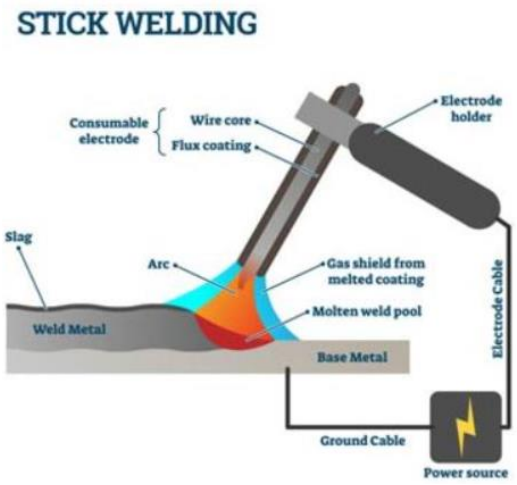


Figure 2.8 SMAW welding process

2.6.1.4 Flux Cored Arc Welding (FCAW)

This was created as a substitute for shield welding. Because of its fast welding speed and portability, the semi-automatic arc weld is frequently utilized in building projects. Because this approach contains so many variables, it can be used in a wide range of welding projects. Variables are frequently determined by the type of welder utilized and the wire used for the job.

The different operating angles, voltage levels, and polarity employed, as well as the wire feed speed, increase the adaptability. The freshly bonded metal cools faster due to the possibility of faster welding speeds. When employing flux cored wire, the welding technician must keep an eye out for porosity in the welded junction.

Due to the volume of smoke and fumes produced during the welding process, Flux Cored Arc Welding is best performed outside or beneath industrial ventilation hoods.

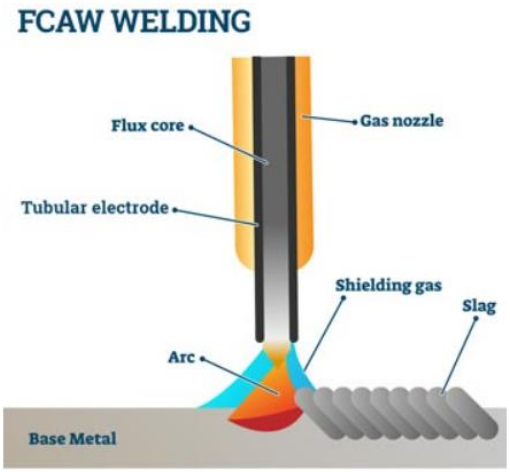


Figure 2.9 FCAW welding process

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter, methodology will clarifies in insight concerning the fabrication method to develop a hand cranked lifter. This project start with literature review. The journal, patents, online article and books will be study in order to get the general idea of this project objectives, to research the improvement for better manual lifting machine by utilizing fabrication technique that has be learn in university.

Lifting machine, usually referred to as lifting gear, refers to any piece of equipment that can be used to raise loads. There are many type of lifting equipment. Examples of lifting equipment is patient hoists, lifting harnesses, cranes, motor vehicle lifts and gantries. Technology has evolved rapidly, this has led to the existence of a good dumping of powerful lifting machines that is available now for modern use. This lifter technology has greatly facilitated manufacturing industries and heavy industries. Because of that, a manual lifter with smaller size will be a good device or machine to make it easier for people to lifting heavy items to store their goods on the car roof rack.

3.2 General Methodology

The following measures are necessary to accomplish the objectives for this project:

a) Literature review

Journal, article and books regarding the manual and modern lifter will be reviewed. For the lifter mechanism, the function of each mechanism design will be revised for the project accomplishment.

b) Survey

A survey will be create will several questions and given out to collect and analysis the data.

c) Design

Several design for hand cranked will be design for this project.

d) Fabrications

A portable manual lifter will be produce to ease user to lift heavy goods to be load on the car roof rack.

e) Testing

The data from testing activities will be the proved for product functionality.

f) Report writing

The report will be composed with respect to the project that has been finished.

The summarization of the project methodology can be seen in the flow chart below:

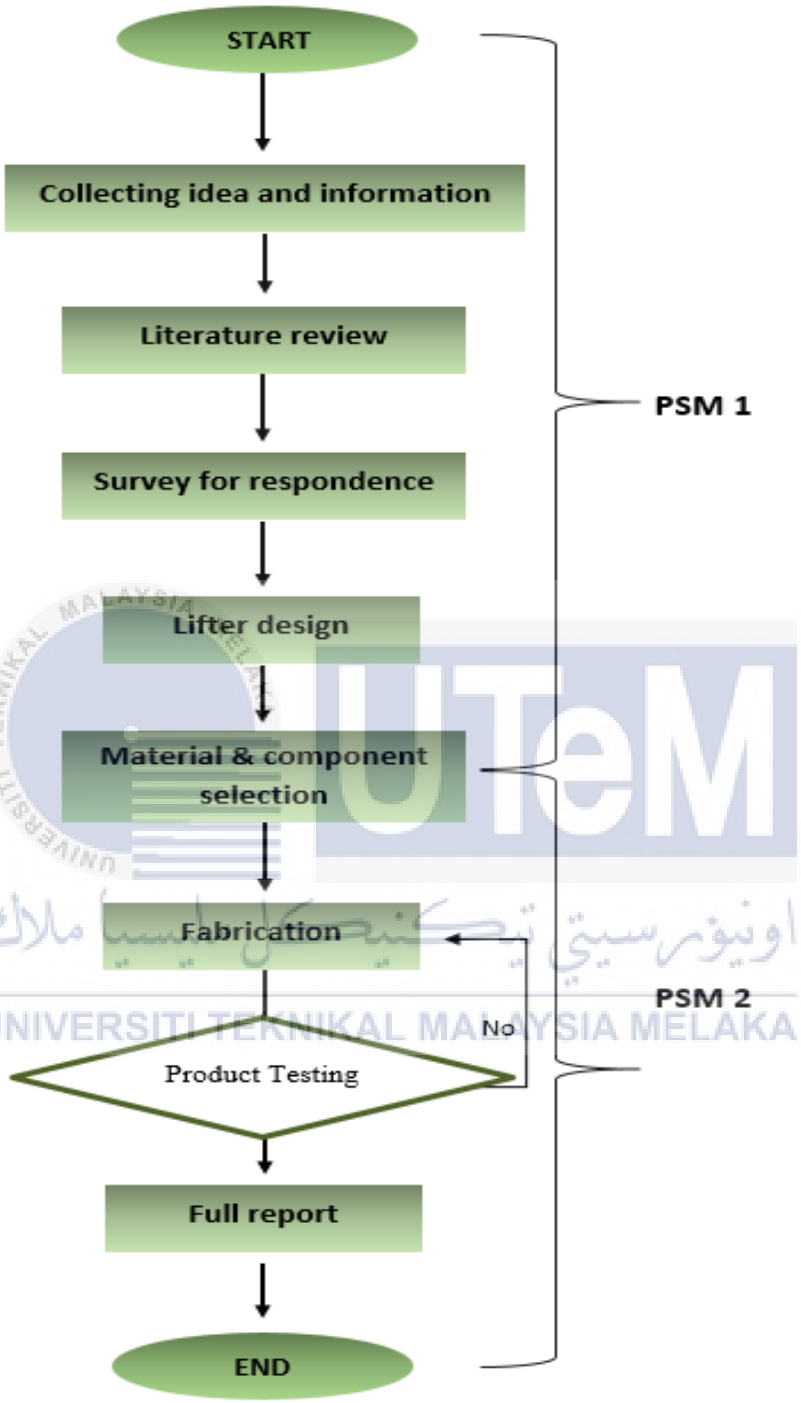


Figure 3.1 Methodology flow chart

3.3 Survey questions

A survey has been delivered to random people through social media. It consists of 11 questions that needed to be answer by the respondents. Below are the surveys questions. The data from the survey can be seen in appendix C.

3.4 Lifter concept design

From the survey provided, an idea of development for portable manual lifter system can be generated. There are three type of mechanism for this project.

a) Hand cranked winch

b) Hydraulic jack

c) Electric motor

This lifter mechanism uses cranked winch, hydraulic jack and electric motor to operate the lifter system.

3.4.1 Design A

Design A uses cranked winch to operated lifter system. This lifter mechanism uses single cranked winch to operate and adjust the fork height. Steel alloy bar is used as a frame and fork material. This alloy bar is connected using welding process. Figure 3.3 shows draft for design A.

