UNIVERSITI TEKNIKAL MALAYSIA MELAKA

HEAVY LIFTING TROLLEY FOR OIL DRUM

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BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (PROCESS AND TECHNOLOGY) WITH HONOURS)

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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 Manufacturing Engineering Technology (Process and Technology) with Honours

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DECLARATION

I declare that this thesis entitled “Heavy Lifting Trolley For Oil Drum” is the result of my research except as cited in the references. This thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : IZZUDDIN FAHMI BIN HADRAWI

Date : 16 January 2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature : 

Supervisor Name : TS. ABD KHAHAR BIN NORDIN

Date : 17/01/2022

DEDICATION

Dedicated to

My honourable father, Hadrawi Bin Mohd Arip,

My lovely mother, Faridah Binti Dangka,

My supportive brothers, Waqiyuddin Hilmi Bin Hadrawi and Fakhruddin Nazmi Bin Hadrawi,

My sweet sister, Qurratu Aini Syafiqah Binti Hadrawi, Khairunnisa Zulaikha Binti Hadrawi, Siti Asiah Khalisyah Binti Hadrawi, Harlina Shuhadah Binti Hadrawi and Uddaimatunnur Farhana Binti Hadrawi.

Thank you very much.

ABSTRACT

This thesis presents the heavy lifting trolley for oil drum. This heavy lifting trolley for oil drum is a mechanical device used to securely clamp, lift and transport cylindrical modules such as steel drums, drums, plastic drums, and fibre drums. Heavy-duty oil drums are typically filled with lubricants, liquids, or chemicals intended for use as operating supplies or raw materials in industrial applications. Since heavy lifting devices used in industrial manufacturing, the objective of the project is to focus on the problem and the need of the user (worker). The products presented in this thesis will add value to the target group, as it is based on a research of user experience. The design process is based on existing journals, observations, studies, benchmarks, and literature reviews.

ABSTRAK

Tesis ini membentangkan troli angkat berat untuk tong minyak. Troli pengangkat berat untuk tong minyak adalah alat mekanikal yang digunakan untuk mengepam, mengangkat dan mengangkut modul silinder dengan selamat seperti tong keluli, tong dram, tong plastik, dan tong serat. Drum minyak tugas berat biasanya diisi dengan pelincir, cecair, atau bahan kimia yang dimaksudkan untuk digunakan sebagai bekalan operasi atau bahan mentah dalam aplikasi industri. Oleh kerana alat pengangkat berat digunakan dalam pembuatan industri, objektif projek ini adalah untuk menumpukan perhatian pada masalah dan keperluan pengguna (pekerja). Produk yang disajikan dalam tesis ini akan memberi nilai tambah kepada kumpulan sasaran, kerana berdasarkan kajian pengalaman pengguna. Proses reka bentuk adalah berdasarkan jurnal, pemerhatian, kajian, penanda aras, dan tinjauan literatur yang ada.

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LIST OF SYMBOLS AND ABBREVIATIONS

A	-	Area
F	-	Force
GMAW	-	Gas Metal Arc Welding
GTAW	-	Gas Tungsten Arc Welding
MIG	-	Metal Inert Gas
P	-	Pressure
SMAW	-	Shielded Metal Arc Welding
TIG	-	Tungsten inert gas

CHAPTER 1

INTRODUCTION

1.1 Background

A lifting trolley is a transport device that is used to transport heavy loads from one location to another. Hand trolleys are commonly used to convey finished goods or raw materials in most industries. Trolleys are such an extremely helpful material handling device for moving both light and heavy things. These improve productivity in most businesses by helping employees to load, carry, and find things rapidly and efficiently. As a result, operating expenses are reduced, and worker safety is improved. There are various types of trolleys, and the one selected is usually based on the type of material it can transport (Shubham et al., 2018).

There's a various type of trolleys which is drum handler (Figure 1.1) and drum lifter (Figure 1.2) A drum handler and drum lifter have a same function which is used to grab, lift, and carry cylindrical modules such as steel drums and barrels in a safe and efficient way. The drum handler is often used to transport a 55-gallon drum container. However, there are devices that can handle both small and large-capacity drums. Drums and barrels can be lifted, stacked, moved, weighed, poured, and stacked using this equipment. Certain drum handler designs can also be used to carry tires. Heavy-duty metals with a smooth finish are commonly used in manufacturing industries (Harari & Powar, 2021).

Figure 1.1 Drum Handler

Figure 1.2 Drum Lifter

Source Figure 1.1: https://www.denios-us.com/shop/handling-equipment-accessories/drum-handling/lifting-equipment/

Source Figure 1.2: https://www.indiamart.com/proddetail/drum-lifter-trolley-2678672548.html

This device widely used to move physical objects in a variety of industries. Those who sort and stock products in retail businesses restock often use trolleys. While done appropriately, a trolley helps prevent back injuries and other health problems that might occur when lifting and transporting big objects (Amir et al., 2020).

A heavy lifting trolley for oil drums is a mechanical device that grips, lifts, and transports cylindrical modules such as steel drums, containers, plastic drums, and fibre drums. This equipment is used in the chemical and petroleum industries, as well as industries that enable cylindrical modules that need to be stored.

In manufacturing industries, the method of transforming raw materials or components into finished products using machines, human labour, equipment, and chemical refining has always been used for decades. Manufacturers can take advantage of

economies of scale by using efficient production processes to produce more units at a lower cost. Manufacturing is a value-adding practice that allows companies to market manufactured goods at more than the expense of the raw materials they used.

Industrial sectors generate new items by working with goods, materials, or substances. Transformations might be physical, chemical, or mechanical. Manufacturers frequently have plantations, mills, or factories that manufacture consumer products. In the production process, machines and machinery are often used. While certain products can be made by hand, this is not always the case.

1.2 Problem Statement

Heavy duty lifting trolley is a kind of lifting equipment that used for moving drums from one place to another. This new trolley can reduce the consumption of a lot of energy. Most of Industrial oil drum weight can reach until 250 kg when full or more. With oil drum weights potentially being 3 times heavier than human's weight, these containers pose a severe health and safety risk to people who handle them. The industrial activities included physical handling tasks that required the workers to lift and handle big things on a regular basis.

The equipment of industrial, which are the company's items, are examples of the things. Although the company has given equipment such as a forklift to raise large panels, there are still numerous panels that cannot be moved by the equipment. It is due to their sizes and the space provided in the warehouse. For companies that use barrels and drums within their operation, drum handling safety should be an important part of work procedure. Employers must look at the risks of loading and unloading heavy drums/barrels and put sensible health and safety measures in place to avoid the need for hazardous manual handling (Kamat et al., 2017).

1.3 Objective

This project initiated by focusing on few objectives to be achieved which are as listed:

i. To study the concepts of lifting trolley based on real problem and the need of the user
ii. To design a heavy lifting trolley that suitable for industrial work
iii. To produce a heavy lifting trolley that make it easy to transport a heavy load

1.4 Scope

This project focuses on the manufacturing industry that uses oil barrel lifting operation. The design and production are particularly focused on heavy lifting trolleys for oil barrels that prioritize user safety. The concept of the design will be generated, and the best concept will be explained in detail. The software will be run for this project is solid work software to enhance the design of the heavy lifting trolley. Meanwhile, the material and parts have been chosen for the heavy lifting trolley for oil drum which is toe hydraulic jack, wheel and sheet metal and it will be prepared. Ascertain that the prototype developed satisfies the requirements of users and achieves the objectives.

CHAPTER 2

LITERATURE REVIEW

This chapter will cover the process involved in the development of the overall enhancement on heavy lifting trolley in achieving the project objectives. The information collected will become an additional source of project research and development projects to make them more successful. To understand the research related to this project, some literature reviews have been conducted.

2.1 Introduction

The heavy lifting trolley idea is based on how the concept would be developed into an interesting device that is simple, easy to use, and efficient, including being an add-on service for the hydraulic system. It is because the concept was based on technology, it was necessary to obtain user feedback. The concept is built on current items with slightly different design (Amir et al., 2020).

Heavy lifting trolley is used for a variety of tasks such as hauling, tilting, lifting, loading, and unloading. Drum barrels are handled manually in small enterprises or workshops, which takes more time and requires more workers. Manually handling a drum without the use of any equipment is dangerous. The moving or sustaining of a cargo by one or more workers is known as manual handling. It includes that lifting, holding, putting down, pushing, tugging, carrying, or transporting a burden are all activities that fall under this category. A load can be an inanimate object (boxes, tools, etc.). Manual handling is common in practically all workplaces (factories, warehouses, building sites, farms, hospitals, offices etc.). Lifting boxes in a packaging line, managing building materials,

pushing carts, dealing with patients in hospitals, and cleaning are all examples of this (Garghate & Ninawe, 2015).

Figure 2.1: Concept of heavy lifting trolley

Source: https://drc.uc.edu/bitstream/handle/2374.UC/732289/MET2007_Bohland_Christopher.pdf?se%20quence=1

2.2 Function of Heavy lifting trolley handling equipment.

Material handling is the productivity of manufacturing and distribution networks. In every industrial or distribution system, it is a key role. Handling equipment is used to increase production, control expenses, and enhance productivity. Warehouse management can utilize a variety of methods to establish how efficient material-handling equipment is used in any given operation. This category of equipment includes anything that has to do with the transport, storage, control, and protection of materials, goods, and products through the manufacture, distribution, consumption, and disposal processes. It's also known as the mechanical equipment that makes up the entire system. Storage and handling equipment, engineered systems, industrial vehicles, and bulk material handling are the four primary kinds of material handling equipment (Heragu & Ekren, 2015).

2.2.1 Principles of material handling

The principle of material handling is to facilitate the work and prioritize the safety of users. Some injuries such as lower back injuries are a serious health threat to users who use manual handling. In addition, this material handling principle is to control costs such as treatment costs in the event of an accident and minimize time in material handling in today's competitive and global world. The creation of methods that improve and simplify the work process is supported by effective material handling procedures.

2.2.1.1 Types of material handling principles

Table 2.1: Types of material handling equipment

No.	Type of principle	Description
1	Planning principle	All material handling should be the outcome of a good strategy in which the demands, performance targets, and functional.
2	Standardization principle	The material handling standardization principle holds that all procedures, equipment, controls, and software should be standardized within the limits of reaching performance goals.
3	Work principle	Material handling work should be minimized without compromising productivity or the degree of service required by the operation, according to the working principle.
4	Ergonomic principle	To maintain safe and successful operations, human capabilities and limits must be acknowledged and respected in the.

No.	Type of Principle	Description
5	Unit load principle	At each level of the supply chain, unit loads must be appropriately sized and structured to meet the material flow and inventory requirements.
6	Space utilization principle	It is important to organize and clear working areas, optimize density in storage areas without compromising accessibility and flexibility and employ overhead space.
7	System principle	All material movement and storage processes should be integrated to establish a coordinated operational system, according to the system concept.
8	Automation principle	All material handling procedures should be automated or automated wherever possible. This increases operating efficiency, responsiveness, stability, and predictability while reducing operating expenses and potentially dangerous human's labour.
9	environmental Principle	When designing or selecting alternative material handling equipment and systems, the environmental concept of material handling considers that all environmental impacts and energy consumption should be considered.
10	Life cycle cost principle	A detailed economic study should take all material handling systems and the associated systems into considerations throughout the life cycle (Carver, 2013).

2.2.2 Type of material handling

The different devices move materials between the various processing stages. There are several kinds of equipment for material handling (Material Handling), most of which transport materials onto the floor of the workplace using material handling ways. Some material handling is still available – such cranes, hoists and overhead conveyors that use the area above the machinery. The selection of a particular material handling depends on several aspects, including costs, weights, size, and load volume; availability of space and working station types (Heragu et al., 2001).

2.2.2.1 Warehouse material handling devices

Materials must be stored and removed and transferred between the pick/depose (P/D) stations and the storage sites of the materials for the primary function of the material handling equipment. They have many benefits, including low cost of work and energy, high land use and space utilization, high dependability and precision, and high flow rates. The material characteristics that affect the processing are as follows: size (width, depth, height); weight (weight per item or per unit volume); shape (round, square, long, rectangular, irregular) (Heragu et al., 2001) (Stephens, 2019).

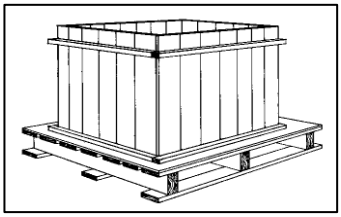
	Physical State		
Material Category	Solid	Liquid	Gas
Individual units	Part, subassembly	—	—
Containerized items	Carton, bag, tote, box, pallet, bin	Barrel	Cylinder
Bulk materials	Sand, cement, coal, granular products	Liquid chemicals, solvents, gasoline	Oxygen, nitrogen, carbon dioxide

Figure 2.2: Material Categories

Source: (Stephens, 2019)

2.2.3 Major equipment categories

Table 2.2: Major equipment categories

No.	Category	Description	Example
1	Transport equipment	Equipment used to transport material from place to place such as workplace, loading dock, warehouse area. No equipment also can carry material manually.	Conveyors, cranes and industrial vehicles are the major categories of transport equipment. 
2	Positioning equipment	Equipment that is used for handling materials in a specific location. Positioning devices are commonly used in a workplace, unlike transport equipment. No equipment can also hand position the material	For putting and/or placing items in the right place to be handled, processed, transported, or stored thereafter 
3	Unit load formation equipment	Equipment used to limit the materials in order to keep them integrated during transit and storage when a single load is handled. If materials are independent, they can form into a loading unit with no equipment.	A single piece or interlocking elements), 

2.3 Material and equipment selections

The process of selecting the material best suited to meet the requirements of a certain application is known as material selection. Mechanical qualities, for example, are just one of several aspects that go into defining the criteria. These must be taken into account throughout the material selection process. Material selection requires a wide range of considerations. As a result, making a suitable choice needs an equally wide range of information.

2.3.1 Wheel

Figure 2.3: Wheel of heavy lifting trolley (Castor wheel)

Source: http://caster-custom.com/5-17-cast-iron-wheel-caster.html

A wheel is a circular component that spins on a shaft bearing. The wheel allows us to move items or load across the ground without dragging them. The payload is transported in the same direction as the wheels are moving in one sort of wheel. Wheel can reduce friction. The wheels dig in and rotate, twisting around robust rods, rather than just rolling over the ground. The wheel is one of the most important components of the wheel and shaft, which is a simple machine. Wheels and axles allow heavy things to be moved more easily, allowing for easier mobility or transit while sustaining a load or doing labour in machines (Shubham et al., 2018).

