DESIGN AND FABRICATION OF SMART RACK GADGET

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JUDUL: DESIGN AND FABRICATION OF SMART RACK GADGET

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CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

The purpose of this chapter is to explain about the project background, problem statement, project objectives, project scopes, flow chart of the project and also a Gantt chart to show the flow and overall process for this project.

1.1 PROJECT BACKGROUND

According to the latest observation in the market, there are various types of smart rack gadgets which differ in design, specification, function and size as well. A smart rack gadget is a specialized tool box which designed for the use of peoples such as a mechanic, wiremen, plumber, carpenter and contractor as well. However, the idea is more concerned on the smart rack gadget for wiremen. The work of wiremen includes simple and complicated wiring maintenance where he may need a smart rack gadget which includes a big storage space for frequently used tools such as long nose pliers, wire stripper, flathead and Phillips screwdriver, fish tapes, Neon tester and many more.

As mentioned above, there is various types of smart rack gadgets in the market but there are only few smart rack gadgets which actually solves the problem of wiremen entirely. The smart rack gadgets readily offered in the market for wiremen lack in portability. A wireman has to work indoor and outdoor. Therefore, the smart rack gadget should not be too heavy until it burdens the wiremen.

The purpose of this project is to design and fabricate a smart rack gadget for wiremen that would actually solve most of the problems faced by a wireman when it comes to smart rack gadgets.

1.2 PROBLEM STATEMENT

A wireman has a problem to carry his tools from one place to another. He also has problem to organize and keep his tools properly. Most of the tools especially small components such as screw, nuts, bolt and nails cannot be put together under one section. The wireman having problem in using power tools when the power source is far from his working area.

1.3 OBJECTIVE

1) To fulfil the need of wiremen by designing a new smart rack gadget that is portable.
2) To design a smart rack gadget which not only act as a tool box but it is also multifunction.

1.4 SCOPE

1) To fabricate a smart rack gadget especially for wiremen.
2) The smart rack gadget can support a maximum load of 25 kg.
3) The smart rack gadgets possess extra function such as extension plugs and removable small toolbox.
4) The smart rack gadget has only two extension plugs and the wires can be extended to 3 metres only.

1.5 PROJECT FLOW CHART

As attached, the Figure 1.1 shows the flow chart of the whole Final Year Project. As for kick starting, an appointment with the supervisor is made to understand about the project given and preparing for weekly meeting. Here, the supervisor will be a guide in order to fulfill the entire requirement to excel in the final year project.

First of all, problems are being identified and the object and scopes are made clear. Further studies will then be conducted regarding the title of the project. This is where literature review started by reviewing the literature study by previous persons.

Then, rough idea about the title is gotten and the designing and drawing phase is then started. Designing phase is commenced by sketching using the available product in the market and editing it to become achievable. The sketching process is carried out using free hand. Then, the design is then drawn into a three dimensional drawing by using the Solid Works software.

After that, the bill of material is being listed out one by one. Market surveying is then commenced. Materials listed are being searched by using all the available media. Once gotten all the materials, fabricating process of the smart rack gadget can be started.

Once the fabrication is done, the product is then tested. If the result is not satisfying, fabrication process has to be repeated until satisfactory result is achieved.

Finally, report everything in the final report writing and presentation slides. Presentation slides are then reviewed by the supervisor so that mistakes can be corrected. Everything regarding the project is then presented to the panels and draft report is submitted to the supervisor. Errors should be corrected and the final product is then submitted to complete the final year project.