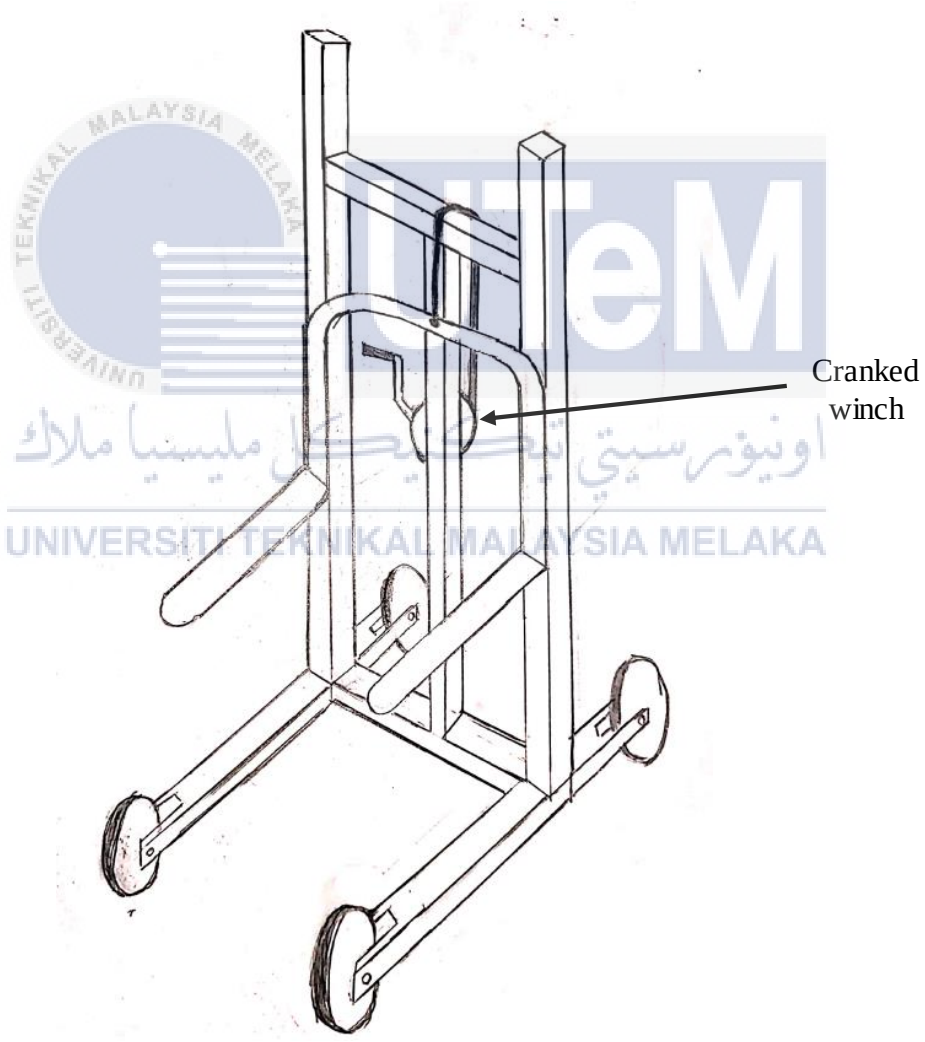


Figure 3.2 Design A

3.4.2 Design B

Design B uses hydraulic jack to operated lifter system. This lifter mechanism uses hydraulic jack to operate and adjust the fork height. When the hydraulic jack pedal is pressed, the piston will increase the height of the fork and when the pedal is being hold, the fork height will decrease. A titanium bar is used as a frame and fork material. This alloy bar is connected using welding process. Figure 3.4 shows draft for design B.

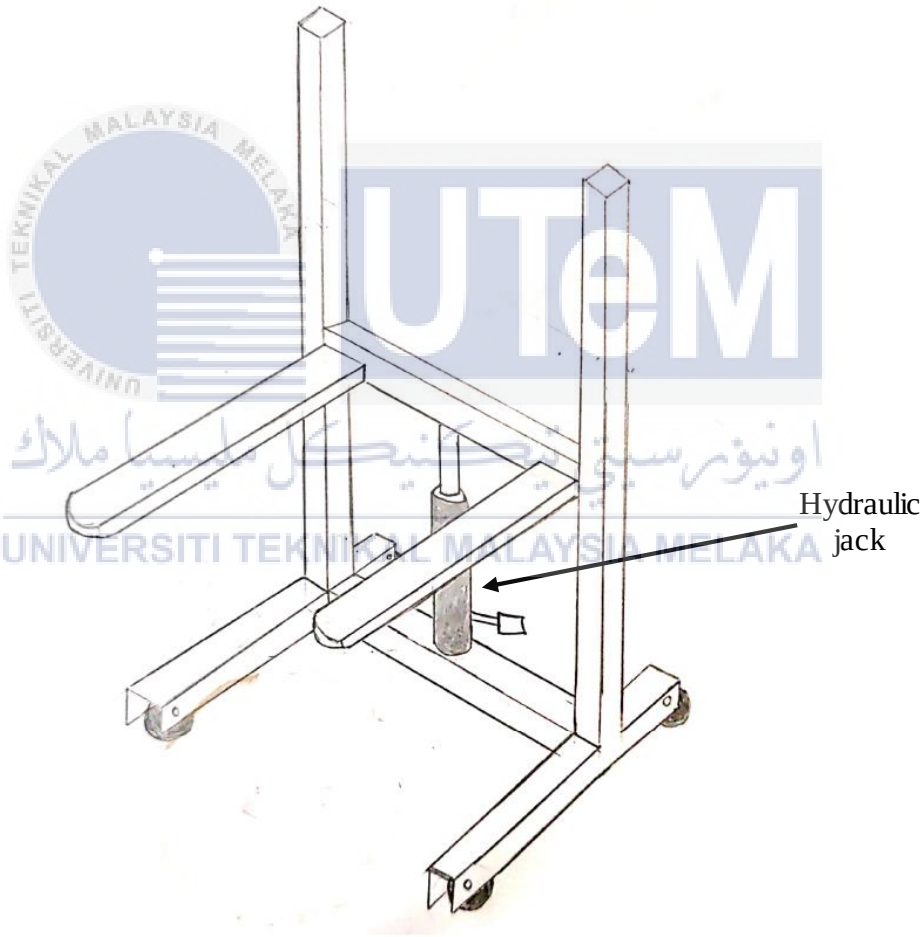


Figure 3.3 Design B

3.4.3 Design C

Design C uses electric motor to operated lifter system. This lifter mechanism uses electric motor to operate and adjust the fork height. A battery is the power supply for the electric motor. When the up button is pressed, the fork height will be increase and when the down button is pressed, the fork height will be decrease. A titanium bar is used as a frame and fork material. This alloy bar is connected using welding process. Figure 3.5 shows draft for design C.

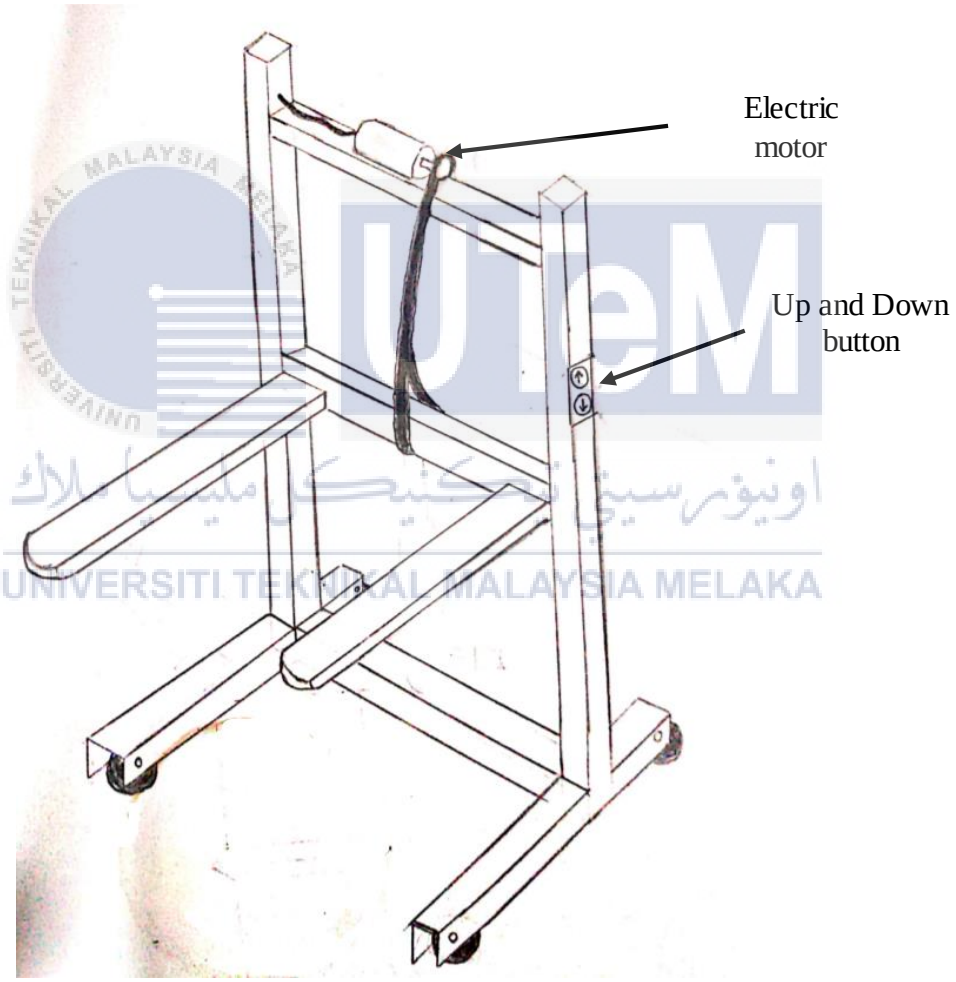
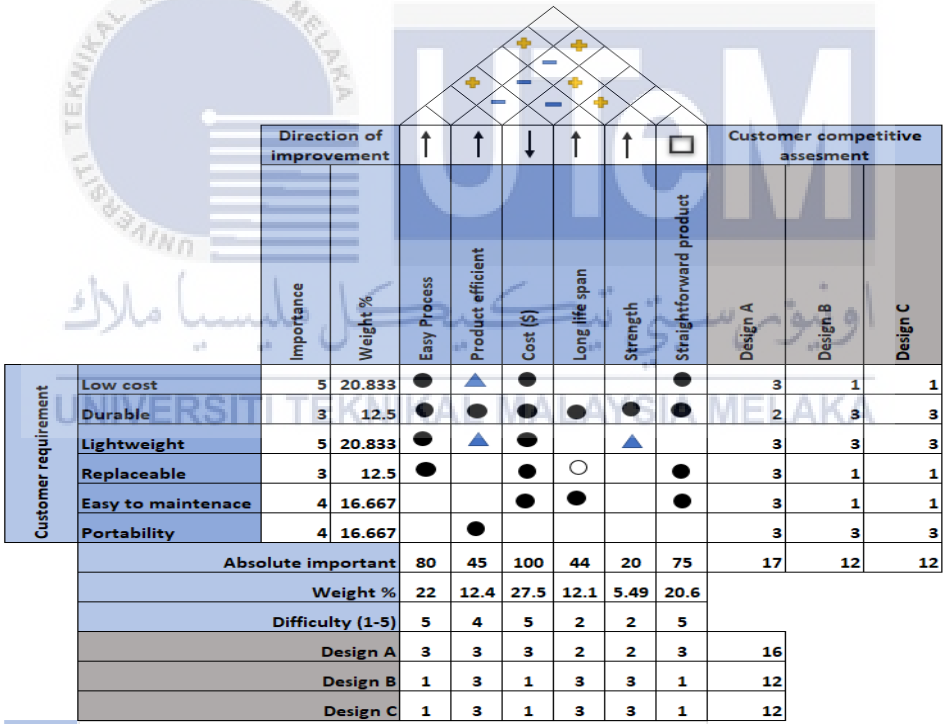


Figure 3.4 Design C

From the observation on survey has been made to the car users in Malaysia, most of the respondent choose cranked winch as the lifter mechanism. From the survey data and result, I have choose design A as my project main design. By using design A, user can adjust the lifter fork much easier and accurate to the specific height. Besides, the frame material for design A is much cheaper and easy to be find. Design A mechanism which is cranked winch is more easy to maintained than hydraulic jack and electric motor. Design C mechanism which is electric motor have major disadvantages which is it has to use battery as a power supply to power up the electric motor. Practicability for design C not so good since it has to be charged frequent after the lifter has been use. Table 3.1 shows the House Of Quality (HOQ) all the design.