2.3.2 Drum lifting clamp

Figure 2.4: Types of lifting clamp kit

Source: https://www.pinterest.co.uk/hsil/drum-cylinder-storage-handling/

Oil drum lifting clamp kit is used for attachment to lift, manoeuvre, turn and dispense steel, attach top and bottom edge of the oil drum and plastic drum. When lifting an oil drum, safety needs to be emphasized by using clamp for clamping around the circumference of the drum usually using a pull action; some carry the drum vertically and others lift the drum horizontally. Several other types of lifting clamps for controlled lifting, rotating, and emptying, lift clamps used for lift, and then put drum from one place to another.

2.3.3 Square steel tube

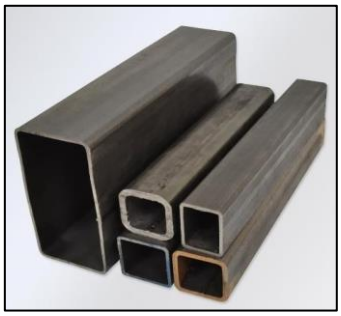


Figure 2.5: Square steel tube

Source: https://www.alro.com/divsteel/metals_gridpt.aspx?gp=0109

Square tube is a structural grade tubing that is available in many types of tube by depending on the size and thickness of the walls. All structural applications, general fabrication, manufacture, and repairs are suited for any grade. Square tube is used in a variety of applications, including industrial maintenance, agricultural tools, transportation equipment, truck beds, trailers, and frames. When compared to angles or channels, its box shape design provides for far better toughness and with the proper tools and experience, this steel shape is simple to weld, cut, form, and machine (Wardenier, 2001).

2.3.3.1 Types of square tube

a. Aluminium tube

Aluminium tubing refers to a pure metal or aluminium alloy that is extruded and treated into a hollow metal tubular material throughout its longitudinal length. Automobiles, ships, aircraft, aerospace, electrical appliances, agricultural, electronics, home furnishings, and other sectors utilize it extensively. Aluminium Pipes or tubes are used in a variety of industries applications, including consumer goods, recreational goods, machine components, automotive, and manufacturing. Aluminium is valued by suppliers for its strength, even though it is just one percent of the weight of steel.

Aluminium tube has a higher capacity per weight than steel tubing due to its low weight. Many goods, particularly those that require a degree of movement, such as wheelchairs and outdoor furniture, benefit from the adoption of a lighter tubing material. For the tubing and pipe the most common aluminium alloys are 2024, 3003, 5052, 6061, 7075. Hydraulic systems, fuel lines, bracing, and frames are common uses for aluminium tube because of its low weight and strength. Aluminium may be found in a variety of alloys (Sapa, 2013).

b. Stainless steel tube

Stainless Steel Square Tube is measured by taking the outer walls (which are the same size) and then the wall thickness. Because of its outstanding weldability and corrosion resistance, stainless steel square tubing is widely used in the construction and engineering industries, and you'll see it in products like signposts and railings. Despite its benefits, stainless steel's high material cost has traditionally kept it from being widely used in structures. Stainless steel has a material cost that is roughly four times that of mild steel, according to reports (Gunawardena & Aslani, 2019).

c. Hot Rolled Steel Tube

Hot Rolled Steel that has been roll-pressed at very high temperatures over 1,700 degrees Fahrenheit, above the recrystallization temperature for most steels, is known as hot rolled steel. This makes the steel easier to form, making it easier to machine the product. Hot rolling has a higher temperature than cold rolling, has a lower deformation resistance, and can show a large amount of deformation. It is Because the stainless steels plate's width to thickness ratio is small, the dimensional accuracy requirements are low, and it's difficult to produce plate shape problems, due mainly to overhang control (Steel, 2010).

d. Cold Rolled Steel Tube

The process is called as "cold rolling," and it involves passing steel stock through a series of rollers to flatten it down and shape it into steel tube. The steel, on the other hand, is treated at room temperature. Cold rolling produces a significant volume of steel tube. Since the incoming steel can't reach temperatures where the underlying crystalline structure is dramatically changed, it's less exposed to the problems affecting less malleable hot steel.

Cold rolled steel is ideal that provides a high level of precision. For moderate draw applications, the metal is easily formable. As a result, it's ideal for use in a variety of household appliances and metal furniture. This metal is commonly used in filing cabinets and school lockers. Plus, cold rolled steel is a common building material for steel sheds, industrial buildings, and garages.

2.3.4 Vertical hydraulic transmission jack (Toe lift hydraulic jacks)

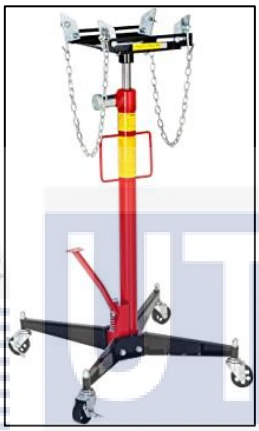


Figure 2.6: Toe lift hydraulic jacks

Source: https://www.toupour.com/la-vidange-le-moteur/334-verin-de-fosse-500-kg-qualite-premium-3700737200526.html

A hydraulic jack is a mechanical device that is used as a lifting device to lift heavy objects or apply large forces even if it is light in weight and it is portable (*Design and Modification in the Existing Model of Trolley Jack 20261,* 2014). Hydraulic Jack also can lift machinery and other loads with a tight space between the ground and the bottom of the load. Hydraulic mechanical jack is the use of hydraulic power system mechanism to lift heavy equipment (Asonye & Nnamani, 2015). The most common forms are car jacks, floor jacks, or garage jacks, which are used to lift vehicles or trucks for maintenance. Hydraulic jacks are generally rated according to their maximum lifting capacity, which can include: 1.5 tons, 3 tons, 20 tons, or 30 tons.

The hydraulic jack uses an incompressible fluid, which the pump plunger presses into the cylinder. Hydraulic oil is used due to its self-lubrication and stability. When the plunger is pulled, it sucks the oil from the oil tank into the pump cavity through the suction check valve. As the plunger advances, it pushes oil into the cylinder through the discharge check valve. The suction valve ball is in the chamber and opens each time the plunger is pulled. The drain valve ball is outside the cavity and opens when oil enters the cylinder. At this time, the suction ball in the cavity is forcibly closed, and oil pressure accumulates in the cylinder (Sivaraj et al., 2019).

2.3.4.1 Principle of hydraulic jack

Hydraulic jacks rely on this basic principle to lift heavy objects: They use pump pistons to move oil through two cylinders. First draw out the plunger, open the internal suction valve ball, and suck the oil into the pump cavity. When the plunger is pushed forward, oil enters the cylinder cavity through the external discharge check valve, and the suction valve is closed, causing the pressure in the cylinder to rise (Sainath, 2014a).

This principle states that the pressure in a closed container is the same at all points. Pressure is described mathematically by dividing force by area. So, if you connect two cylinders, a small cylinder, and a large cylinder, and then apply a small force to the small cylinder, it will cause a certain pressure. According to Pascal's principle, the pressure is the same in the larger cylinder, but since the larger cylinder has a larger area, the force exerted by the second cylinder will be greater. The pressure in the second cylinder remains constant, but the area increases, resulting in a larger force. The greater the difference in the cylinders, the greater the capacity of the cylinders (Abuzaid et al., 2013). The principle in this hydraulic system concept is Pascal's law ($F = P \times A$).

2.3.4.2 Advantage of hydraulic system

Hydraulic systems are widely used because they can effectively transmit energy or power to remote areas with fewer moving parts and high efficiency. The hydraulic system is characterized by simplicity, flexibility, and agility. These are some of the advantages of hydraulic systems:

a. It is easy to repair the main machines in the hydraulic system, such as hydraulic gates, directional control valves, gear pumps and motors.
b. It is easy to find leaks in the hydraulic system.
c. Hydraulic systems are simpler and easier to maintain because they use fewer moving parts
d. The hydraulic system is easy to control and accurate. Because the system operator can use simple levers and buttons to easily start, stop, accelerate, and decelerate the system
e. Minimize unwanted noise

2.3.4.3 Disadvantage of hydraulic system

The hydraulic system also has some disadvantages. These are some of the disadvantages of hydraulic systems:

a. Hydraulic oil is the main requirement of any hydraulic system. The leakage of these fluids will create environmental and safety problems.
b. Contaminants in hydraulic oil can damage system performance and productivity. Therefore, it needs continuous filtration
c. Choosing the wrong hydraulic fluid for your system can damage components.
d. Need proper maintenance.

2.3.4.4 Types of hydraulic jack

a. Bottle jacks

Figure 2.7: Bottle jack

Source: https://www.homedepot.com/p/Big-Red-2-Ton-Bottle-Jack-T90203/100594344

Bottle jacks provide an easy way for people to lift vehicles for inspections or road maintenance. The design of hydraulic bottle jacks is like that of milk bottles, hence the name of bottle jacks; today, its size and lifting capacity range from one hundred pounds to several tons. The bottle jack has a vertical axis that supports a platform (called a support platform) that directly supports the weight of the object when it is lifted. Although they are most often used in the automotive industry (1.5 to 5 tons jacks are generally used to lift cars in the capacity range), sockets also have other uses. In the medical industry, they can be used in hydraulic stretchers and patient lifts. In industrial applications, they can be used as pipe bender in pipes, cable cutters for electrical projects and material lifts in warehouses. Its ability to lift heavy objects plays an important role in the maintenance of large agricultural machinery and many construction operations. The bottle jack can be fixed to the frame, mounted to a beam, or simply used as a standalone type to allow repositioning as needed (Sainath, 2014b).

b. Floor jacks

Figure 2.8: Floor jack

Source: https://www.tractorsupply.com/tsc/product/big-red-3-ton-suv-floor-jack

Unlike the axis of the vertically operated bottle jack, the axis of the floor jack is horizontal-the axis pushes the crank connected to the lifting platform, and then the lifting platform is raised vertically. Floor jacks usually provide a larger vertical lifting range than bottle jacks, plus available in two sizes. The original cats were about four feet long, one foot wide, and weighed about 200 pounds; they could lift 4 to 10 tons. Later, a more compact model was created, which was about one meter long and could lift 11/2 tons. Although also manufactures "mini jacks", they are not recognized as standard type floor jacks. Generally, one of the first two sizes should be used.

2.3.5 Ball bearing

A ball bearing is a bearing that uses balls to maintain the space between the bearing races. The purpose of ball bearings is to reduce rotational friction and support radial and axial loads. To do this, it uses at least two raceways to accommodate the balls and transfer the load through the balls. In most applications, one track is fixed, and the other track is connected to a rotating component (for example, a hub or shaft). When one of the raceways rotates, it also causes the balls to rotate. Because the balls are rolling, their coefficient of friction is much lower than when the two planes slide against each other.

There are a variety of bearing types to choose from which is single row radial ball bearings, angular contact bearings, cylindrical roller bearings, tapered roller bearings, needle roller bearings, spherical roller bearings, double row ball bearings and self-aligning. In addition, there are a wide range of variants in each category (Bakolas et al., 2021).

2.3.5.1 Angular contact bearings

This type of ball bearing is widely used in precision applications such as machine tool spindles and turntables, where the static stiffness is also important. They provide good but not excellent running accuracy at a competitive price. In addition to good running precision, ball bearings are different from other types of bearings, and there are many other attributes that can be used for ultra-precision applications. They have low friction, which minimizes thermal deformation and allows high rotational speeds.

Angular contact bearings can have more balls, so they have higher load capacity and static stiffness than single row radial ball bearings, but they can only bear axial and radial loads in one direction. The axial load capacity of angular contact ball bearings increases as the contact angle increases. The contact angle is defined as the angle between the line of the contact point between the ball and the raceway in the radial plane and the line perpendicular to the axis of the bearing. The combined load is transferred from one raceway to another along this line (Bakolas et al., 2021).

Figure 2.9: Angular contact bearing

Source: https://www.skf.com/my/products/rolling-bearings/ball-bearings/angular-contact-ball-bearings

2.3.6 Pulley

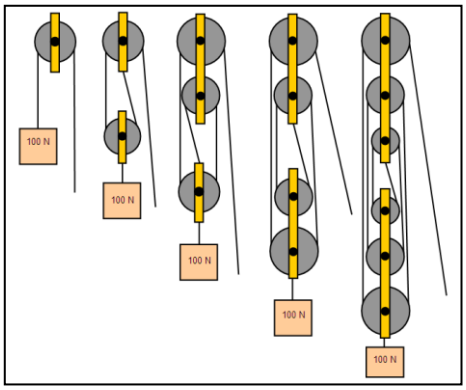


Figure 2.10: Types of Pulley

Source: https://www.schoolphysics.co.uk/age11-14/Mechanics/Forces%20in%20motion/text/Pulleys_/index.html

Pulley is a mechanical device that allow to easily lift heavy things. Pulleys are used to transport energy and motion, either separately or in combination. Pulleys are made up of a wheel or gear that revolves on an axle, which is a rod that runs through the wheel or gear's centre, and a rope, cable, or chain. Fixed, moveable, and compound pulleys are the three primary types of pulleys that available that made from manufacturing industry. To provide a mechanical advantage, one or more independently moving pulleys can be employed, especially when lifting weights. Blocks and tackles are shafts with pulleys that may link them to frames or blocks, as well as pulleys, blocks, and a combination of rope or other flexible material (Chowdhury & Yedavalli, 2016).

2.3.6.1 Types of Pulleys

a. Fixed pulley

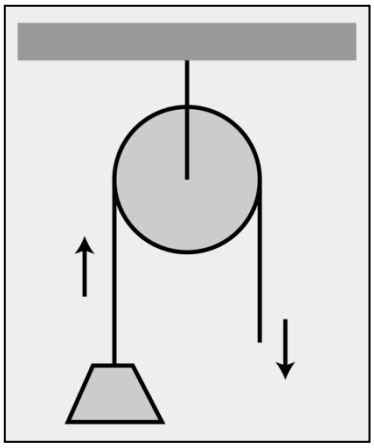


Figure 2.11: Fixed pulley

Source: https://www.ck12.org/c/physics/pulley/lesson/Pulley-MS-PS/

Fixed pulley is the one in which the drum is fixed in one place. While the force necessary to lift or move an object is the same as if it were lifted by hand, the fixed pulley allows you to adjust the direction in which the force is applied. The pulley is called fixed because it remains fixed when the cable or rope moves through it, connected to something like a wall or ceiling. Because the pulley is permanent, the force applied to the side you're pulling will be the same as the force applied to the opposing side.