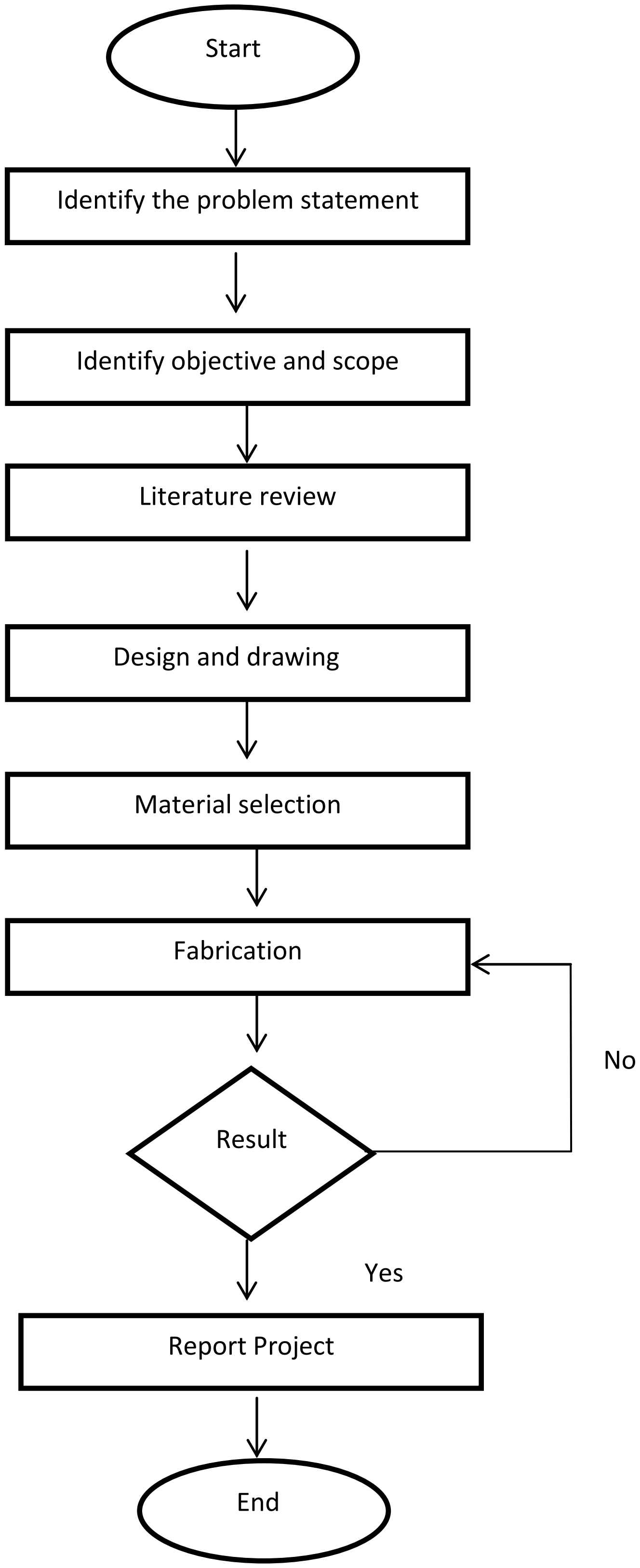

Figure 1.1: Project Flow Chart

1.6 PROJECT GANTT CHART

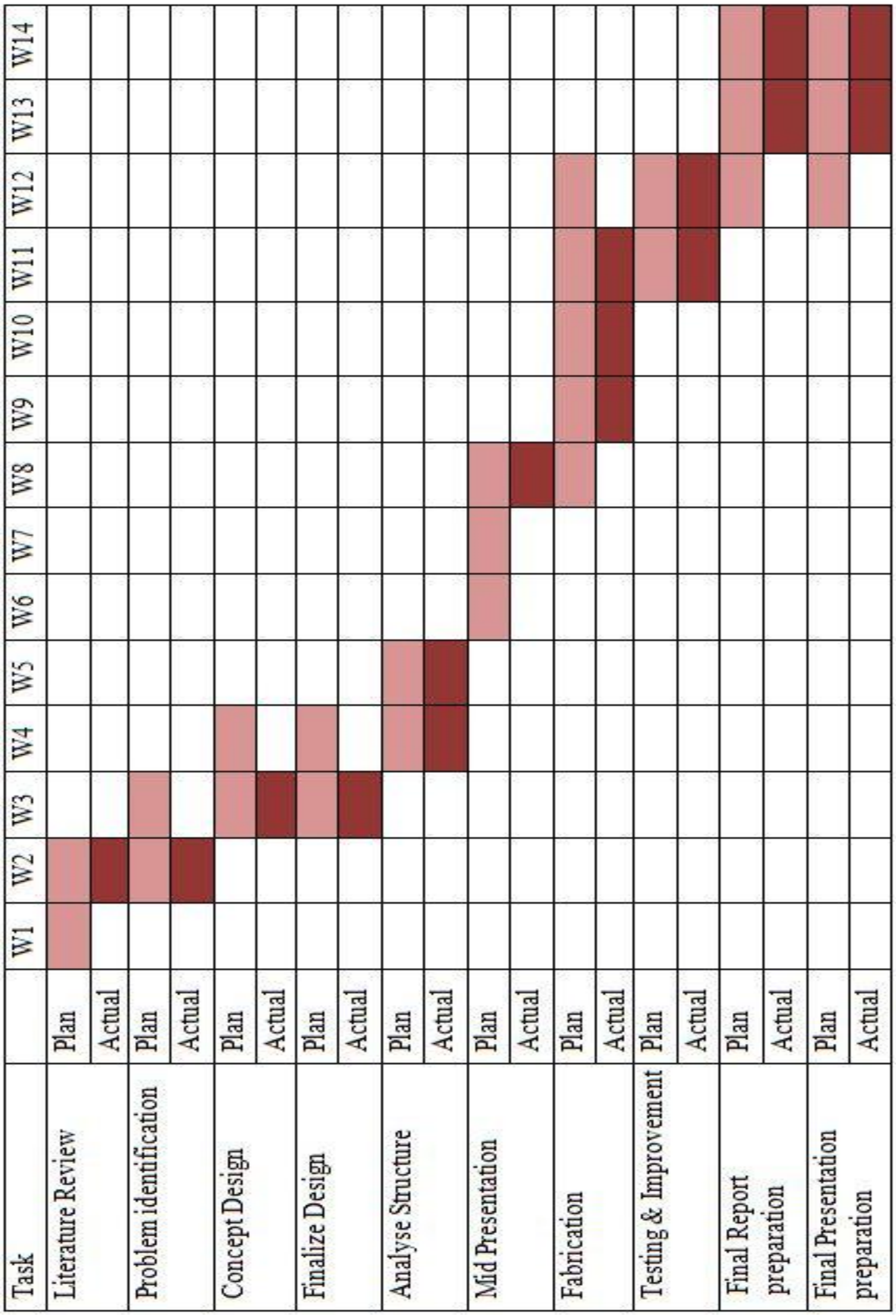

Figure 1.2: Gantt chart

1.7 THESIS ORGANIZATION

Chapter 1 would explain about introduction, problem identifications, objectives, scopes, flow chart and Gantt chart. This particular chapter planned the direction of the final year project.

Chapter 2 will then go through the literature review of the smart rack gadgets. This chapter will discuss about the advantages and disadvantages of market existing smart rack gadgets and also the comparison between these existing smart rack gadgets.

Chapter 3 will then enlighten about the methodology of carrying out this project from beginning to the end. The tools and machine that were used for fabrication would be discussed as well.

Chapter 4 would then study on the final produce that has been fabricated. The fabricated product would be explained part by part and the testing of it would also be shown. Not only that, discussion on the project would also be made.

Chapter 5 is the conclusion of the project. This specific chapter would then summarize the result related to the real world problem and recommend some suggestion for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter mainly provides detail description of literature review done regarding the differences, advantages and disadvantages and comparison between the existing smart rack gadgets in the market.

A smart rack gadget for wiremen is a simple toolbox which designed to ease the work of wiremen to carry and arrange their tools in order. There are various types of smart rack gadgets which differ from each other by size, function, portability, cost and durability.

2.2 PRODUCT REVIEW

This topic will summarize the advantages and disadvantages besides comparing between the chosen existing smart rack gadgets in the market.