		Direction of improvement		↑	↑	↓	↑	↑	□	Customer competitive assesment		
		Importance	Weight %	Easy Process	Product efficient	Cost ($)	Long life span	Strength	Straightforward product	Design A	Design B	Design C
Customer requirement	Low cost	5	20.833	●	▲	●			●	3	1	1
	Durable	3	12.5	●	●	●	●	●	●	2	3	3
	Lightweight	5	20.833	●	▲	●		▲		3	3	3
	Replaceable	3	12.5	●		●	○		●	3	1	1
	Easy to maintenace	4	16.667			●	●		●	3	1	1
	Portability	4	16.667		●					3	3	3
	Absolute important			80	45	100	44	20	75	17	12	12
	Weight %			22	12.4	27.5	12.1	5.49	20.6			
	Difficulty (1-5)			5	4	5	2	2	5			
	Design A			3	3	3	2	2	3	16		
	Design B			1	3	1	3	3	1	12		
	Design C			1	3	1	3	3	1	12		

Relationship	
Strong (5)	●
Moderate (3)	○
Weak (1)	▲

Competitive assesment	
Strong	3
Moderate	2
Weak	1

Correlations	
Positively related	+
Related	−
Not related	

Direction of improvement	
Has to be increased	↑
Has to be decreased	↓
The target value is desired	□

Figure 3.5 HOQ of selected design

3.5 Fabricate lifter according to design A

To construct the portable manual lifter for car user in Malaysia by using design A is the better choice as most of its specification is more practical for Malaysia car user. The lifter fork adjuster mechanism are operate by cranked winch which is more practical and accurate to adjust the fork height. The main process to develop this lifter is welding process. Welding process is used to connect and joining all the steel alloy to form the lifter frame and fork. The cranked winch will be attach to the lifter main frame using bolt and nut.

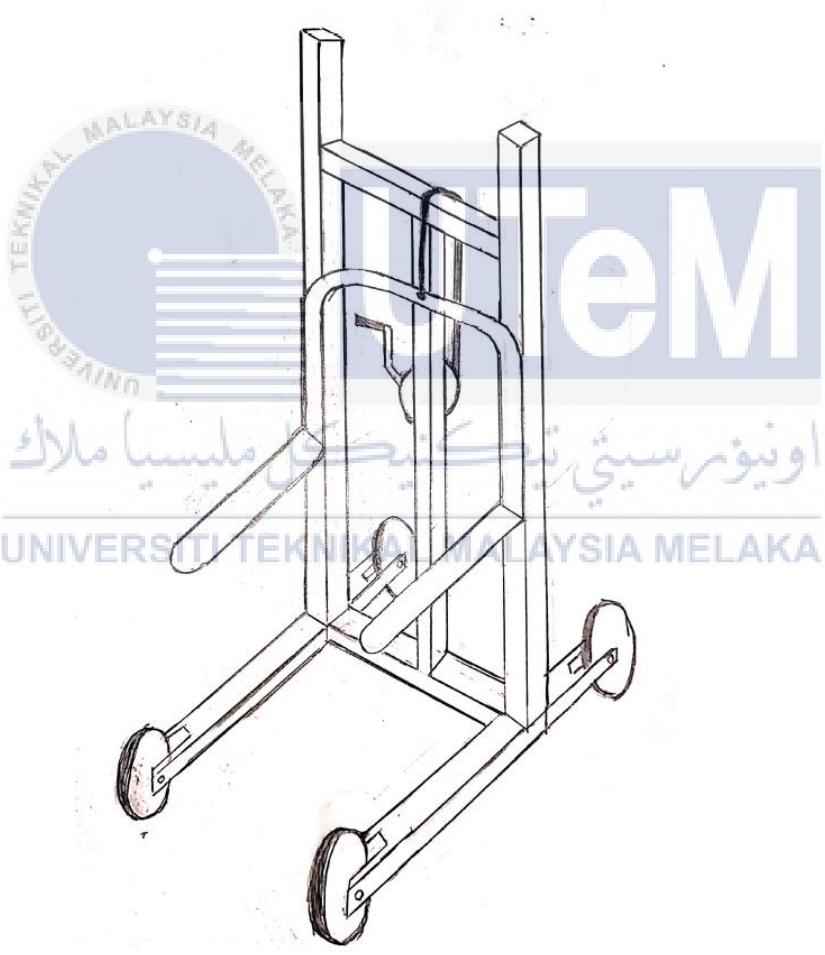


Figure 3.6 Design A

3.6 Fabricate process

To fabricate the Hand Cranked Lifter for this project, The following steps are the process to fabricate this project.

i) The first step to fabricate this lifter is cutting process. The hollow steel bar were cutted using metal cutting saw machine. The hollow steel bar were cutted into 8 pieces wich each pieces is 2 meter, to make the fabrication process easier.

Figure 3.7 Hollow steel bar cutting process

ii) After the hollow steel bar is cutted into 8 pieces, the hollow steel bar were grinded to remove the burr using grinder.

Figure 3.8 Grinding process

iii) Drill 4 hole (12mm) to the hollow steel bar to make bolt hole for lifter wheel.

Figure 3.9 Drilling process

iv) After all the burr is removed, the fabrication process is continued with joining process. Welding method is used as the joining process. The frame of the lifter is fabricate using MIG welding type.

Figure 3.10 Frame welding process using MIG

v) The frame is completed fabricate

Figure 3.11 Completed frame

vi) All 4 wheels were installed using bolt and nut.

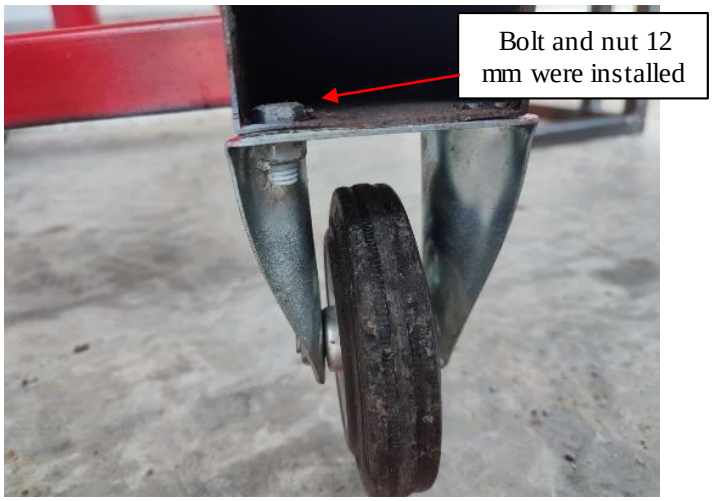


Figure 3.12 Wheel installed

vii) Continued welding process to fabricate the fork

Figure 3.13 Fork welding process

viii) The fork is completed fabricate.

Figure 3.14 Fork completed fabricate

ix) Installed hand cranked winch to the lifter frame using 12mm bolt and nut

Figure 3.15 Hand cranked winch installation

x) Insert fork to the frame lifter. Hook were attaced to the fork

Figure 3.16 Fork assembled to the frame

xi) A testing were made to try the lifter funtionality

Figure 3.17 Testing of the lifter

3.7 Finishing Process

i) All the lifter part were dissemble to make the finishing process easier.

ii) Doing a paint job to the lifter part.

iii) Frame and fork were sprayed by using aerosol spray tin white colour as the base colour.

Figure 3.18 Base colour paint job

iv) Yellow aerosol spray colour were used for the primer colour of the fork.

Figure 3.19 Primer colour paint job on the fork

v) Red aerosol spray colour were used for the primer colour of the frame.

Figure 3.20 Primer colour paint job on the frame

vi) Reassemble the frame and the fork.

Figure 3.21 Completed finishing job

3.8 Limitation

There are several limitation to develop this product. Some of them is the material that need to be use is very durable but also so expensive since it's a very high quality material. The material have to be changed to another material with similar quality. Next, since this day our country face with Covid-19 crisis, there will be limitation on time to use the lab and workshop that provided by the university.

CHAPTER 4

RESULT & DISCUSSION

4.1 Survey's result

This survey is made to produce the idea to develop the lifter and collect the data from the respondent about the difficulties of lifting the object to the car roof rack and what type of lifter they want. This survey has been filled up by 227 respondents. Below are the detail of the survey.

4.1.1 Analysis for age and gender

From two hundred and twenty seven respondent, most of the respondent is age around 26 to 35 years old. This range of age is with most of them that have roof rack on their car roof. From the survey, about 85.9% of the data survey are male while 14.1 is female. Female has the minority because usually they don't use car roof rack as their compartment bay.