When shafts are too far apart for a gear drive to be functional, flexible connector like as belts, ropes, or chains are used to transmit motion and power. They're also employed as hoists and conveyors. The Spanish Burton (Figure 2.12) (a) and Weston differential pulley block (Figure 2.12) (b) is an example that have been used for ages. As for mention, Parallel motion is typically achieved by using cables, rope and chain with pulleys(Hong & Cipra, 2003).

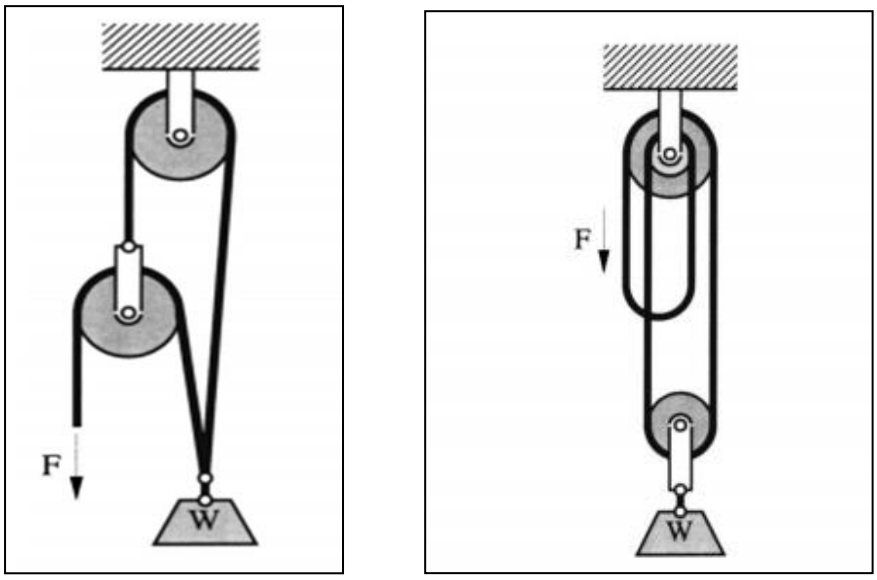


Figure 2.12(a) & Figure 2.12(b): Example that have been used for ages

(Source: (Hong & Cipra, 2003)

b. Movable pulley

A moveable pulley is one in which the drum moves as the load moves. There is no change in the force direction that must be applied, but the weight will "feel" lighter than it is. As for example, if you are trying to haul a heavy corn bale up into the barn, a movable pulley will make the load feel much lighter, even though pulling in the same direction.

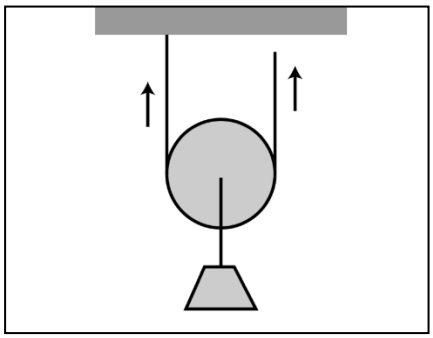


Figure 2.13: Movable pulley

Source: https://www.toppr.com/ask/content/story/amp/way-to-change-the-direction-of-effort-using-a-movable-pulley-82501/

c. Compound pulley

Fixed and movable pulleys are both in compound pulley systems, making the weight feel lighter and allowing you to change the direction of the force. These systems can handle extremely heavy loads, even though additional motion is sometimes required to do the job properly. In the simplest terms, the number of pulleys that it's used in a compound pulley system can reduces the weight reduction of a given load. With this in view, a system that lifts an object using four pulleys will seem like the user is lifting one-fourth of the item's weight. Therefore, crane may function with a smaller cable and pulley, reducing space on the machine and allowing the crane to be physically smaller and lighter while yet being operational and capable of lifting bigger loads (Kong & Parker, 2005).

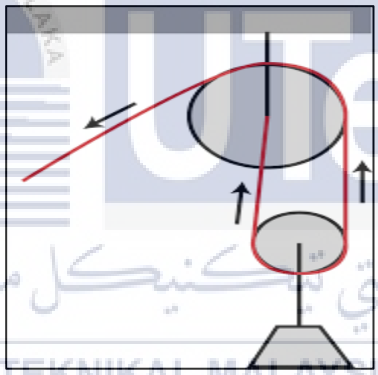


Figure 2.14: Compound pulley

Source: https://www.ck12.org/physics/pulley/lesson/Pulley-MS-PS/

2.3.7 Chain drive

The chain drive is one of the oldest machine components, yet it is still a popular method of power transmission. This is mostly because chain drives have a wide range of applications and can be found in many machinery types. The combination of chain drive and pulley system works by having a rope or belt with parts on either end passed over them to change the direction of rotating power. There are many advantages to using the chain drive instead of pulley systems (Pereira et al., 2010).

The first advantage is that it's several times more efficient than pulley drives because it only has one moving surface. In a complete transmission, a chain drive is designed to transport power between different parts. Because the chain drive's dynamic problems are caused by its surroundings, it's necessary to include them in a dynamic model. A chain links the driving and driven sprockets in the chain drive itself. These have a shaft that connects them to the driving and driven mechanisms. There is some inertia in these processes, as well as some differences in driving and braking torque. Because the surrounding systems are unknown, they are believed to be made up of one inertia and one stiffness on both sides of the chain drive, separated from one another (Troedsson & Vedmar, 2001).

2.3.7.1 Application of chain drive

Chain drive is a method of moving mechanical energy from one place to another. It is often used to transmit power to the wheels of a vehicle, especially on bicycles and motorcycles. In addition to automobiles, it is also found in many types of machinery. Power is usually transmitted through a roller chain, also known as a drive chain or drive chain, through chain gears, with the teeth of the gears meshing with the holes in the links. As the gear turns, the chain is pulled, providing mechanical force to the system.

A roller chain drive is well-balance between one chain wraps around two or more sprockets in a standard roller-chain drive as shown in Figure 2.15(a). The roller chain is made up of bearing pins and bushes that connect alternating inner and outer links in pivots. The mass of the chain is packed at the roller locations. The connections are described by springs and dampers with constant stiffness characteristics. The clearances between the pin and the bushing are neglected as well as the rotational inertia of the rollers around their centre of gravity. The actual links are shown in Figure 2.15(b) with alternating inner and

outer connections. Bearing pins and bushes connect the inner and outer links in pivots (Pedersen, 2005).

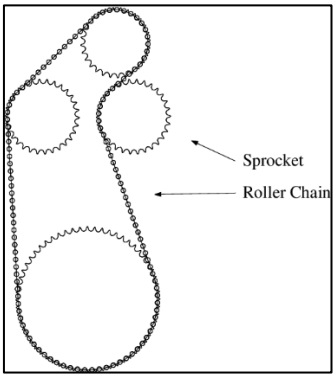


Figure 2.15(a): Sprocket and Roller chain

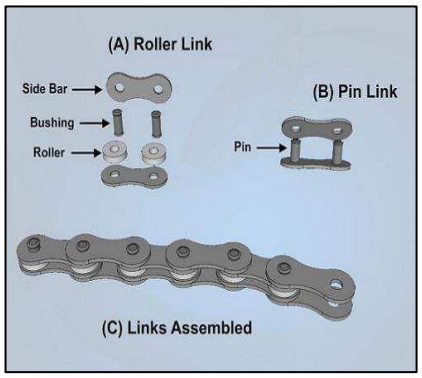


Figure 2.15(b): Real Roller link

(Pedersen, 2005)

2.4 Manufacturing process

Manufacturing is the process of transforming raw materials into finished products using labour, machinery, equipment, and biological or chemical formulations. Manufacturing can refer to the large-scale conversion of raw materials into finished products or the development of more complex objects by supplying basic products to manufacturers to build vehicles, airplanes, and household appliances. The manufacturing process can be described as the transformation of raw materials into final goods through manufacturing engineering. Product design and material selection are the first steps in this process. To produce the completed product, the materials are transformed through various manufacturing processes.

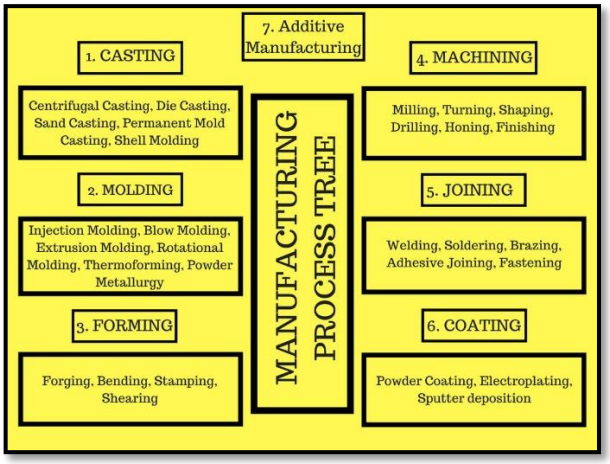


Figure 2.16: Types of manufacturing process

Source: https://www.linkedin.com/pulse/different-types-manufacturing-processes-all-one-guide-sayeed-afzal

2.5 Joining operation (Welding)

The thickness of the work pieces has an impact on joint preparation. An edge or flange-joint can be used to attach thin sheets. A lap or fillet joint can be used in several cases. Without any joint preparation, a sheet with a thickness more than 4.5 mm can be welded using a butt junction. There are many types of joints widely employed in welding are shown in Figure 2.17.

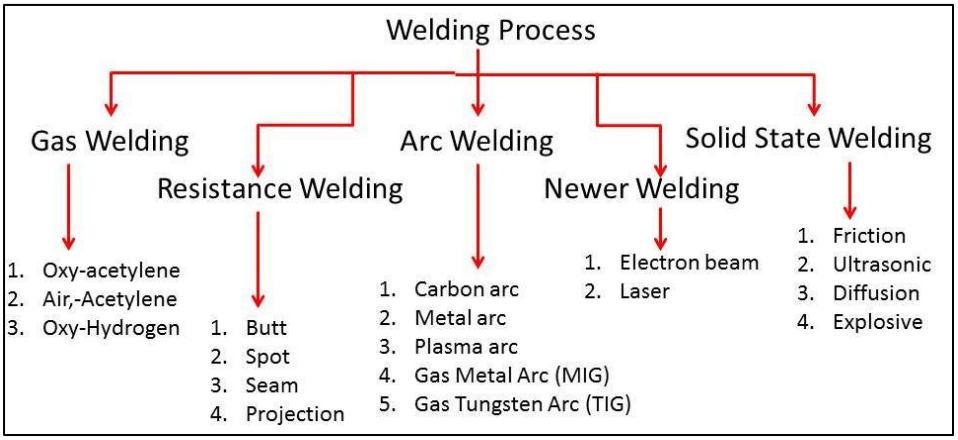


Figure 2.17: Types of welding

Source: https://www.rocheindustry.com/types-of-welding/

2.5.1 Types of joining (Welding)

Joining is a method of putting together individual parts to make a bigger, more complicated component or assembly. At the joints, the component's individual pieces meet. Joining is a general term that refers to a variety of methods that are used to join two or more parts. Joints are used to transfer or distribute forces produced during operation from one part of the assembly to the other part.

2.5.1.1 MIG - Gas Metal Arc Welding (GMAW)

MIG welding is an arc welding process that involves passing a solid wire electrode continuously through a welding gun and into a welding puddle to join two base materials together. The welding gun also creates a shielding gas that protects the weld pool from contamination. Usually used for large and thick materials. It uses a consumable conductor that serves as the electrode and filler material. It is much faster than TIG welding, resulting in shorter lead times and lower production costs. It's also easier to learn and create welds without much cleaning or polishing (Correia et al., 2004).

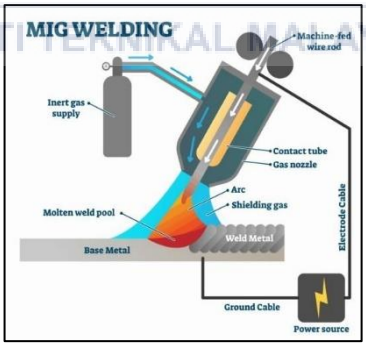


Figure 2.18: MIG welding

Source: https://www.technoxmachine.com/blog/mig-vs-tig-welding/

2.5.1.2 TIG - Gas Tungsten Arc Welding (GTAW)

TIG-Gas Tungsten Arc Welding (GTAW) is a non-consumable tungsten electrode arc welding method that generates a weld. The procedure was a highly appealing choice for gas and manual metal arc welding since it used an inert gas shield instead of a slag to protect the weld pool. TIG assisted in the acceptance of aluminium as a material for high-quality welding and structural applications. Compared to MIG welding, it is a lot slower which means longer lead times and higher production costs. Welders also require specialized training to guarantee that they attain the required precision and accuracy. However, provide more control during the welding process and results in strong, precise and visually beautiful welds (Modenesi et al., 2000).

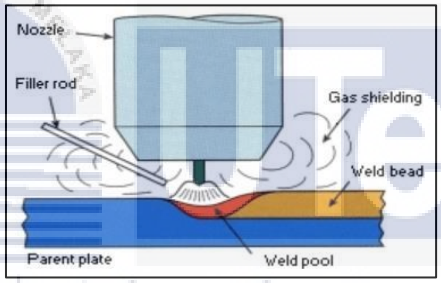


Figure 2.19: TIG welding

Source: https://www.twi-global.com/technical-knowledge/job-knowledge/tungsten-inert-gas-tig-or-gta-welding-006

2.5.1.3 STICK - Shielded Metal Arc Welding (SMAW)

It makes use of electrode rods, which are formed of a wire core and an external coating made up of chemicals, minerals, and iron powder. They come in a variety of core sizes, each of which is designed for a specific current range. Welding is done by creating an arc between the electrode and the workpiece, with the arc's heat melting the electrode coating and forming a protective slag. Both the core electrode wire and the iron powder in the coating generate the weld metal. After welding, the slag layer on top of the joint must

be removed. The required equipment is simple, as shown in Figure 2.18 is implying that the procedure is easy to perform.