2.2.1 Product A

Figure 2.1: Hip-Roof Smart Rack Gadget with Metal Tote Tray

Source: http://www.holtwaterloo.com/?pid=7&grp=15&page=steel%20portables

Table 2.1: Overview of Product A

Design concept	Light and portable
Cost	Cheap
Materials	Aluminium

Hip-Roof Smart Rack Gadget with Metal Tote Tray is simple and easy smart rack gadget where it is easy to arrange tools in this smart rack. The smart rack gadget come with small toolbox as this toolbox can be used for bringing limited amount of tools to perform simple repairing or maintenance work. The advantage of this type of smart rack gadget is it is made out of Aluminium. Thus, it will not rust. It can be brought to any place as it is light and portable. The disadvantages are the spaces allocated are small so not many tools can be put in the smart rack gadget. It also cannot support high loads.

2.2.2 Product B

Figure 2.2: Wiremen Maintenance Smart Rack Gadget

Source: http://orangeblossoms.net/santuary-carpenters-toolbox-usa/

Table 2.2: Overview of Product B

Design concept	Bigger storage space
Cost	Expensive
Materials	Aluminium

Wiremen Maintenance Smart Rack Gadget is a big sized rack gadget where it has three drawers and more storage section at upper portion of the smart rack gadget. The advantages of this smart rack gadget are it has a bigger storage capacity where a lot of tools can be placed inside it. It is durable can uphold more weight. It cannot rust as it is made of Aluminium. The disadvantages are it is very expensive as the size is bigger and it cannot be moved from one place to another because it is not portable.

2.2.3 Product C

Figure 2.3: Mobile Smart rack Gadget

Source:http://www.lkltd.com/web/8888/nsf/sbs.py?&_id=11224&did=3958&title=tool%20boxes%20&%20bags

Table 2.3: Overview of Product C

Design concept	Bigger storage space
Cost	Expensive
Materials	Plastic and steel

Mobile Smart rack Gadget is a big sized rack gadget where its appearance is more towards a trolley bag. It has three wide and deep drawers to place more tools and equipments. The advantages of this type of smart rack gadgets are it has more storage capacity and durable as well. It is portable and can withstand more loads. It is long lasting as it is made of plastic and steel. However, the disadvantages are it is expensive. The wheels of the smart rack gadgets have to be changed for a period of time. If the wheel is broken, the Mobile smart rack gadget is no longer portable.

2.2.4 Product D

Figure 2.4: Stainless Steel Smart Rack Gadget

Source: http://maxtoolbox.en.made-in-china.com/

Table 2.4: Overview of Product D

Design concept	Bigger storage space
Cost	Expensive
Materials	Stainless steel

Stainless Steel Smart Rack Gadget is rack gadget which have seven drawers and trolleys. The advantages of this smart rack gadget are the storing capacity for this smart rack is big. Therefore, it can support more tools frequently used by wiremen. It is made of Stainless steel so the smart rack gadget can resist impact better when the tools is dropped inside it. It is also rust resistance. There are more drawers in this smart rack gadget. Therefore, it can be helpful to arrange and labializing the tools place. It also can support load very well. The only disadvantage of this smart rack gadget is it is expensive.

2.2.5 Product E

Figure 2.5: Cantilever Smart Rack Gadget

Source: http://www.power-tools-pro.co.uk/tool-boxes-chests-pouches-tool-boxes-c-425_85.html

Table 2.5: Overview of Product E

Design concept	Divided compartment to store different sizes of tools orderly.
Cost	Cheap
Materials	Zinc

A Cantilever Smart Rack Gadget is a small sized rack gadget where it has more storage compartment of different sizes. It has three layers, where the first layer for small tools and parts such as nuts, bolts, and nails. Second compartment to store slightly bigger tools compared to tools in layer one while the third layer is the biggest layer to store big tools and equipment. The advantages of this smart rack gadget are it has big storage capacity. It is cheap and durable. As the size of the smart rack gadget is small, it can be carried from one place to another. The only disadvantages of this type of rack gadgets are it is made of zinc. Thus, it cannot withstand high impact resistance and if the paint coating cracks, the smart rack gadgets may get rust.