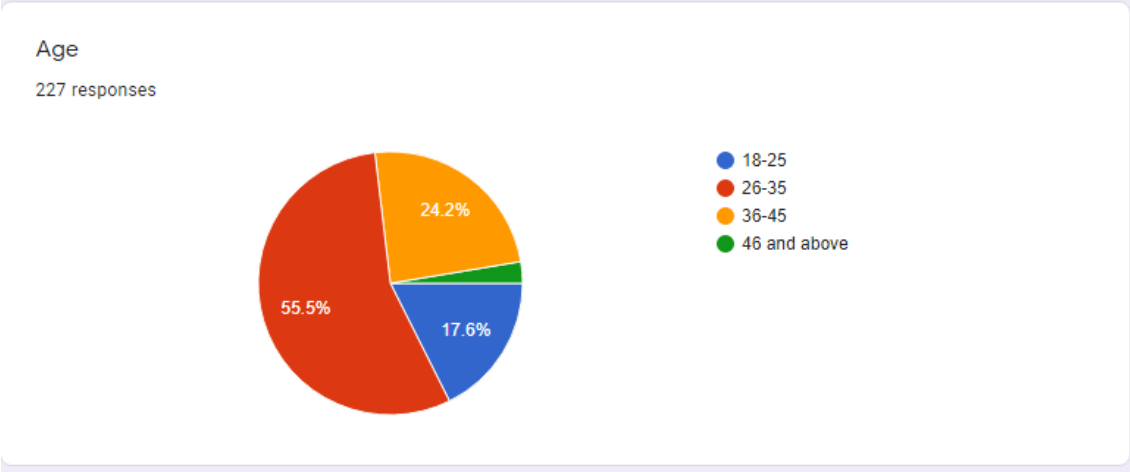


Figure 4.1 Respondent age percentage

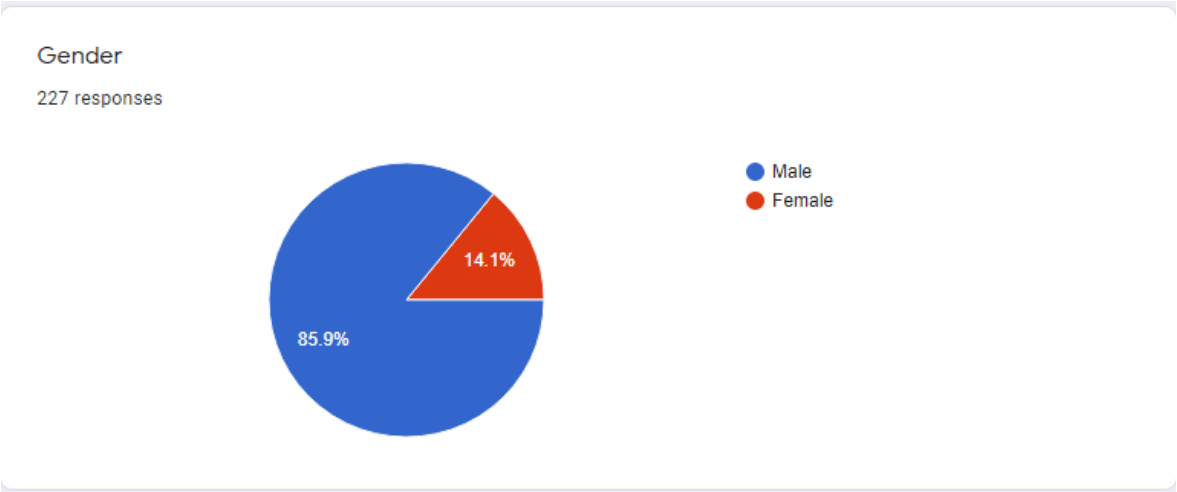


Figure 4.2 Respondent gender percentage

4.1.2 Type of car use

From the pie chart, 69.2% out of two hundred and twenty seven respondent has a car that height is around 1.5m to 1.7m. While 1.2m to 1.4m height is 17.2% and 1.8m to 2.0m is 13.7%. From the data we can conclude most of the car's user in this country own a Sedan car or segment A and B car.

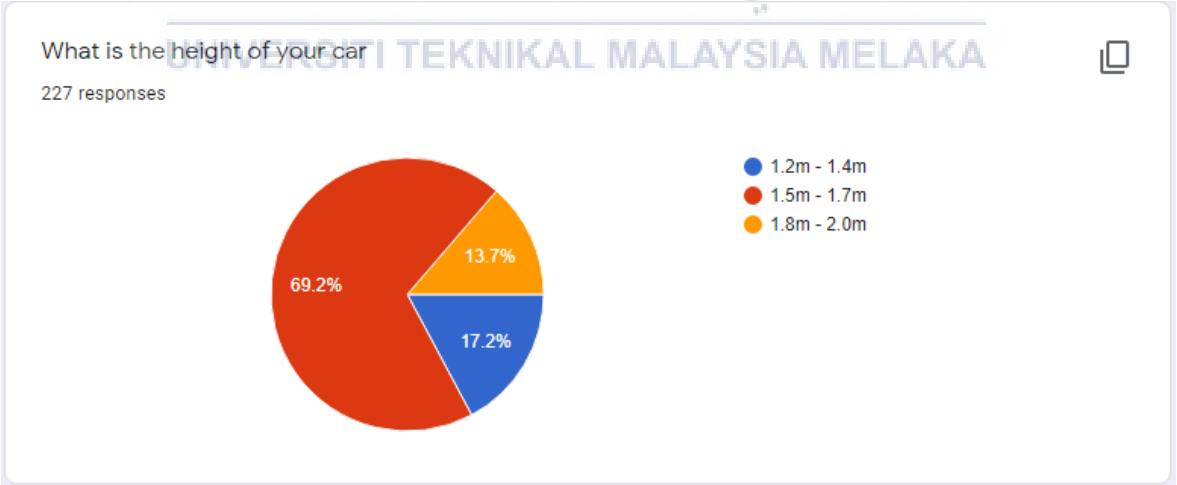


Figure 4.3 Respondent car height percentage

4.1.3 Difficulty to store goods on the roof rack

From the data collected in the survey, 97.8% out of the two hundred and twenty two respondent has difficulties to store items and goods on the roof rack. This mean majority of car user in this country has to face the same problem to store item on the roof rack. Most of the respondent need two or more people to help them store item on the roof rack.

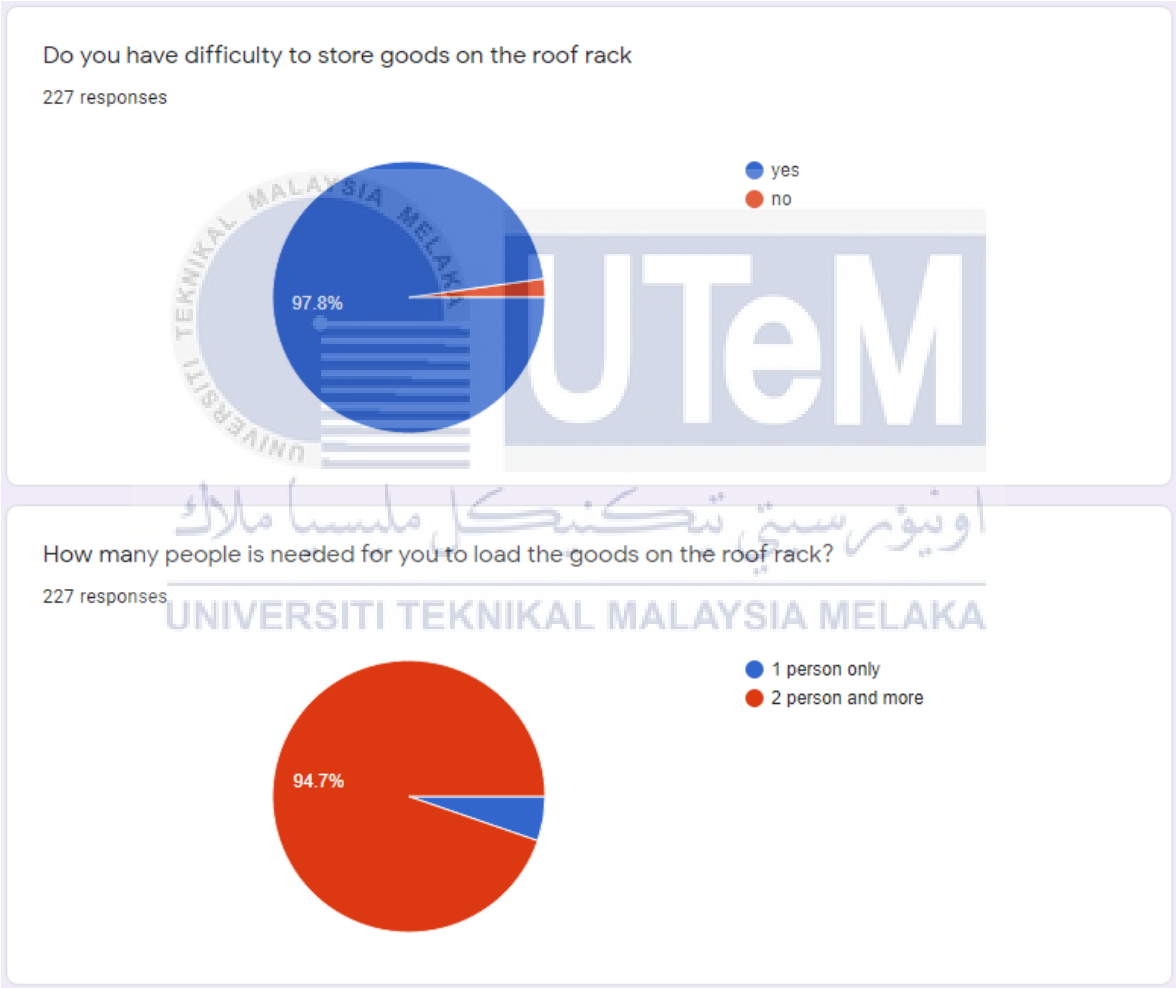


Figure 4.4 Respondent difficulty to store item on the car roof rack

4.1.4 Mechanism use for the lifter

Most of the respondent agree to use hand cranked winch as the mechanism to be use in this lifter. This mechanism got 88.1% vote by the respondent which is majority of the respondent agreed to use hand cranked winch as the mechanism of this lifter. By the next question we can know why respondent agreed to use this mechanism to be installed to the lifter. This is because this mechanism is easy to be maintenance. Another than that, it's also has the lowest cost to be compared this the others mechanism. Lastly, this mechanism has the highest durability compared to the others two mechanism.