SMAW is suitable for a wide range of metal kinds and thicknesses. It is frequently utilized in heavy-duty applications involving industrial iron and steel such as carbon steel and cast iron as well as low- and high-alloy steels and nickel alloys. Construction, pipelines, shipbuilding, underwater welding, and farm machinery production are all industries obviously use SMAW.

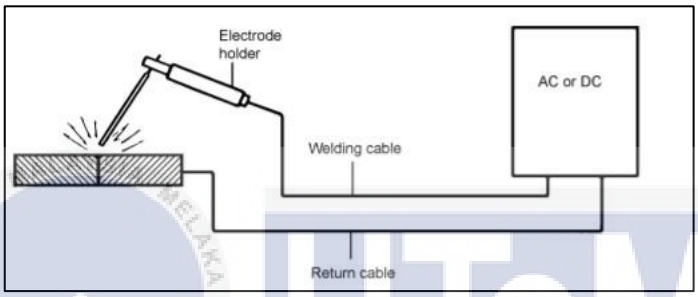


Figure 2.20: Schematic diagram of SMAW (Weman, 2012)

2.5.1.4 Flux-cored – Flux-cored Arc Welding (FCAW)

Flux-cored arc welding (FCAW) is a more economical alternative to shielded metal-arc welding (SMAW) since it is a continuous-wire method. It is possible to achieve good, effective deposition rates due to the increased effective duty cycle. Mechanization is also a good fit for the process. Recently developed self-shielded and gas-shielded consumables with all-position capability have been evaluated and welding procedures for both vertical downhill and vertical uphill welding of large-diameter, cross-country pipelines and compression and metering facilities have been developed and qualified. This is supported by the fact that the procedure can be carried out outside, even in windy conditions. Flux-cored arc welding is commonly used for surfacing and hard-facing because it can be utilized on a variety of alloys, plain carbon, stainless and duplex steels (Mohamat et al., 2012).

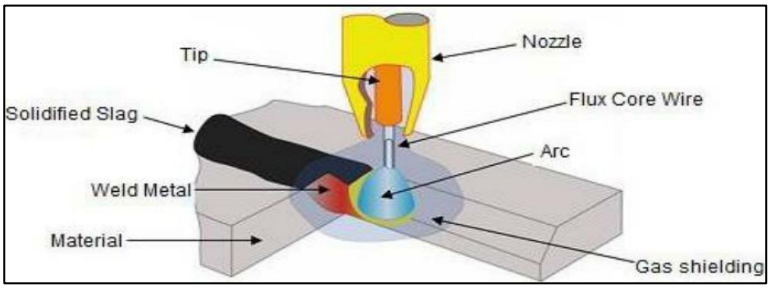


Figure 2.21: Schematic flux cored arc welding process

Source: https://www.researchgate.net/figure/Schematic-flux-cored-arc-welding-process_fig2_269399548

2.6 Material used in joining operation

Mild steel is a form of carbon steel. All steel contains the element carbon. When carbon is the dominant alloying element, the alloy is referred to as carbon steel. Mild steel is often known as "low-carbon" steel. Other carbon steels exist each with a different carbon concentration. Which is better is determined on the steel's intended application. Mild steel is not an alloy steel. Thus, it doesn't have a lot of other elements in it besides iron. It might not find a lot of chromium, molybdenum, or other alloying elements in mild steel. Along with its low carbon and alloying element content, it has several characteristics that set it apart from higher carbon and alloy steels.

Mild steel is more ductile, machinable and weldable than high carbon and other steels because it contains less carbon. It is almost impossible to harden and strengthen through heating and quenching. Due to its low carbon content, it contains relatively little carbon and other alloying elements to prevent dislocations in its crystal structure, resulting in lower tensile strength than high carbon and alloy steels. Mild steel is magnetic due to its high iron and ferrite content. It is affordability, weldability and machinability are what make it such a popular steel choice among customers. Plus, it is used in a variety of metal items such as structural, workshop, home furniture and structural steel.

Mild steel is a ferrous metal that is composed of iron and carbon. It is a low-cost material with qualities that are appropriate for most common engineering applications. Because of its high fibre content, low carbon mild steel possesses strong magnetic characteristics and is hence classified as 'ferromagnetic.' Mild steel is still an essential engineering material that is widely used in the building, chemical, power generation, automotive, and electrochemical sectors due to its availability and low manufacturing cost. Above all, mild steel has distinct and amazing mechanical features such as high strength, toughness, ductility, formability, and weldability, which confirms its suitability as a superior building material when compared to other materials (el Kacimi et al., 2020).

CHAPTER 3

METHODOLOGY

3.1 Introduction

The purpose of “Heavy Lifting Trolley for Oil Drum” is to take care of grabbing, lifting, and moving the drums from start to end. Once it got fastened on the grabbing device, you'll easily transport the drum to its destined location. The drum lifter thereby functions as a drum trolley, lift drum, and drum turner at the same time. This chapter will clarify on the methodology of this project which is done during this whole project run. The planning process is important to make the project run smoothly and finish on time that has given. This chapter explain about in detail the methodology that has been adopted in this project. This chapter also contains the flow chart of the project, material and equipment, type of welding that have been used, production process and drawing explanation that been used by using SolidWork software.

3.2 Process planning of the project

Process planning is a preparation step before manufacturing, which determines the sequence of operations or processes needed to produce a part of an assembly. This step is more important that what must be done before starting a project. The project planning consists of planning the procedure or steps for the project, define what must do, arrange the method needed, choose what software is acceptable to use, and estimate the time for each step to be done. Flow chart and Gantt chart are made to point out the entire process more clearly.

3.2.1 Flow chart

This process flow chart shows the process of making the whole project with research step and production step until finish. Figure 3.1, it shows the first step which is gaining information (research study) about the project by doing research that been collected from sources such as journal, internet, article, and other sources might involve. The target for improvement has been defined and generated by analysing the other existing product through following the objective of the project. After research study about my project, designing a concept is to know whether the design is suitable to be adopted or not.

Material selection is a step in the process of designing any physical object. It is because the appropriate material influences the strengths of the product. Strength is very important to be used over a long period of time. Detail drawing where includes all dimensions and assembly part will be generated. Manufacturing process or production process will be conducted according to the drawing and plan that been made in order to make sure the process made correctly. Heavy lifting trolley fabricating or manufacturing process will be conduct after the planning. Lastly, the product will be ready according to the plan that has been made.

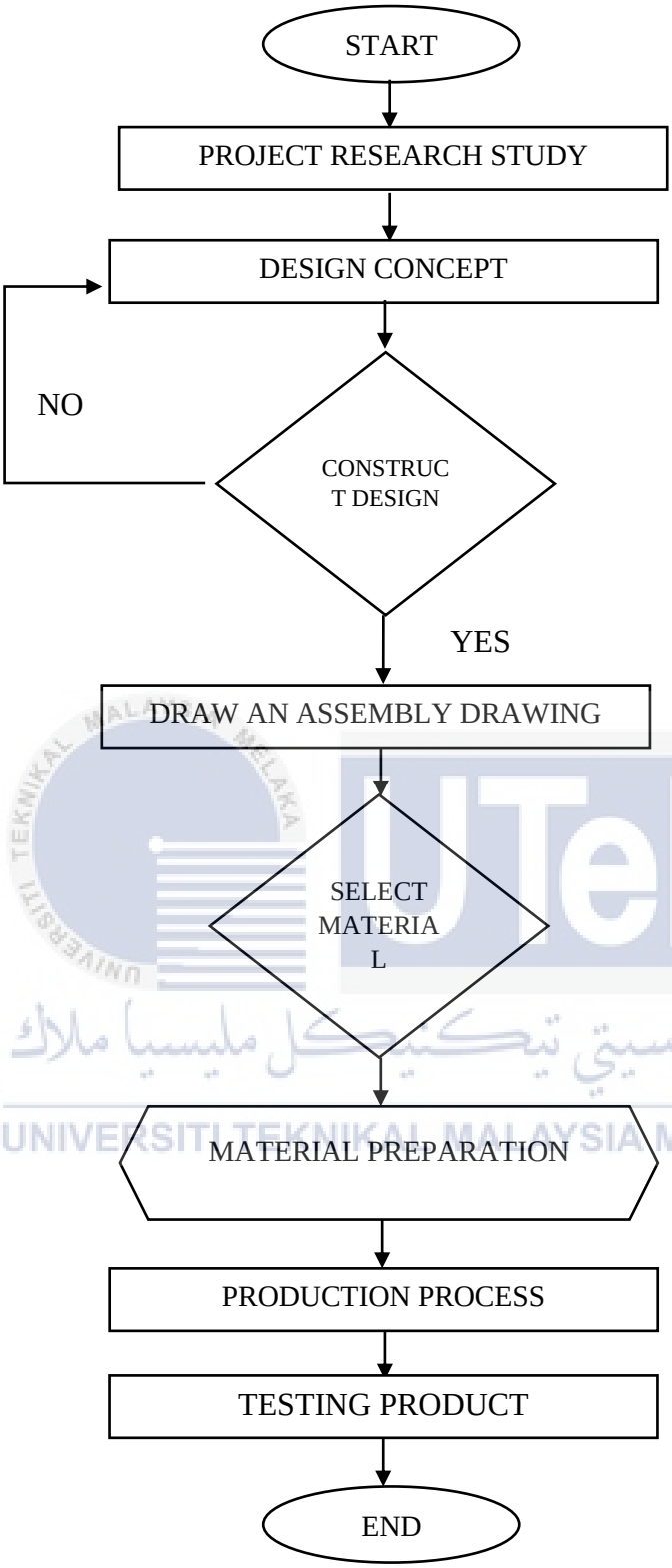


Figure 3.1: Flow chart

3.3 Material and equipment used

This section shows that the material and equipment has been selected. The material is mild steel which is suitable to be used in this project based on its characteristic.

3.3.1 Material of "Heavy Lifting Trolley for Oil Drum"

Mild steel is a type of carbon steel with a low amount of carbon. Less carbon means that mild steel is typically more ductile, machinable, and weldable than high carbon and other steels and it is affordability, weldability and machinability that make it such an ideal choice for this project. The sizing of the tube is 50 mm x 50 mm, 25 mm x 75 mm, and the thickness of the wall is in a range of 0.2 or 1.5.

Figure 3.2: Mild steel square tube

Source: https://steelonline.co.za/product/rectangular-tube-100mm-x-50mm-2mm-mild-steel/

3.3.2 Equipment of "Heavy Lifting Trolley for Oil Drum"

The equipment that can be used in this project is a welding machine (GMAW) (GTAW) (SMAW). Welding machine is used to make a between join metal to metal by using electricity to create enough heat to melt metal, and the melted metals, when cool, result in a binding of the metals.

(SMAW)

Figure 3.3: Type of welding machine

Source: https://www.ebay.com/itm/163877387634

3.3.3 Additional tools

Table 3.1: Additional tool

Type	Description
C channel (mild steel)	Used to support a heavy structural load
Heavy Duty Wheel	Heavy duty wheels are used for an application with a heavy loads or higher travelling speeds. Heavy duty wheel is a features particularly stable design. For applications with high loads, the wheels are available in a very strong welded steel construction.
Drum Lifting Clamps Kit	Drum lifting clamp is used to lift and attach drums such as chemical drums, oil drums and other types of drums or circular objects.
Toe hydraulic jack	Toe hydraulic jack is used to lift and lower a heavy load such as machinery's part, barrel and etc.
Ball Bearing	A ball bearing is a type of rolling-detail bearing that serves 3 main features at the same time as it allows motion: it carries loads, reduces friction, and positions moving device parts.

Type	Description
Round Pipe	Round pipe is placed on the trolley as a handle to push the trolley to the desired place.
Sheet Metal Plate	Sheet metal plate is used as a barrier on the pulley for safety and as an additional tool.
Chain Drive with Pulley System	It is used to transfer mechanical energy from one point to another and support the toe hydraulic jack to decrease the weight of the loads.
Pin Stopper	Used to make the oil drum in fix desired position.
Threaded Rod	Used to support systems and used for a variety of applications.
Screw and Nuts	To fasten and connect multiple pieces together.

3.4 Production process

This section shows the type of process that will be used to make this project run according to the plan. For the production process, there are two processes used to produce a heavy lifting trolley with oil drum which are the welding process, cutting process, grinding process and torsion test to find the rigidity of mild steel. The welding process is used to fabricate the two elements together with a firm connection between metal and metal. Welding is used to ensuring the construction of the frame of this heavy lifting trolley is stronger and more intact. The cutting process is used to cut the material to obtain an accurate measurement which in turn can avoid wastage of material. Cutting can be done using a variety of techniques that existing in manufacturing industries. For The grinding process is used to produce a good surface finish and accuracy for work piece where it can apply to both harden and soft material. Lastly, the torsion test is performed due to determine the mechanical properties such as rigidity of the material which is mild steel/low carbon steel.

3.4.1 Welding process

The welding process is a manufacturing process that connects materials, usually metals or thermoplastics, and causes coalescence. The manufacture of almost all modern products involves combining several individual components together. When a permanent connection is required, welding is usually used. Welding processes are often used for Aerospace, Automobile, Shipbuilding, Construction, Steel industry. During the welding process, metal is melted to form a bridge for the parts to be joined, so that when the weld metal solidifies, the parts come together. Welding is usually done under pressure, sometimes combined with heat, to produce a weld. This welding process is used to ensure the joining between a metal with metal on this heavy lifting trolley to strengthen the structure according to the shape that has been formed.

Figure 3.4: Welding process (SMAW) and (MIG)

Source for MIG: https://www.vtc1.org/Page/186

Source for SMAW**:** **https://waterwelders.com/what-is-mig-welding/**

3.4.2 Cutting process

Cutting is the separation or beginning of a physical object, into or extra portions, thru the utility of an acutely directed force. Cutting is a method wherein the operator actions a material (workpiece) which includes metallic and the device when it comes to every different so that you can form the work piece into the desired shape via shaving, drilling, etc. The use

of this process can help to obtain the measurement required in the construction of this heavy lifting trolley.