2.3 COMPARISON

Table 2.6: Comparison between existing products

Aspect	Product A	Product B	Product C	Product D	Product E
Ability to withstand load	Low	High	High	High	High
Cost	Cheap	Expensive	Expensive	Expensive	Cheap
Material used Steel	Aluminium	Aluminium	Plastic& Steel	Stainless	Zinc
Storage Capacity	Low	High	High	High	High
Portable	Yes	No	Yes	Yes	Yes

2.4 FABRICATION EQUIPMENT

Machining process is one of the important methods in fabrication process. There is a variety of machining method readily available. Below are some details about the machines used.

2.4.1 Shearing machine

Figure 2.6: Shearing machine

Source: http://appleyardsmithmorgan.co.uk/interview-body-warmers-for-operating-room/

A shearing machine is an automation machine which can be used to cut materials up to width (x axis) of 6 mm while length (y axis) of 6 mm too. It is also known as die cutting machine. The angle of cutting of the blades is adjusted based on the thickness of the material. The work piece will be clamped by the machine clamping mechanism before the blade strikes onto the work piece to cut the material.

2.4.2 Bending machine

Figure 2.7: Bending machine

Source: http://y--square.blogspot.com/2010/10/how-to-create-magnetic-lock-phase-4.html

Bending machine consist several dies where the materials that needed to be bend will be placed onto the die. Next, the angle of bending will be pressed into the touch screen so that the metal plate can be bended according to the value of bending angle. The punch will press against the material and then bend the material according to its bending angle. The limit of a bending angle that can bend by a bending machine is 120 degrees.

2.4.3 Bench drill press

Figure 2.8: Drill press machine

Source: http://y--square.blogspot.com/2010/10/how-to-create-magnetic-lock-phase-4.html

Bench drill press is a vertical fixed drill where the work piece which needs to be drilled will be clamped using the drill clamp. There are various diameters of drill bits which can be used to drill holes into a work piece. In order to drill holes in wood, metal and a variety of other materials, the machine must have enough power and the proper drill bits. A drill press consists of a base, pillar, table, spindle and drill head which is driven by an induction motor.

2.4.4 Pedestal grinding machine

Figure 2.9: Pedestal grinding machine

Source: http://www.gandmtools.co.uk/cat_leaf.php?id=8071

A pedestal grinder is a type of bench grinder that is mounted on a pedestal, which is bolted to the floor. These types of grinders are commonly used to hand grind cutting tools and perform other rough grinding. Depending on the grade of the grinding wheel it may be used for sharpening cutting tools such as lathe tools or drill bits. Alternatively, it may be used to roughly shape metal prior to welding or fitting.

2.4.5 Arc welding

Figure 2.10: Arc welding

Source: http://en.wikipedia.org/wiki/Arc_welding

Arc welding is a type of welding that uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is usually protected by some type of shielding gas, vapour, and/or slag. An electric current is used to strike an arc between the base material and a consumable electrode rod or 'stick'. The electrode rod is made of a material that is compatible with the base material being welded and is covered with a flux that gives off vapours that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination. The electrode core itself acts as filler material, making separate filler unnecessary.

2.4.6 Riveting

Figure 2.11: Riveting

Source:
http://www.bikudo.com/product_search/details/39962/blind_riveting_pliers.html

A rivet is a permanent mechanical fastener. Before being, installed a rivet consists of a smooth cylindrical shaft with a head on one end. The end opposite the head is called the buck-tail. On installation, the rivet is placed in a punched or pre-drilled hole, and the tail is upset, or bucked (i.e. deformed), so that it expands to about 1.5 times the original shaft diameter, holding the rivet in place. Normally, the hole that drilled is always will fit to the exact diameter of rivet. Then, the rivet is put into the hole and a riveter is used to join sheet metals by riveting the rivet.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will further clarify about the concept design that been made in order to solve the problem statement. This section will also describe about the method used to evaluate all the concept design in order to obtain the final concept**.** Material selection and fabrication process done in order to produce the project will be discussed in this chapter as well where the process of cutting and shaping it into finished product will be additional put in plain words.