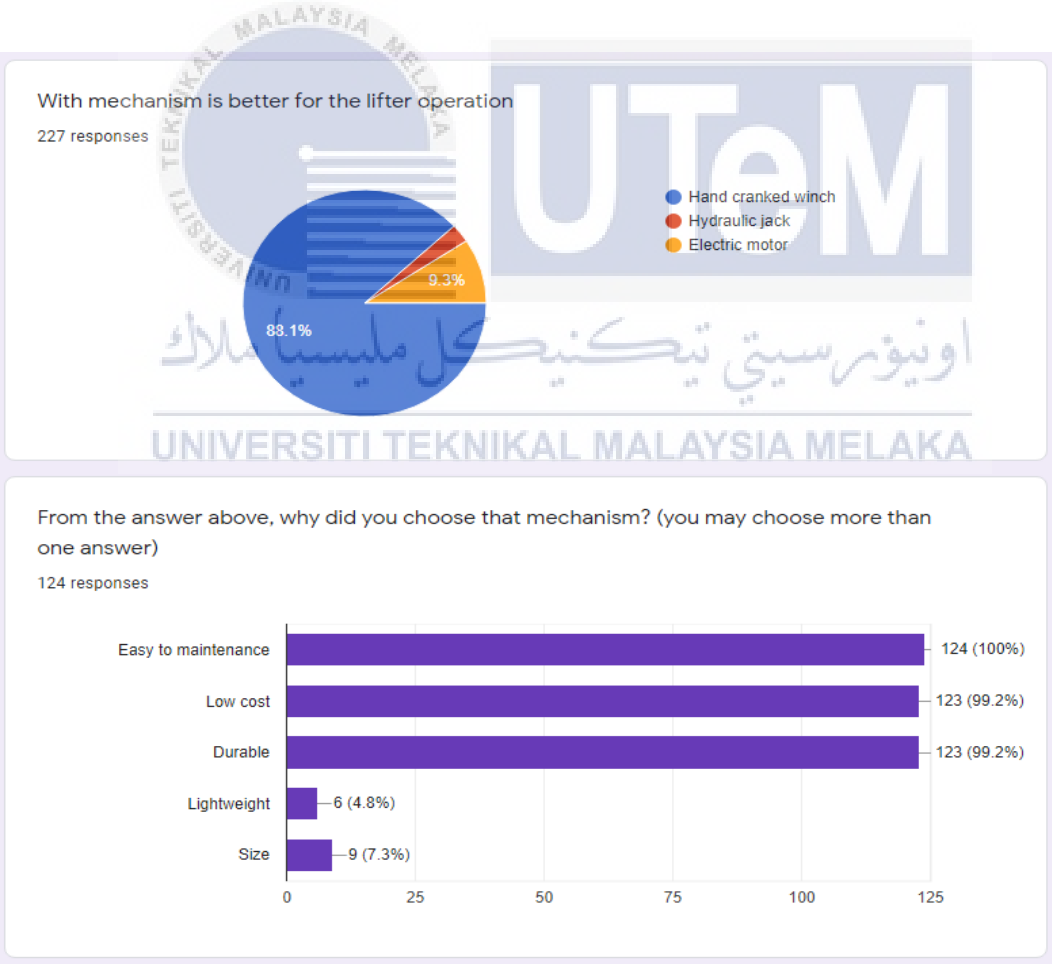


Figure 4.5 Mechanism selection and reason why they choose the mechanism

4.1.5 Material of the lifter

96.8% of the respondent agreed to use hollow stainless steel bar as the material of the lifter. From the survey, respondent agreed to use this material because this material is cheap and has less weight that others two material which is mild steel bar and stainless steel bar.

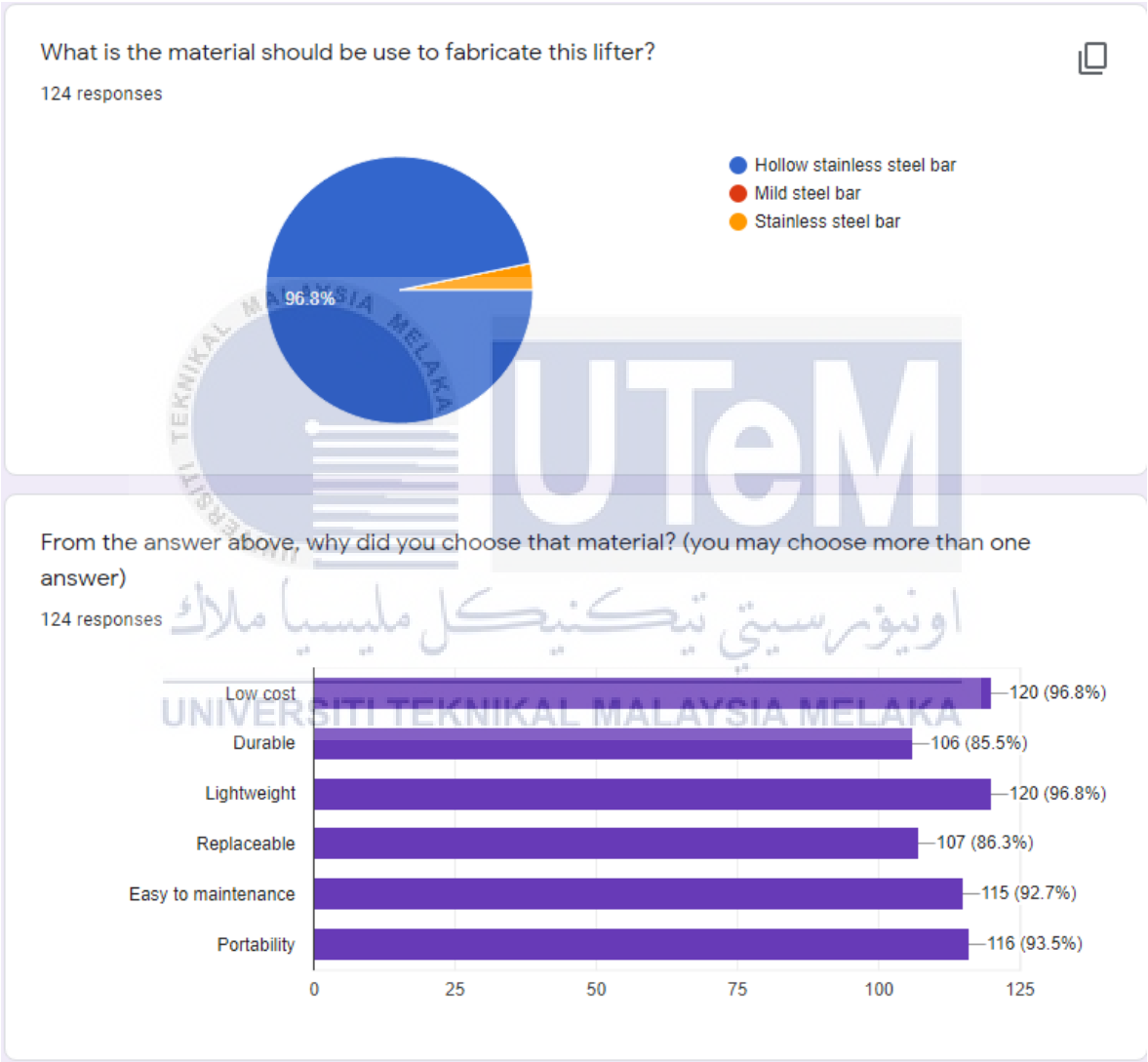


Figure 4.6 Material selection by the respondent

4.2 Design

From the data collected on the survey, the House of Quality (HOQ) has been develop. From the HOQ data, design A has the most score than design B and C. Design A has the most customers requirement based on the survey data collection. This is the design that has been made by using Catia v5 base on design A as shown in figure 4.7. Measurement and ISO drawing of the lifter is in the appendix C.

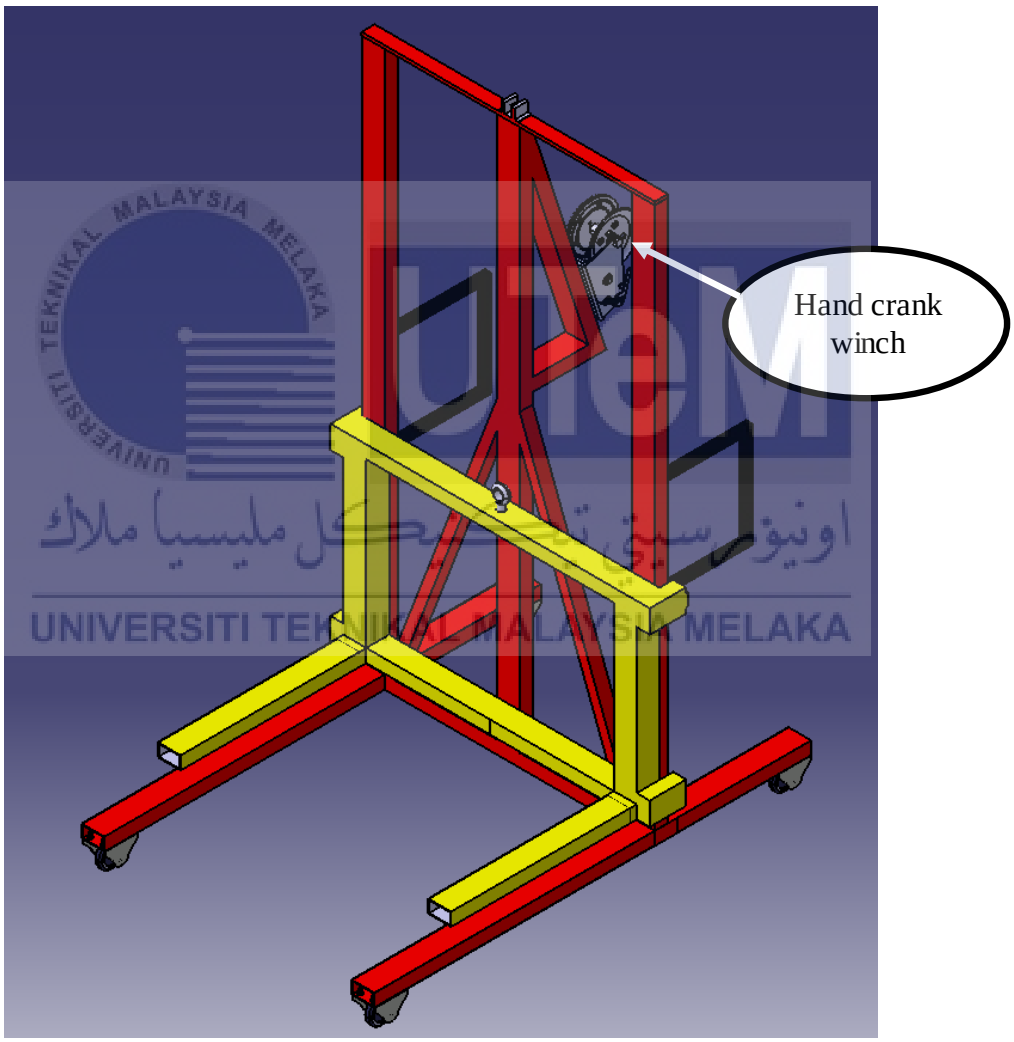


Figure 4.7 CAD drawing were develop according to design A

4.3 Fabrication Result

The actual fabrication prototype after the fabrication process is shown in the figure 4.8

Figure 4.8 Completed product

From figure 4.8, the frame, fork and handle has been colored with different colour to differentiate different part of the lifter. The frame has been colored with red colour, the fork has been colored with yellow colour and the handle is black colour.