Figure 3.5: Cutting process

Source: https://www.vecteezy.com/photo/1134800-machines-for-metal-cutting-with-sparks-light

3.4.3 Grinding process

Grinding is an abrasive machining process that uses a grinding wheel or a grinder as the cutting tool. Grinding is a subset of the cutting process, as grinding is an actual process for cutting metal. Cutter for grinding process are grains of abrasive material also name as grits where they have sharp cutting points, hard, high chemical stability, and good wear resistance. Grinding is commonly used for surface finishing, groove finishing and cutting of flat and cylindrical surfaces. Grinding can produce a good precision and surface finish for parts, and it can also be applied to both hard and soft materials. The figure below shows the manual grinding process.

Figure 3.6: Hand grinding process

Source: https://www.thefabricator.com/thefabricator/article/powertools/free-the-manual-cutting-and-grinding-bottleneck

3.4.4 Turning process

Turning is the metho of cutting external or internal cylindrical and angular surfaces on a lathe by rotating the object as the tool is held against it. Every area machined on a lathe is a surface of rotation. Turning process also called a removal process of the workpiece in which a sharp cutting tool is used to mechanically cut away material while maintaining the required component shape. We may get a nice finish by using this method towards the process of cutting in the mild steel turning process (Litak & Rusinek, 2012).

Figure 3.7: Turning machine

Source: https://ceria.utem.edu.my/images/ceriaphoto/CeRIA/content/List-JTKP_Lab.pdf

3.4.3.1 Parameter

1. Spindle Speed

Spindle speed is a well-known approach for reducing regenerate machine tool vibrations, but it's typically thought to work best at low spindle speeds. The spindle speed is the machine's spindle's rotating frequency, measured in rotations per minute (RPM). Working backwards from the required surface speed (m/min) and integrating the diameter, the preferred speed is determined of workpiece or cutter (Seguy et al., 2010).

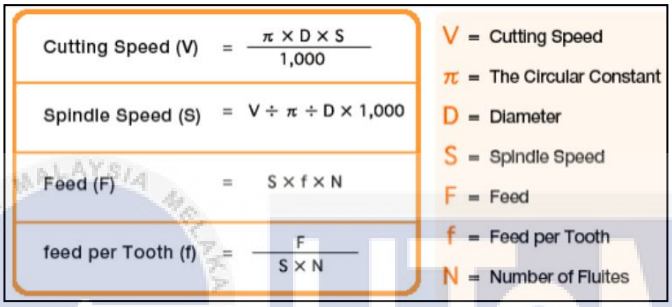


Figure 3.8: Cutting process formula

Source: https://openoregon.pressbooks.pub/manufacturingprocesses45/chapter/unit-2-speed-and-feed/

2. Depth of Cut

The depth of cut parameter is focused with the tool's main cutting action as it is pushed further into the workpiece to the desired depth. Thousandths of an inch or thousandths of millimetres are the units of measurement for this characteristic. The cut depth will typically range from 0.1 to 1.0 mm. The impact of process parameters as well as visual qualities on cutting results in terms of cut depth (Karakurt et al., 2012).

$$Depth\ Of\ Cut = \frac{d_1 - d_2}{2}$$

Figure 3.9: Depth of cut

Source: https://www.theengineerspost.com/lathe-machine-formula/

3.4.5 Drilling process

Drilling is the process of making a cylindrical hole in the centre of metal. A spinning tool, the spinning side of the cutter, called as a drilling drill, is used to accomplish this. The workpiece is rotated in a chuck or faceplate, and the drill is kept in the work piece drill holder or drill chuck during this process. Drilling is a complex three-dimensional cutting operation, but two-dimensional models may be used to replicate the action of a two-flute twist drill if the effect of feed velocity on the cutting geometry at the drill tip is considered (Vijayaraghavan & Dornfeld, 2007).

Figure 3.10: Drilling process

Source: http://www.mini-lathe.com/Mini_lathe/Operation/Drilling/drilling.htm

3.4.6 Comparison between existing products

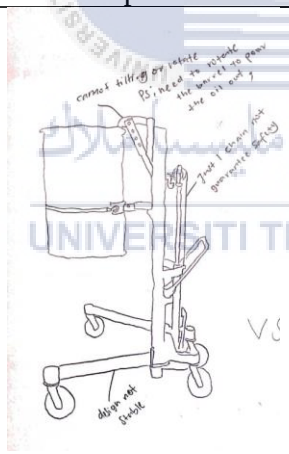
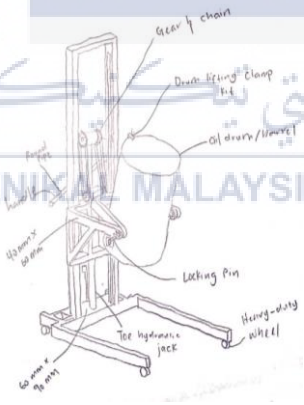
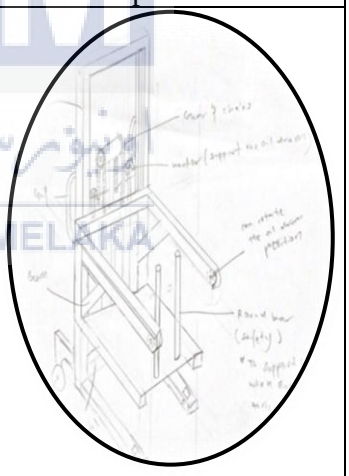
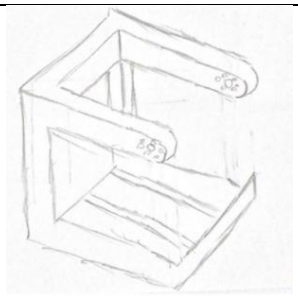
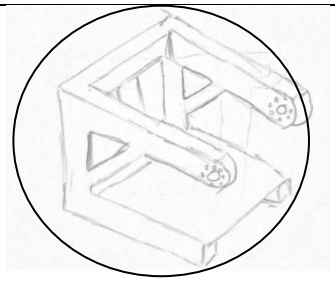
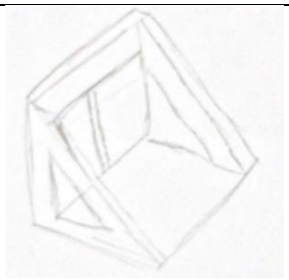
Table 3.2: Existing product

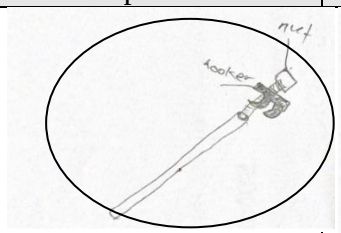
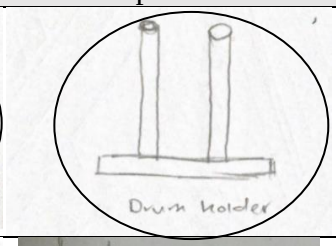
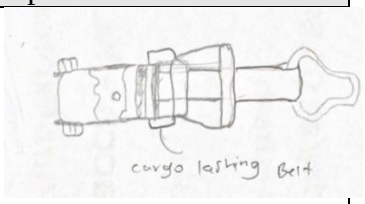
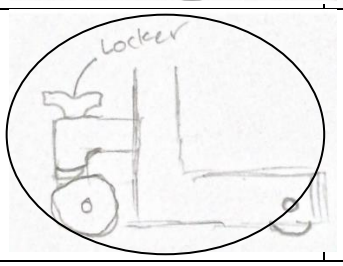
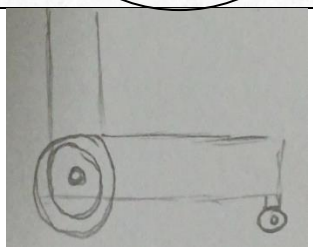
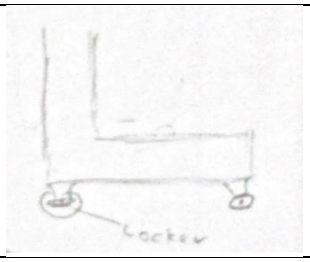
	Taixhing Jichuan Hydraulic Manufacturers Co. Ltd	Wuxi Sflift Machinery Factory	Selby Engineering and Lifting Safety Ltd.
Types of Heavy lifting device	Manual Pallet Truck	Manual Drum Lifter	Manually Manoeuvred Mobile Drum Carrier
Design			
Dimension	Width = 730 mm Length = 1500 mm Height = 1940 mm	Width = 900 mm Length = 1020 mm Height = 1250 mm	Width = 600 mm Length = 1020 mm Height = 450 mm
Materials	Mild Steel	Mild Steel	Mild Steel
Features	Hydraulic integrals oil pump Rubberized Pedal Standard Fork stack Resistant nylon wheel Thick Chain Braking Lock Wheel	Hydraulic integrals oil pump Rubberized Pedal PU Caster Wheel Lifting Clamping Kit Braking Lock Wheel	Lifting Clamping Kit Fingertip Raised Drum. Polyurethane Wheel Swivel Castor Wheel
Weight can be lifted	Maximum Load = 1000 kg/1 Ton	Maximum Load = 450 kg	Maximum Load = 364 kg

3.5 Conceptual System Design

The morphological chart for this project is shown in Table 3.3. This project's concept design focuses on the design and material aspects of the project. The research and decision of this morphological chart were taken based on the literature review. As illustrated in the column, there are primarily four choices generated for each component, with four concepts engaged in the selection of ideas. Each topic is symbolized by a unique design or substance. This option is intended to be functional and to satisfy the project's objectives. Morphological charts are the most effective method for capturing the needed product function. This solution may be represented and shown using the chart.

Table 3.3: Morphological Chart

Morphological Chart			
	Option 1	Option 2	Option 3
Shape of main body			
Shape of lock arm			

Morphological Chart			
Option 1	Option 1	Option 1	Option 1
Type of safety			
Types of wheels			

3.6 Target Specification

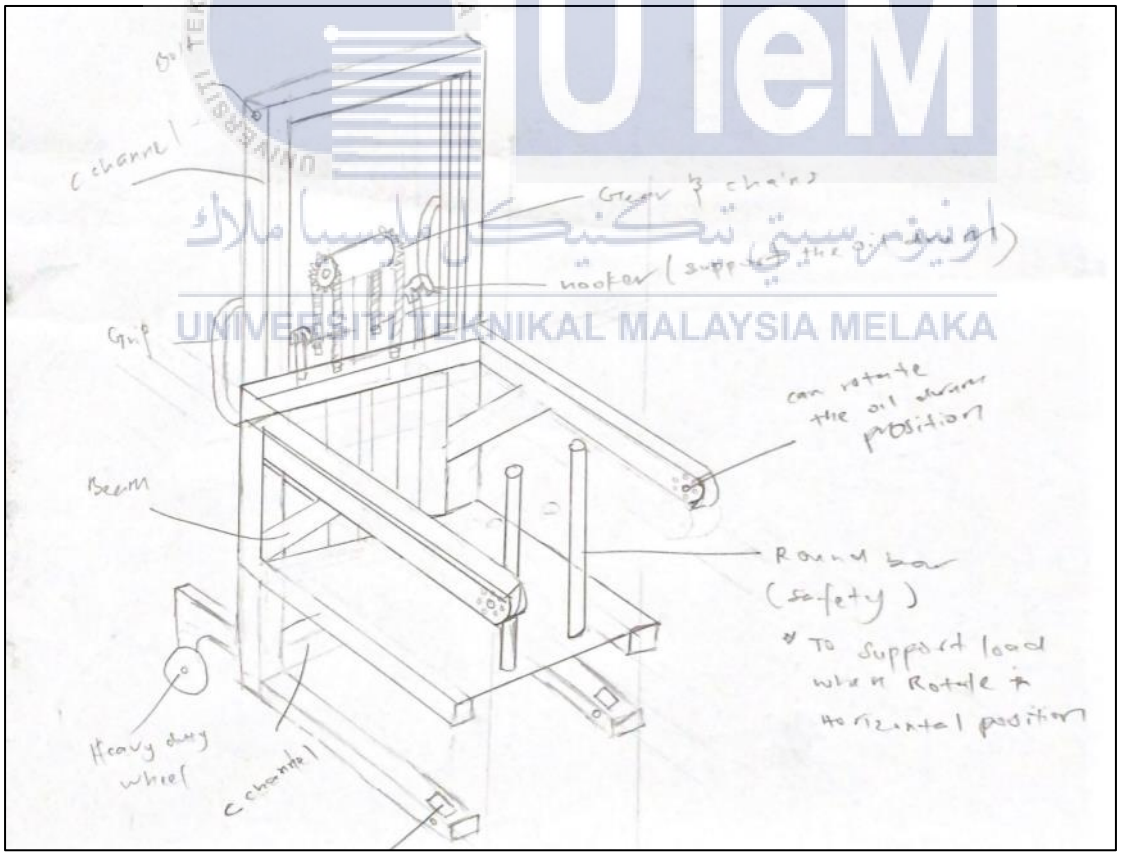


Figure 3.11: Target specification of this product

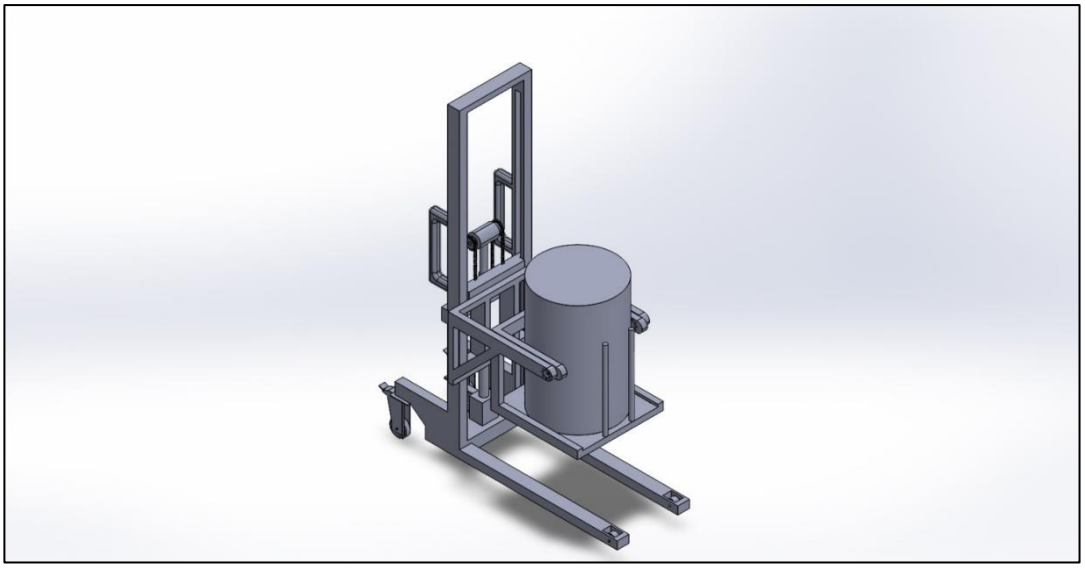


Figure 3.12 The drawing of Heavy Lifting Trolley

Based on the existing product form, there are shortcomings that need to be improved that as adding components that can rotate or tilting the oil drum to allow users or workers to pour the oil out of the barrel. This can help users or employees with back pain problems and reduce a lot of energy that might decrease working performance. Not only that, the addition of gears and chains is to reduce the load on the product and help support the lift of 55 gallons equivalent to 208 kg of oil drums. Just one chain is not guaranteed the safety of the user. Moreover, it is necessary to improve the shape of existing products because the shape is less stable. This is because the area of the basement is moderately large and the probability of the product to overturn and fall is higher. Figure 3.11 shows illustrated by using hand sketch and Figure 3.12 shows the drawing using SolidWork software.

The sizing of the project is 800 mm x 1400 mm. The height of this heavy lifting trolley is 2040 mm. This project can reach the height until 1600 mm. For the lifting area width is 667 mm which is the original size of 55 gallons oil drum/barrel. The material that would be used in this project is mild steel round tube, mild steel square tube, mild steel plate, and channel mild steel.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter discuss about the complete of the "heavy lifting trolley for oil drum" project was achieved or not based on the result. Here, it will show the result and discussion based on the finished product that has been made.

4.2 Expected Result

In this section shows that what to expect in this project is to study the concepts of lifting trolleys based on the problem and the need of the user. This is because there are problems such as back pains that needed to be avoided to ensure work performance is not reduce and can meet the needs of users that is easy and convenient when using the device. Not only that, designing a heavy lifting trolley that suitable for industrial work is very important to ensure user's safety risks that people who handle the device. Lastly, producing a heavy lifting trolley that makes it easy to transport a heavy load is one of the expected results desired.

4.3 Fabrication and Installation Process

Several types of manufacturing operations are involved in the fabrication process. Welding, drilling, turning, and grinding are all part of the production process. To create favourable results, proper methods and planning for various types of manufacturing operations should be done and considered prior to the operation. The proper way that has been mentioned is to build a product that can lift, tilt, and rotate drums with maximum precision and minimum effort, or simply transfer things to their destination that need to be prioritized. Not only that but planning on how to make the product is a must to prevent the

occurrence of waste. Once a plan is in place, it is possible to track and evaluate its progress, efficiency, and effectiveness. Plans may need to be modified as circumstances change.

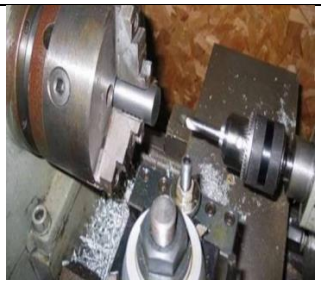
As shown below, the first process is cut, or cutting may be understood as to separate 'or' to 'sever'. This is a major task in creating sheets to size, reducing waste material, prepping weld joints, and removing defects in the context of manufacture. The fabrication process is started by cutting the square tube and ‘C channel’ according to the design measurement based on the solidwork drawing that has been sketched. This cutting process is done to get the size and shape to shape the material into the desired form. After the cutting process is carried out, again, make sure each material is the prescribed size to avoid mistakes and waste material.

The second process is the grinding process. Grinding is a real metal-cutting technique; hence it is a subset of cutting. Grinding is used in this process to have a finish material that need a surface quality and form and dimension precision. As for example, when the cutting process takes place there is an excess which is a chip that needs to be cleaned to get a good surface. It has several uses when grinding rapidly removes tiny or large amounts of metal. After welding, grinding is also performed to achieve the appropriate fineness of finished material. Most of the grinding process run, we use the angle grinder and a grinder to remove a tiny chip from the square tube.

Turning and drilling are the next processes that have been done. The turning process is used to make rotatable pieces by removing unnecessary material, a material removal process, and getting the shape that is needed by using a turning or lathe machine. It is used for making a pin of the heavy lifting trolley for oil drum. For the drilling process, it uses a drill bit to cut a hole with a circular cross-section in solid materials. For example, the pin is punched to get a hole that secures the position between the "locker arm" and the "heavy-duty lifting arm" that relate to each other. This process is carried out using a drill machine.

The last process is welding. Welding is a method of joining materials that achieves localised melding under the effect of temperature, pressure, or both. Concentrated melding helps the friction between two surfaces in fusing together to form a single unit. This process is used to strengthen the structure of the product (heavy lifting trolley for oil drum). As an example, joining a metallic part such as the square tube, the C channel, and other parts. The types of welding that have been used are shielded metal arc welding SMAW or stick welding and gas metal arc welding, also known as metal inert gas, or MIG (Alkahla & Pervaiz, 2017).

Table 4.1: Types of Process

No	Types Of Process	Photo
1	Cutting- Cutting the square tube according to the measurements that have been made	
2	Turning- Removing unneeded material till the diameter 30.	
3	Drilling- cutting the solid round bar by using a drill bit to make a circular cross-section hole of diameter 20.	 
4	Welding- Forming a joint of the part by using SMAW and Mig machine.	

No	Types Of Process	Photo
5	Grinding- Grinding the surface after welding to achieve a high surface quality, shape, and dimension accuracy.	
6	Finishing/Spray Product- Paint the product using the spray can to prevent it from rusting.	

4.4 Product Testing

The heavy lifting trolley for oil drum prototype consisted of square tube support frame 555 mm x 667 mm, which is mounted on a wheeled base frame with a rectangular size The base frame with rectangular size is measured at 800 mm (width) x 1400 mm (length) x 2040 mm (height). The maximum height that the prototype can lifted is 1600 mm.

Figure 4.1: Maximum Height Can Lift

Two handles are attached at the backside of the prototype frame to provide grip supports for pushing/pulling activities. The frame sits at 90 degrees to hold the prototype from falling during transfer load or loading the oil drum. In addition, the heavy lifting trolley prototype feature has been added, which can change the position of the barrel from 90 degrees to 210 degrees to help or facilitate the user to lift the barrel, whether the position of the barrel is in a vertical or horizontal position. Figure 4.2 show the prototype can rotate.

Figure 4.2: The Prototype Can Rotate

All frames are made of squared hollow metal tubes, round tube, and c channel. The squared hollow metal tubes size is (50 mm x 50 mm, 25 mm x 25 mm, and 27 mm x 75 mm) while the round tube size is diameter 40. For c channel size is 100 mm x 50 mm. The prototype is specially designed to decrease human energy which can transfer the oil drum from oil drum storage to the desired place. The roller bearing is attached at the centre of the c channel as the mounted frame to easily slide and carry the load up and down.

The swivel casters also can be locked to prevent the lifting trolley from moving while transporting the oil drum to its destination. Even though the design is comparable to a few other commercially available drum lifters that can tilt, rotate, and navigate, there were a few significant design aspects that were previously mentioned. Moreover, the prototype also has

the safety zone that has been installed to prevent the oil drum from slipped out of the oil barrel lifting chamber. Figure 4.3 shows the heavy lifting trolley prototype safety.

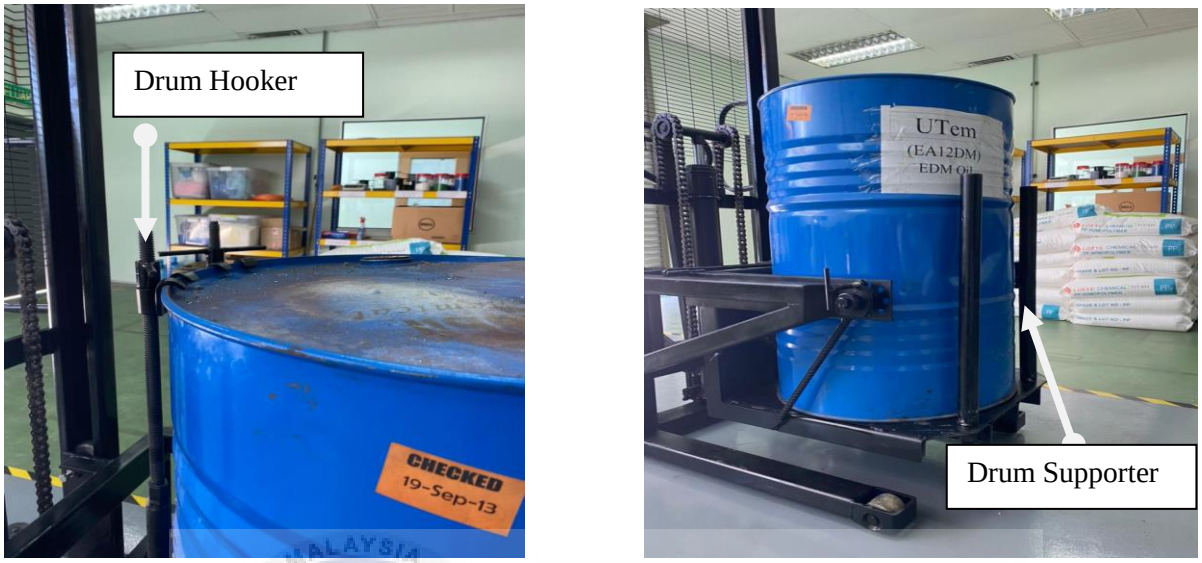


Figure 4.3: Heavy Lifting Trolley Safety

This proves the stability and safety of the heavy lifting trolley prototype from accidents happening. It should be highlighted that the drum lifter is developed to be extremely precise while lifting drums. This metal transfer duty may not operate as well in other duties and work settings. As figure 4.4 below, it shows the detail drawing that been sketched to facilitate the process of making a lifting trolley.

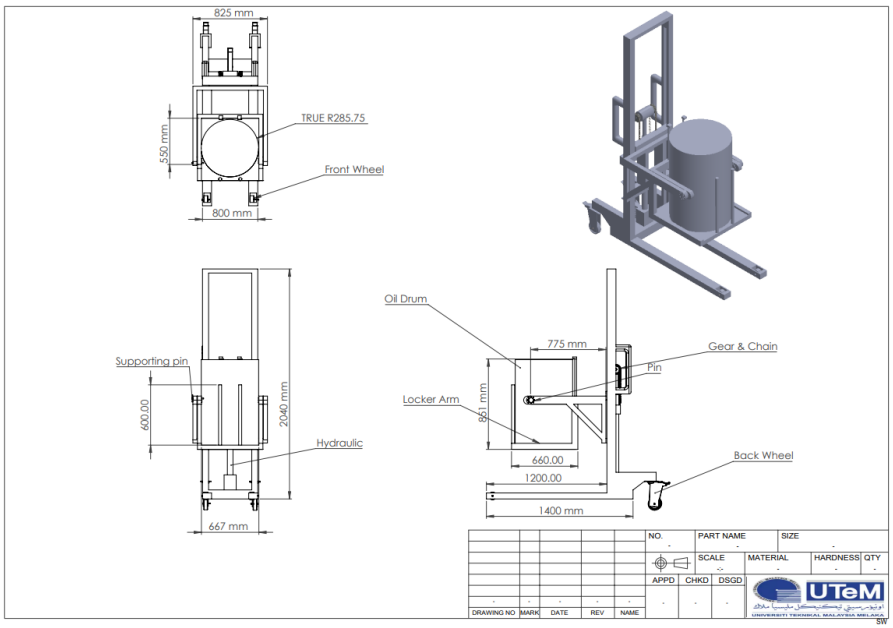


Figure 4.4: Detail Drawing

4.5 Project Costing

The project costing is attached as shown in Table 4.4.

Table 4.4: Project costing for Heavy Lifting Trolley Prototype

Item /Description	**Quantity**	**Unit price (RM)**	**Amount (RM)**
C Channel (T5mm, 2-inch x 4 inch)	2	RM 220.00	RM 440.00
U Channel (custom)	2	RM 40.00	RM 80.00
Square Hollow Tube (50 mm x 50 mm) 3 meter	1	RM 230.00	RM 230.00
Square Hollow Tube (25 mm x 25 mm) 3 meter	1	RM 100.20	RM 100.20
Square Hollow Tube (27 mm x 75 mm) 3 meter	1	RM 130.50	RM 130.50
Solid Rectangular Bar (27 mm x 75 mm) 3 meter	1	RM 200.00	RM 200.00
Round Hollow Bar (Diameter 30) 3 meter	1	Rm 1100.00	Rm 110.00

Item /Description	**Quantity**	**Unit price (RM)**	**Amount (RM)**
Bolt and Nut (M20, length=50 mm)	4	Rm 10.00	Rm 40.00
Castor Wheel (back) 8 inch	2	Rm 50.00	Rm 100.0
Castor Wheel (Front) 2 inch	2	Rm 20.00	Rm 40.00
Hydraulic System	1	Rm 550.00	Rm 550.00
Chain	2	Rm 55.00	Rm 110.00
Gear	2	Rm 85.00	Rm 170.00
Total			RM 2240.70

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project's target is to produce the heavy lifting trolley for oil drums directly, which can make it easier to transport a heavy load. This project focuses on the manufacturing industry that uses oil barrel lifting operations. The design and production are particularly focused on heavy-lifting trolleys for oil barrels that prioritise user safety. The previous section detailed the findings of the investigation.

As a conclusion, the experiment of this project concludes that the material that been used which is mild steel was a success that can hold enough the oil drum weight that contains fluid which is oil. With oil drum weights potentially being 3 times heavier than human's weight, these containers pose a severe health and safety risk to people who handle them. The industrial activities included physical handling tasks that required the workers to lift and handle big things on a regular basis. Therefore, it is important to prevent problems like this. Although, this process takes a long time and requires good skills to succeed in the manufacturing process of this project it is very happy to help and to solve this problem.