4.4 List of material

The bill of material and components that have been selected to complete this product have been listed in Table 4.1

Table 4.1 List Of Material

Item	Quantity	Description	Specification	Price (RM)
1.	3	Hollow stainless steel bar	40mm x 70mm x 1828mm	300.00
2.	1	Hollow steel bar	15mm x 15mm x 1828mm	50.00
3.	1	Hand cranked winch	1200 lbs	87.90
4.	2	Trolley rubber wheel (rigid)	75mm	11.80
5.	2	Trolley rubber wheel (swivel with lock)	75mm	25.80
6.	2	Aerosol spray paint (Red)	400ml	11.80
7.	2	Aerosol spray paint (Yellow)	400ml	11.80
8.	2	Aerosol spray paint (White)	400ml	11.80
9.	1	Aerosol spray paint (Black)	400ml	5.90
TOTAL				516.80

4.5 Lifter operating process

i) If the item is smaller than the fork base area, put a long stick as the base as shown in figure 4.9.

Figure 4.9 Long stick inserted on the fork

ii) Put the item on the fork base as shown in figure 4.10.

Figure 4.10 Put item on the fork

iii) Release the lock of the winch as shown in figure 4.11.

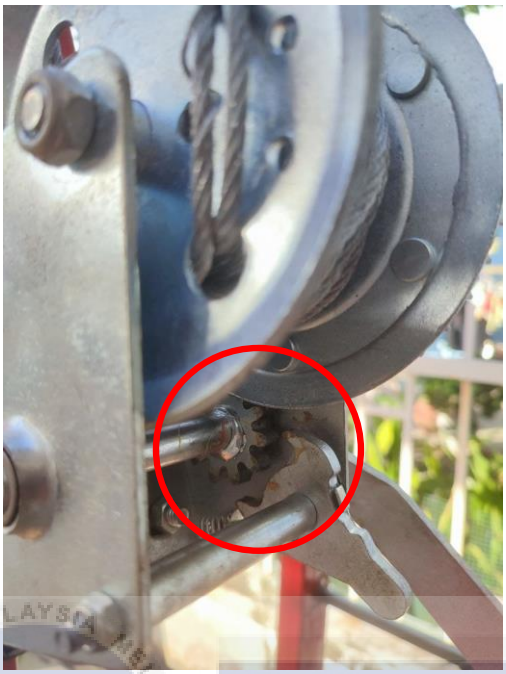


Figure 4.11 Lock release position

iv) Rotate the crank handle to lift the fork and item up and shown in figure 4.12.

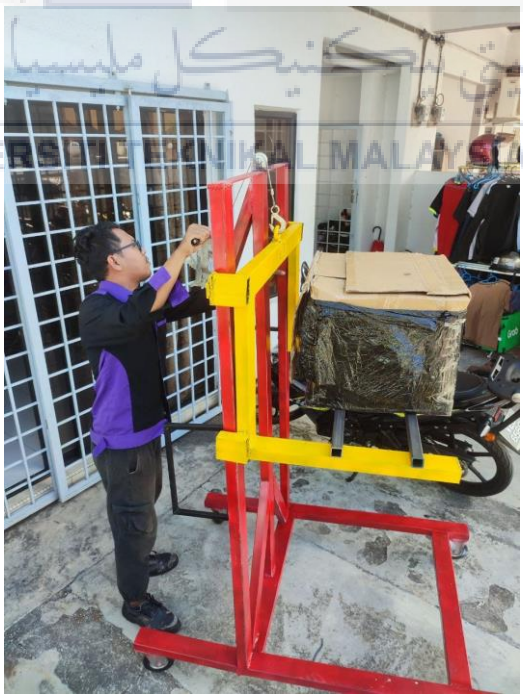


Figure 4.12 Item lifting

v) Maximum height for this fork can be lift is 1.2m as shown in figure 4.13.

Figure 4.13 Fork maximum height

vi) Lock the winch gear to prevent fork from sliding down as shown in figure 4.14 (make sure hand always hold the crank handle until the winch gear is locked).

Figure 4.14 Winch locking position

vii) To slide down the fork, release the lock.

4.6 Testing

Lifter testing has been done in two type of conditions, load testing and moving testing. For load testing, the load has been lift and maintained on the fork for 10 minutes to see whether the condition of the fork is changed or damaged for a particular load without moving. For moving testing, the lifter has been move from 3m to 10m while holding the load. This testing is to see whether the condition of the fork is changed or damaged for a particular load while moving. Figure 4.15 shows the load testing area and figure 4.16 shows the moving testing.

Figure 4.15 Load testing area

Figure 4.16 Moving testing area

4.7 Test result

4.7.1 Load test

For load testing, the load has been lift and maintained on the fork for 10 minutes to see whether the condition of the fork is changed or damaged for a particular load without moving. For this testing, the off road tire (1 pieces = 10kg) were use as the load for this testing. Figure 4.17 shows the testing load and table 4.2 shows the testing result.

Figure 4.17 Tire use in the testing

Table 4.2 Load test result

Load (kg)	Time (minutes)	Able to lift the load (Yes/No)	Fork condition (Good/No good)
10	10	Yes	Good
20	10	Yes	Good
30	10	Yes	Good

4.7.2 Moving test

For moving testing, the lifter has been move from 3m to 10m while holding the load. This testing is to see whether the condition of the fork is changed or damaged for a particular distance while moving. Figure 4.18 shows the testing example and table 4.3 shows the testing result

Figure 4.18 Example of moving testing

Table 4.3 Moving test result

Load (kg)	Distance (m)	Able to lift the load (Yes/No)	Fork condition (Good/ No good)
10	3	Yes	Good
10	5	Yes	Good
10	10	Yes	Good

4.8 Discussion

Based on the result from Tables 4.2 and 4.3, this lifter can operate well and achieve the objective of this project. This lifter can lift a load of up to 30kg without any damage to the load and the lifter part. This lifter also can move with the load without any damage to the load and the lifter part. This result shows that even a kayak can be lifted using this lifter because commonly, kayak weight is around 25kg to 30 kg.

4.9 Contribution of chapter

This chapter explains project fabrication results to produce a hand-cranked lifter. In addition, this chapter also helps to collect data from the public about the products produced, in order to get a product that accordance with customer demand, this result will help in the improvisation process of the development. Other than that, it also can help to increase product improvement in the future. Lastly, the result of the testing on the product has been done and achieved the objective of this project. From the result of the testing, we can conclude that this lifter is effective in reducing the conservation of human force and energy to lift items on the car roof rack. This lifter can lift objects up to 30kg and can move while lifting a load without any damage to the lifter and the load.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

This chapter summarized the project's conclusions and recommendations for further research. The conclusion section includes an outline of the research as well as a summary of the findings. The recommendations section includes ideas for additional research and development of this project.

5.1 Conclusion

Many factors can contribute to back pain problems. One of the factors is the wrong position when lifting items to the high area. Many cars in Malaysia usually come with a roof rack compartment. When lifting objects on the roof rack compartment, the wrong position can lead to back pain problems. The core idea of this thesis is to reduce the conservation of human force and energy to lift goods by developing a lifter to make it easier for them to raise the item to the roof rack compartment.

The first goal of this project is to design a hand-cranked lifter. Essentially, this goal was accomplished by developing a model of hand-cranked lifter in CAD software. The design has been decided according to the data collected from the survey made. By creating a House of Quality (HOQ), the mechanism and material used to develop this lifter have been decided.

Finally, the lifter also has been successfully fabricated according to the design that has been made in CAD software. The testing of this lifter shows that this lifter can reduce the conservation of human force and energy to lift items to the high area.

5.2 Recommendation

With all the data from testing that has been made, this project always can be evolve, here are some suggestion toward this project in the future.

i) Change the material of the frame and the fork to a better and durable material such as alloy steel.

ii) Reduce the size of the lifter to make it more portability.

iii) Change the joint method to fabricate this lifter from welding to using bolt or screw to make it much easier to be dissembled.

5.3 Project potential

Based on discussion and observation, there are several project potentials found. This current product is too big if it has to be used in the narrow space area. If the product has been improvised according to the recommendation, this product can be used in almost all areas, such as in house. People can use this product not just to lift items to the car roof rack. But also can use it as a multi-purpose lifter machine to be used everywhere.