5.2 Recommendation

The future work that I suggest is to manufacture the fulcrum at the best position. The position that I made was too far in front making it difficult for the oil barrel to rotate due to the unbalanced load. So, maybe in the future need to replace the position at the centre or at the back of the oil drum then it is easy to rotate the position of the oil barrel. Moreover, maybe in the future, the addition of safety as for example chains can also be proposed to further strengthen safety from accidents such as oil barrels crashing into legs while lifting oil barrels. This needs to be emphasized before this problem occurs.

Finally, the addition of an electric motor can also be added to the prototype of this oil barrel lifter to reduce energy consumption, but it should be noted that high costs should also be avoided. This is because we want to reduce manufacturing costs, which can benefit us.

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APPENDIX A

Gantt Chart Psm 1

Project Activity	Weeks														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Confirm The Project Title															
Discuss with Supervisor															
Collecting Data and Information Project															
Find and Research Journal															
Chapter 1 : Introduction															
Chapter 2 : Literature Review															
Chapter 3 : Methodology															
Compile Report															
Submit report															
Preparation slide															
Presentation PSM 2															

	Planning		Actual

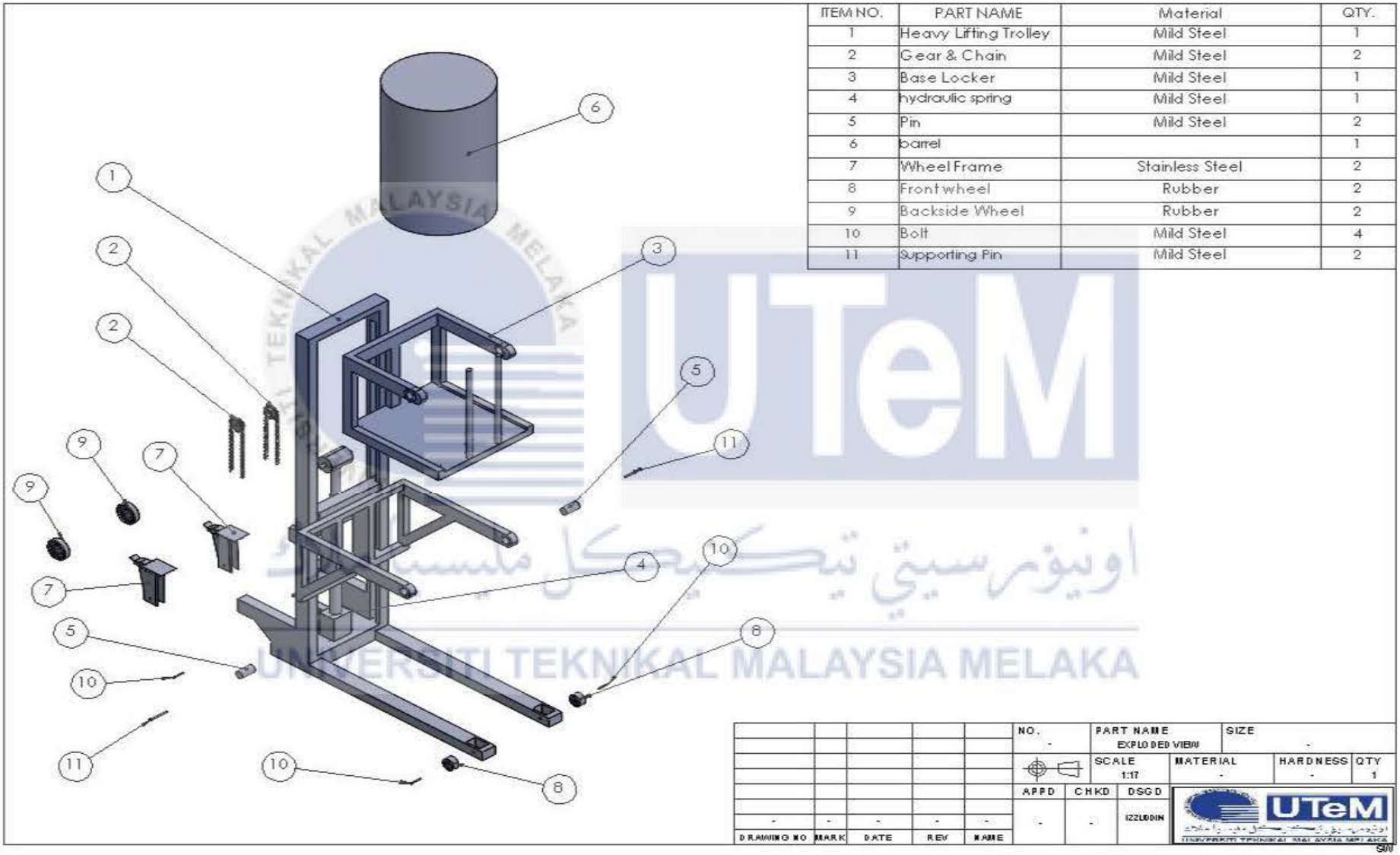
Gantt Chart Psm 2

Project Activity	Weeks														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	11/10 - 15/10	18/10 - 22/10	25/10 - 29/10	1/11 - 5/11	8/11 - 12/11	15/11 - 19/11	22/11 - 26/11	29/11 - 3/12	6/12 - 10/12	13/12 - 17/12	20/12 - 24/12	27/12 - 31/12	3/1- 7/1	10/1- 14/1	17/1- 21/1
Discussion with Supervisor															
Survey Material and Parts Price															
Fabricate The Heavy Lifting Trolley															
Product Testing															
Chapter 4 : Result & Discussion															
Chapter 5 : Conclusion & Recommodation															
Compile all chapter															
Fill the log book															
Submit report															
Preparation slide															
Presentation PSM 2															

	Planning		Actual

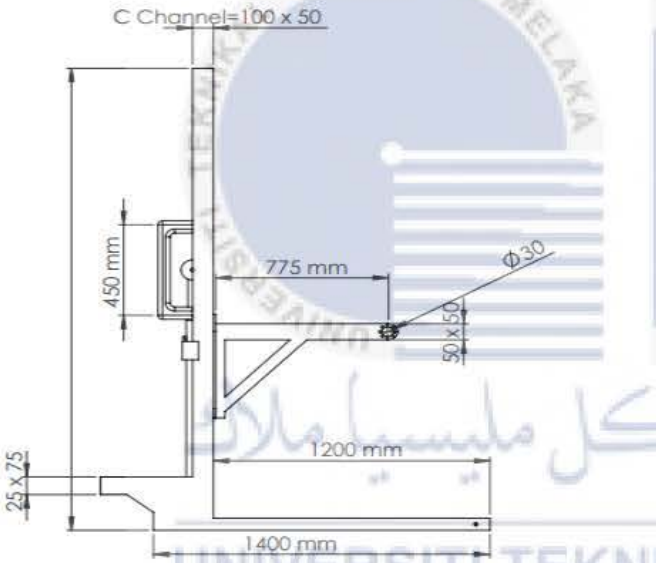
APPENDIX B

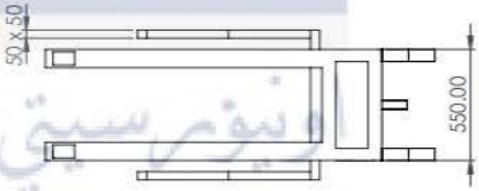
PART BY PART DRAWING



ITEM NO.	PART NAME	Material	QTY.
1	Heavy Lifting Trolley	Mild Steel	1
2	Gear & Chain	Mild Steel	2
3	Base Locker	Mild Steel	1
4	hydraulic spring	Mild Steel	1
5	Pin	Mild Steel	2
6	barrel		1
7	Wheel Frame	Stainless Steel	2
8	Front wheel	Rubber	2
9	Backside Wheel	Rubber	2
10	Bolt	Mild Steel	4
11	Supporting Pin	Mild Steel	2

					NO.	PART NAME	SIZE		
					-	EXPLODED VIEW	-		
						SCALE	MATERIAL	HARDNESS	QTY
						1:17	-	-	1
					APPD	CHKD	DSGD		
-	-	-	-	-	-	-	IZZUDDIN		
DRAWING NO	MARK	DATE	REV	NAME					





					NO.	PART NAME	SIZE		
					1	Body	-		
						SCALE	MATERIAL	HARDNESS	QTY
						1:17	Mild Steel	-	1
						APPD	CHKD	DSGD	
-	-	-	-	-		En. Khahar	En. Khahar	Izzuddin	
DRAWING NO	MARK	DATE	REV	NAME					

SW

					NO.	PART NAME	SIZE		
					4	Chain&Gear	-		
						SCALE	MATERIAL	HARDNESS	QTY
						1:3	Mild Steel	-	4
						APPD	CHKD	DSGD	
						En. Khahar	En. Khahar	Izzuddin	
-	-	-	-	-					
DRAWING NO	MARK	DATE	REV	NAME					

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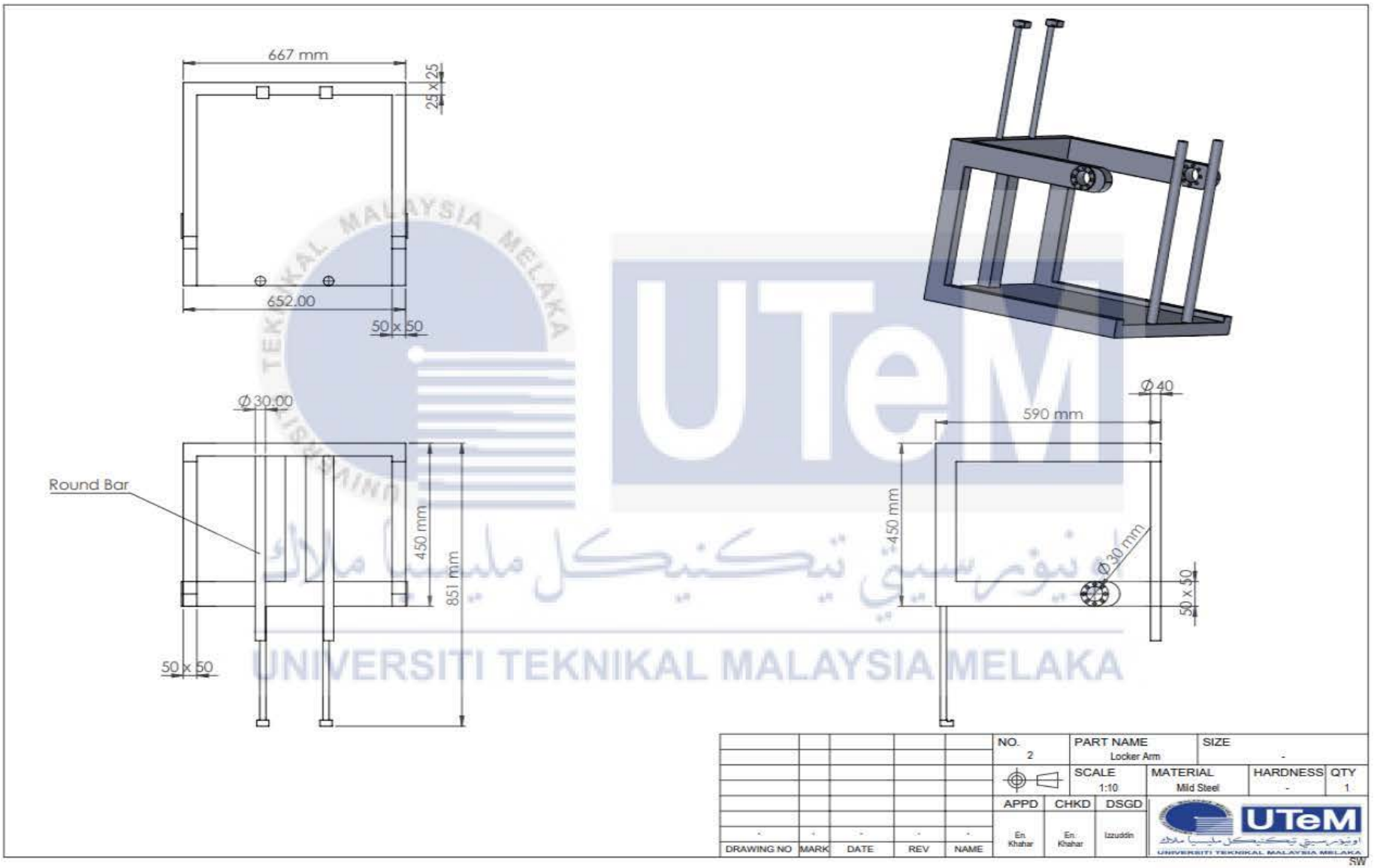

					NO.	PART NAME	SIZE		
					8	Bolt	-		
						SCALE	MATERIAL	HARDNESS	QTY
						1:1	Mild Steel	-	6
					APPD	CHKD	DSGD		
-	-	-	-	-	En. Khahar	En. Khahar	Izzuddin		
DRAWING NO	MARK	DATE	REV	NAME					

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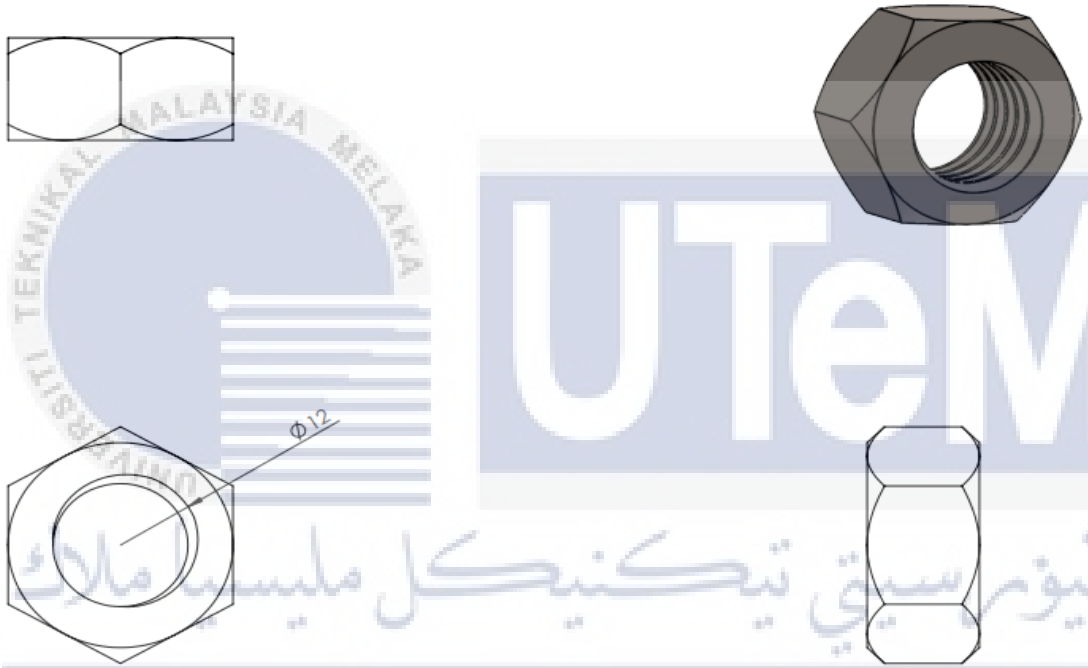