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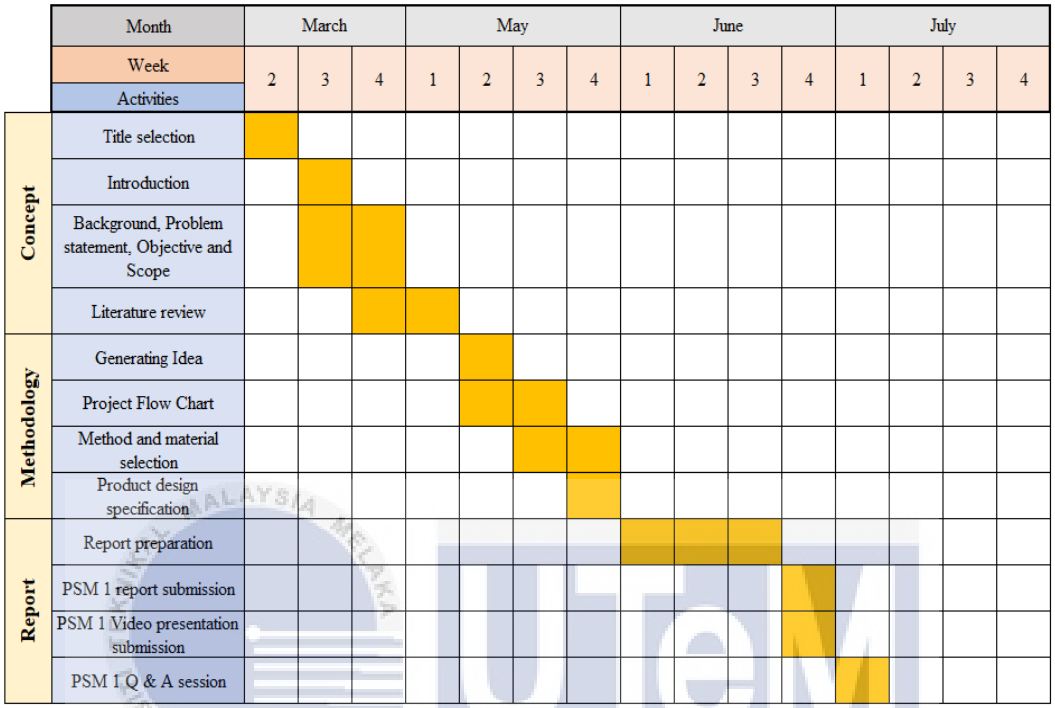
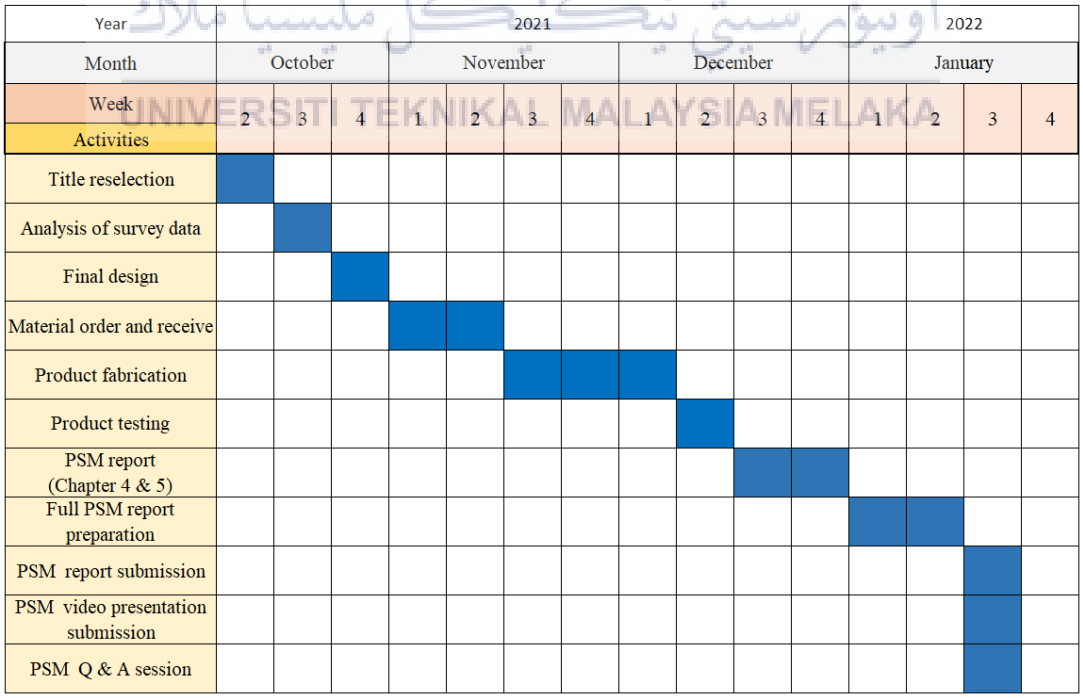
APPENDICES

APPENDIX A Gantt Chart for PSM 1



APPENDIX B Gantt Chart for PSM 2



APPENDIX C Surveys Questions

Survey for develop a manual lifter for car roof compartment

Assalamualaikum, greeting to all respondent,

I am final year student of Bachelor Degree of Mechanical and Manufacturing Engineering Technology(Automotive) from Universiti Teknikal Malaysia Melaka (UTeM).

Currently I'm on my final year project to develop a portable manual lifter. This survey is important to collect data from the respondent and come out with the best decision for the lifter mechanism.

Your respond is highly appreciated. Thank you for your coopertion.

Age

- 18-25
- 26-35
- 36-45
- 46 and above

What is the height of your car

- 1.2m - 1.4m
- 1.5m - 1.7m
- 1.8m - 2.0m

If your car have a roof rack, did you often to store goods on the roof rack?

- yes
- no

Do you have difficulty to store goods on the roof rack

- yes
- no

How many people is needed for you to load the goods on the roof rack?

- 1 person only
- 2 person and more

Do you agree if a portable manual lifter is develop to reduce the energy and force needed to lift and store the goods on the car roof rack

- ○ yes
- ○ no

With mechanism is better for the lifter operation

- ○ Hand cranked winch
- ○ Hydraulic jack
- ○ Electric motor

From the answer above, why did you choose that mechanism? (you may choose more than one answer)

- ☐ Easy to maintenance
- ☐ Low cost
- ☐ Durable
- ☐ Lightweight
- ☐ Size

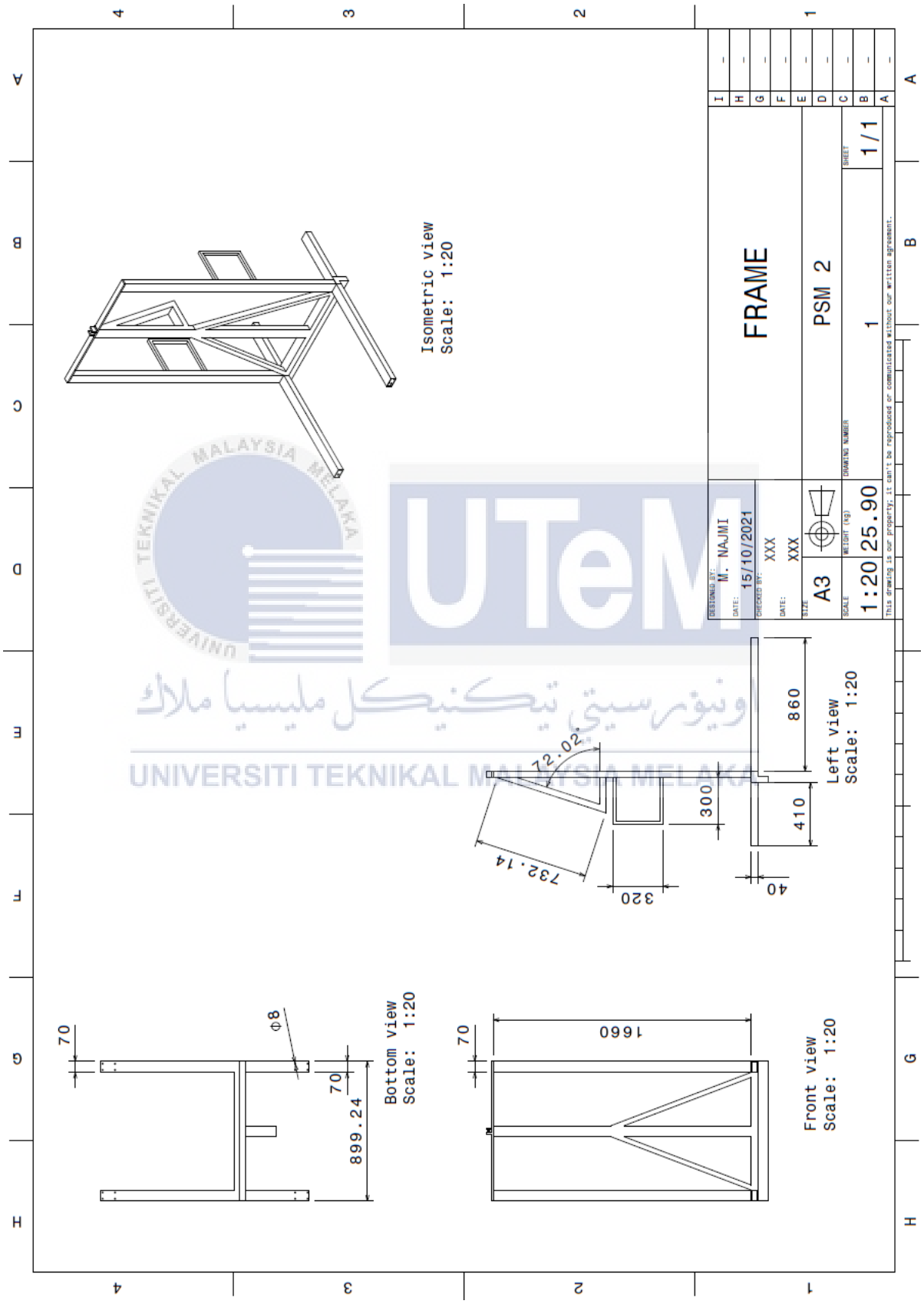
What is the material should be use to fabricate this lifter?

- ○ Hollow stainless steel bar
- ○ Mild steel bar
- ○ Stainless steel bar

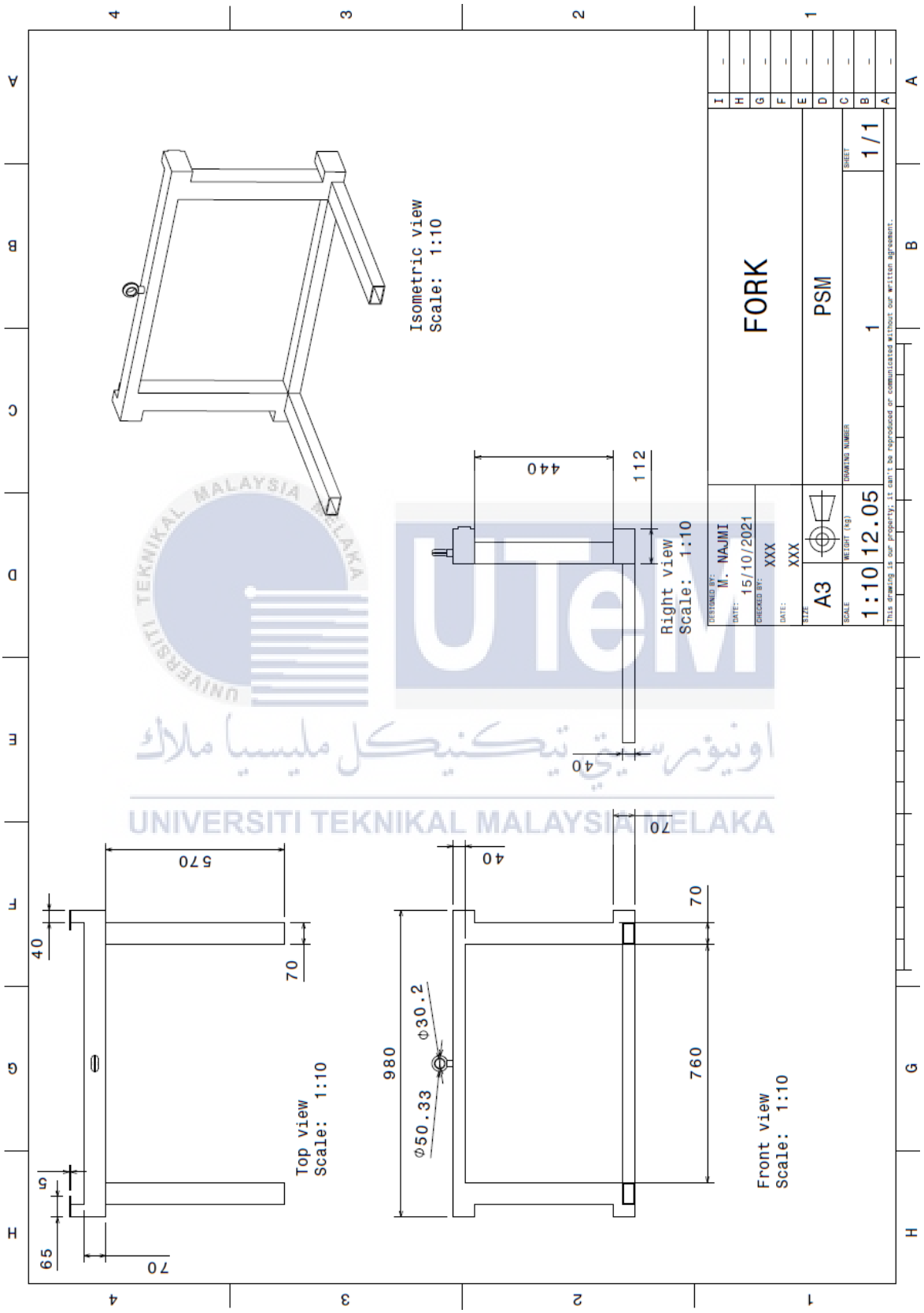
From the answer above, why did you choose that material? (you may choose more than one answer)

- ☐ Low cost
- ☐ Durable
- ☐ Lightweight
- ☐ Replaceable
- ☐ Easy to maintenance
- ☐ Portability

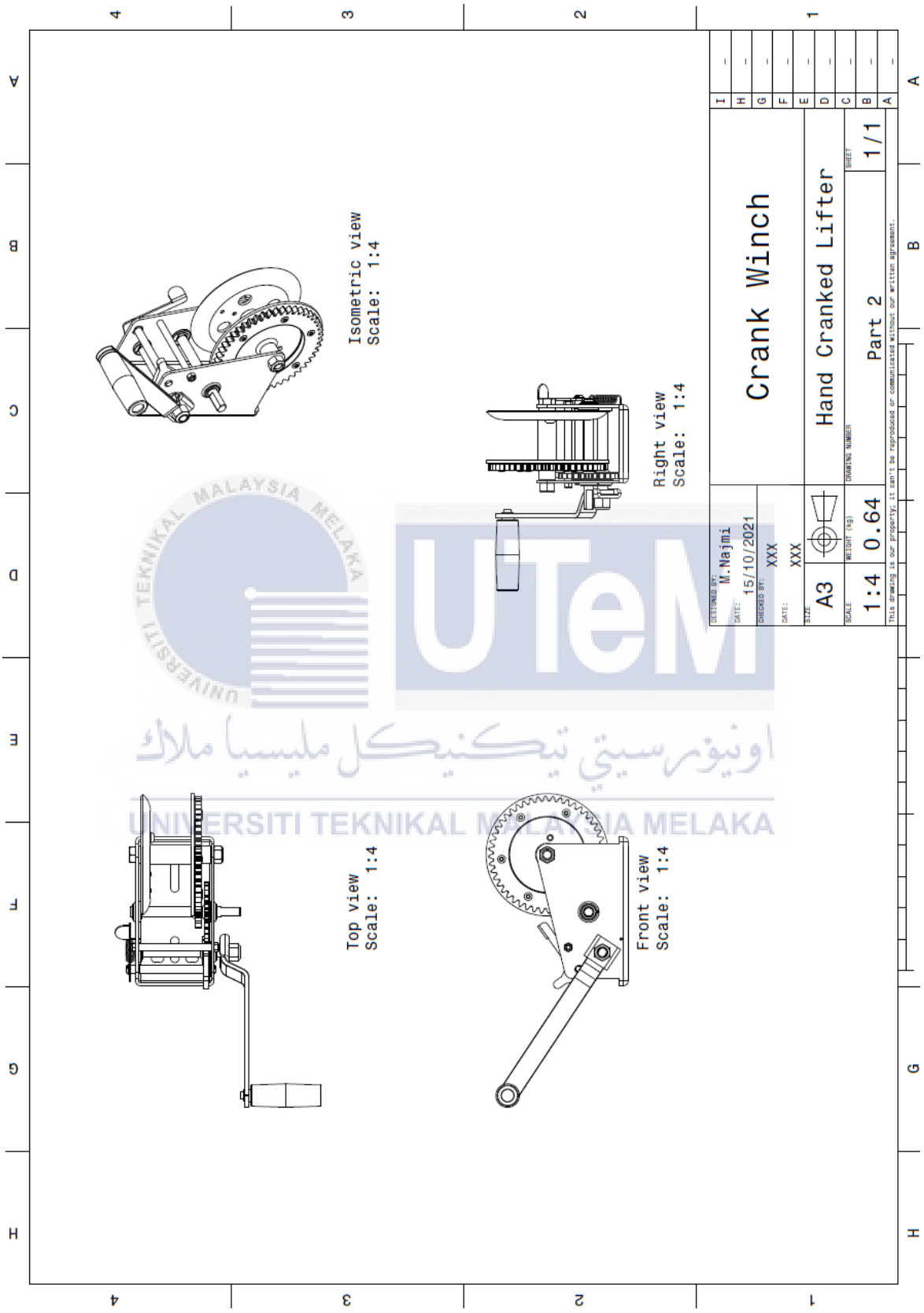
APPENDIX D ISO Drawing of Frame



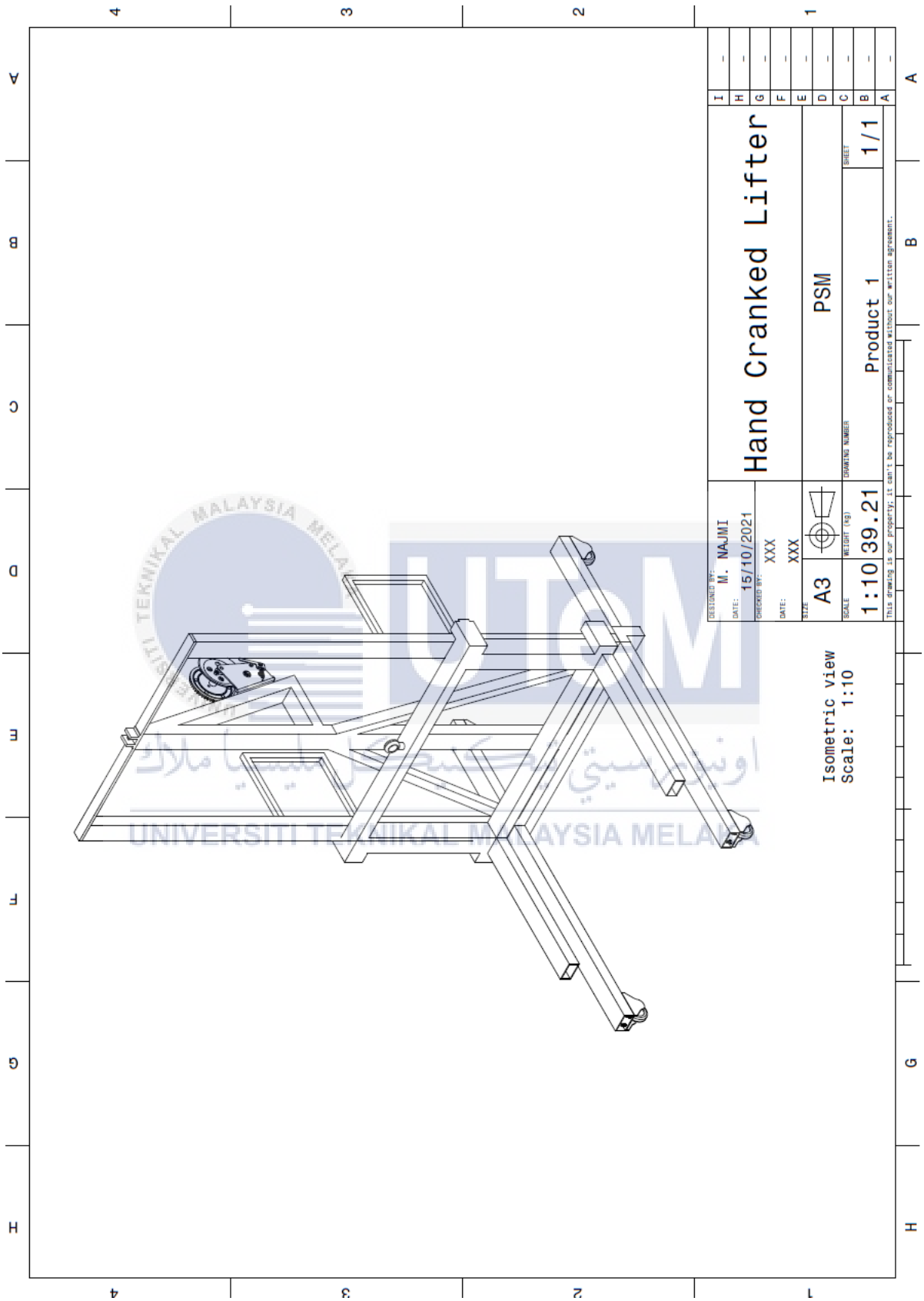
APPENDIX E ISO Drawing of Fork



APPENDIX F ISO Drawing of Crank Winch



APPENDIX G Assemble Drawing



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: **DESIGN AND FABRICATE HAND CRANKED LIFTER FOR CAR ROOF COMPARTMENT**

SESI PENGAJIAN: **2021/22 Semester1**

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DESIGN AND FABRICATE HAND CRANKED LIFTER FOR CAR ROOF COMPARTMENT

by Ir. Mazlan Ahmad Mansor

ENDORSED BY:

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