					NO.	PART NAME	SIZE		
					9	Nut	-		
						SCALE	MATERIAL	HARDNESS	QTY
						1:1	Mild Steel	-	6
					APPD	CHKD	DSGD		
-	-	-	-	-	En. Khahar	En. Khahar	Izzuddin		
DRAWING NO	MARK	DATE	REV	NAME					

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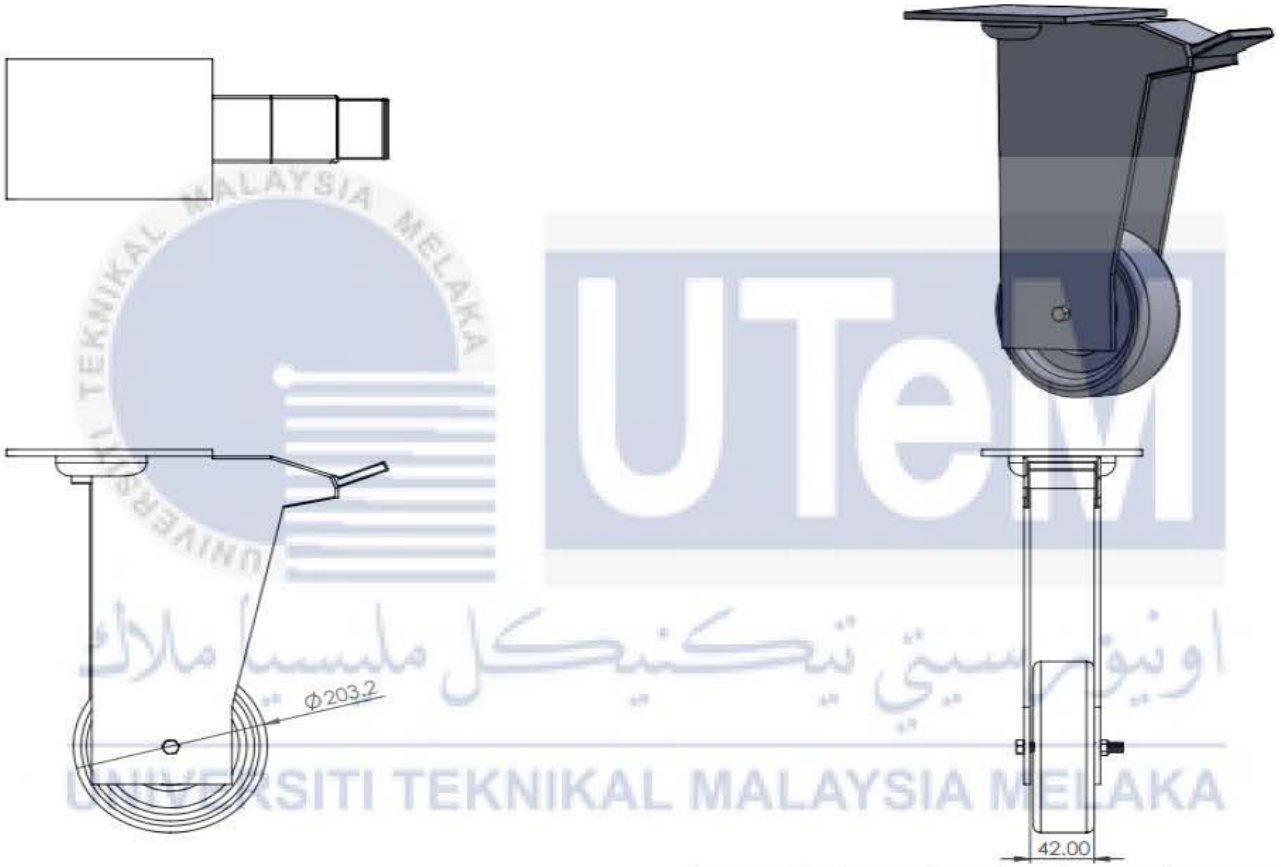

					NO. 7	PART NAME Back Wheel		SIZE -	
						SCALE 1:3	MATERIAL Thermoplastic/Mild steel	HARDNESS -	QTY 2
						APPD	CHKD	DSGD	
-	-	-	-	-		En.Khahar	En. Khahar	Izzuddin	
DRAWING NO	MARK	DATE	REV	NAME					

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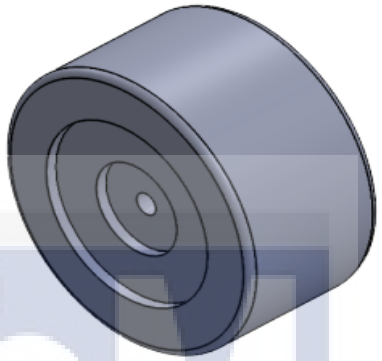

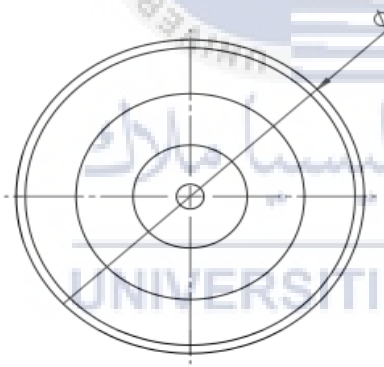

					NO.	PART NAME	SIZE		
					7	Front Wheel	-		
						SCALE	MATERIAL	HARDNESS	QTY
						1:2	Thermoplastic	-	2
					APPD	CHKD	DSGD		
-	-	-	-	-	En. Khahar	En. Khahar	Izzuddin		
DRAWING NO	MARK	DATE	REV	NAME					

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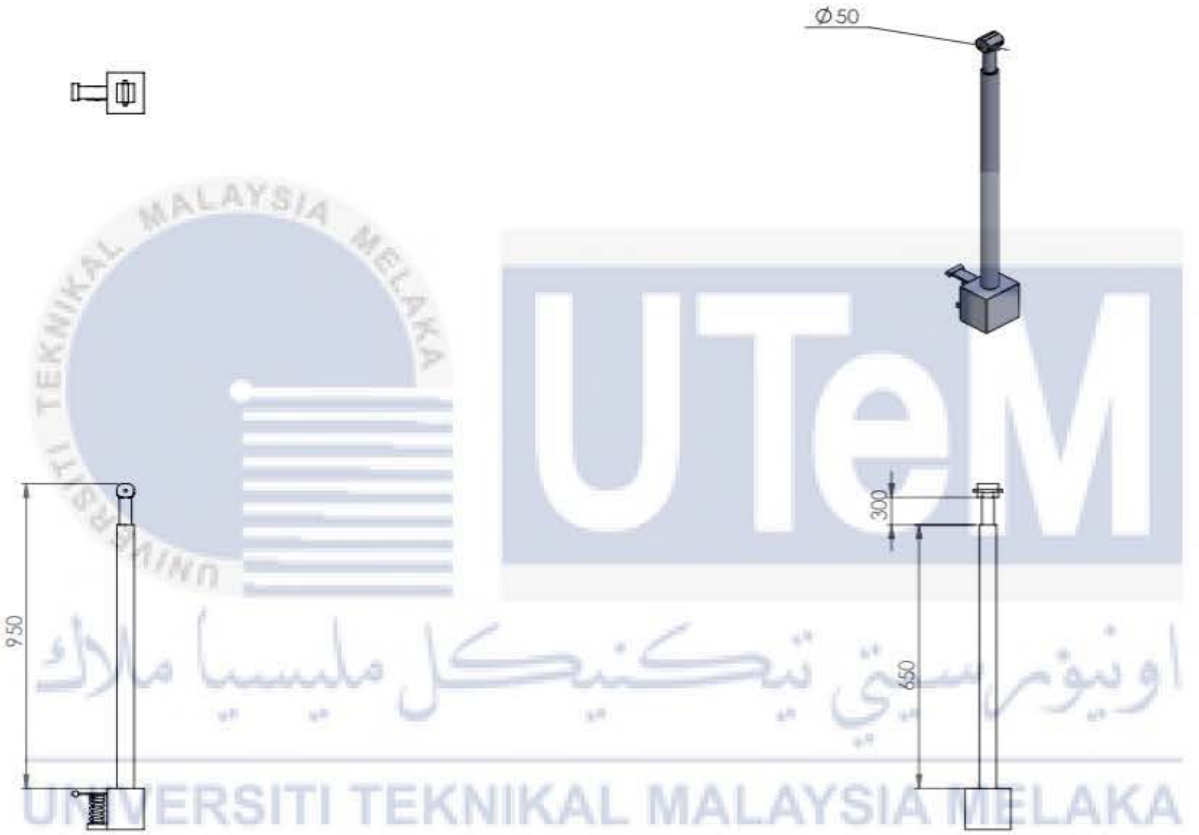
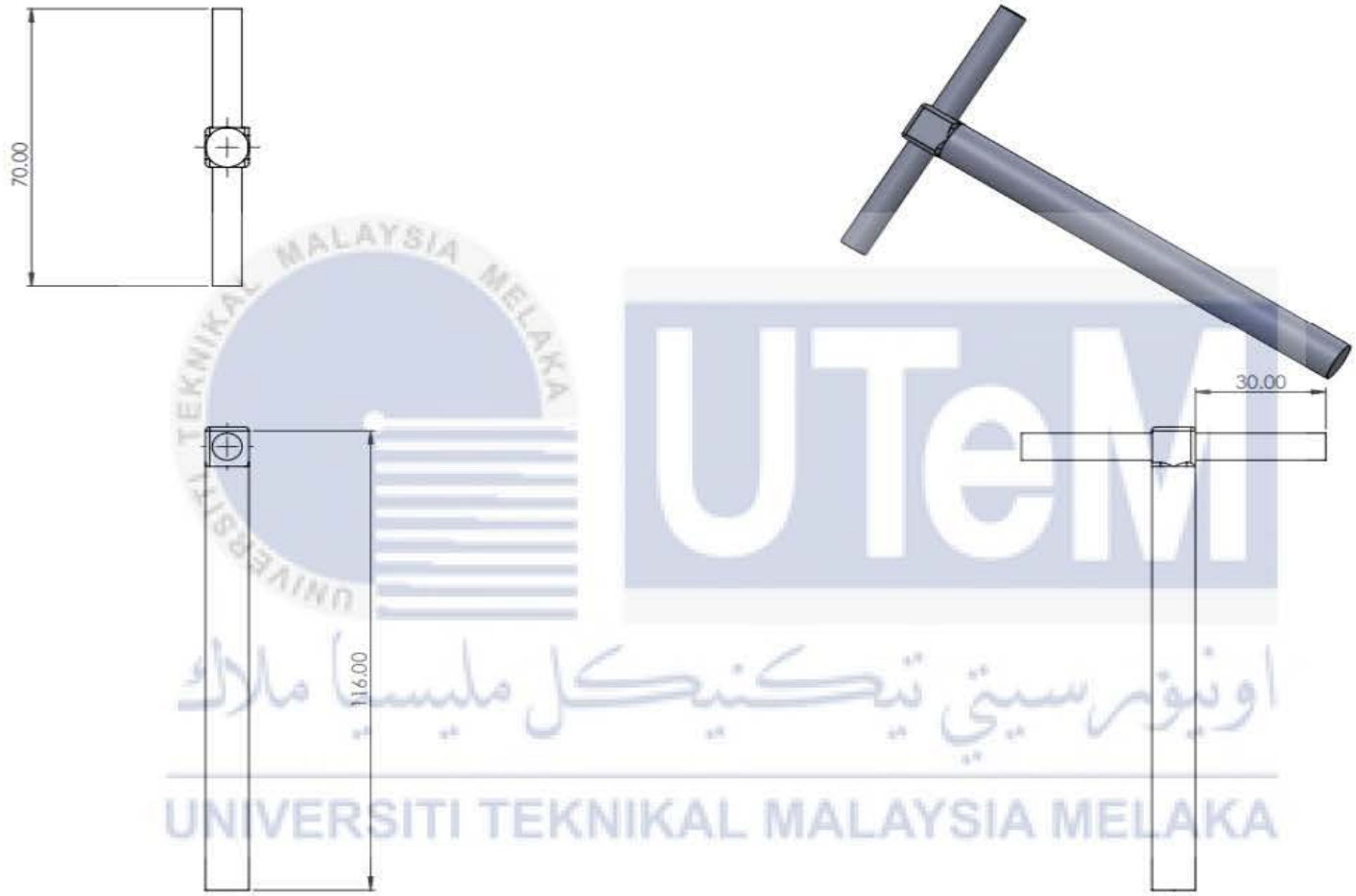


					NO.	PART NAME	SIZE		
					3	Hydraulic	-		
						SCALE	MATERIAL	HARDNESS	QTY
						1:15	Mild Steel	-	1
					APPD	CHKD	DSGD		
-	-	-	-	-	En Khahar	En Khahar	Izzuddin		
DRAWING NO	MARK	DATE	REV	NAME					



					NO.	PART NAME	SIZE
					6	Supporting Pin	-
						SCALE 1:1 / MATERIAL Mild Steel / HARDNESS - / QTY 2
					APPD	CHKD	DSGD
-	-	-	-	-	En. Khahar	En. Khahar	Izzuddin
DRAWING NO	MARK	DATE	REV	NAME			

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: **Heavy Lifting Trolley for Oil Drum**

SESI PENGAJIAN: **2020/21 Semester 1**

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Nama pelajar: IZZUDDIN FAHMI BIN HADRAWI (B091810061)
Tajuk Tesis: HEAVY LIFTING TROLLEY FOR OIL DRUM.

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Sekian, terima kasih.

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"KOMPETENSI TERAS KEGEMILANGAN"

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