3.2 SYNOPSIS

This subchapter will give brief explanation regarding the flow or step involved in designing out the finalize concept. The flows of the project methodology are as mentioned below:

i. Recognize the problem statement and discover the solution
ii. Concept design and evaluation
iii. Finalize concept
iv. Material selection
v. Fabrication process and finishing

3.2.1 METHODOLOGY FLOW CHART

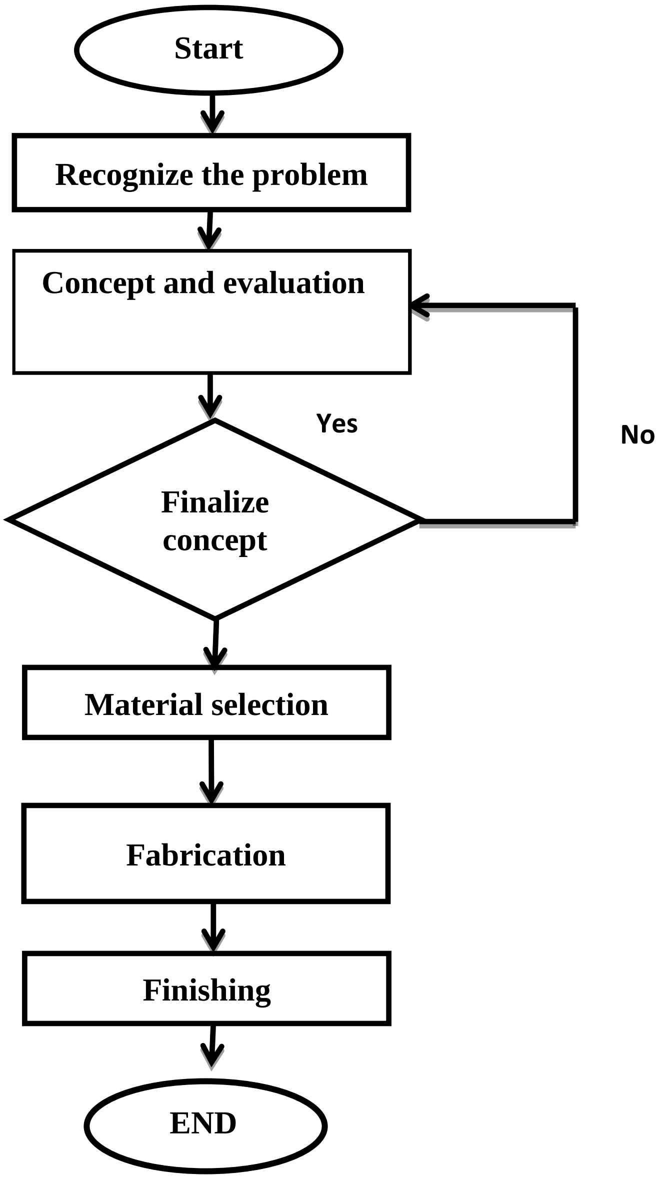

Figure 3.1: Methodology flow chart

From the methodology flow chart in Figure 3.1, the project is started by recognizing the problem that being faced by wiremen. Thus, in order to find out the problem that been faced by the wiremen, literature review and research concerning to the title is carried out. After the problem has been recognized, concept design is carried out. In this project, four concept designs have been drafted out and after that evaluation of those sketching have been done. Concept screening and scoring are used as the technique to evaluate the sketched design in order to obtain the finalize concept.

After the finalize concept have been chosen, material selection is the next process. Galvanized Iron 2mm has been chosen as fabrication material due to its robustness, tough impact resistant and antirust. Later, as the material has been selected, fabrication process is the next stage. Several tools and machining process like cutting, drilling, bending, welding and riveting have been used to fabricate the project. Once the fabrication process is over, finishing project is done where the product is been repaired if there are any defects and painted.

3.3 CONCEPT DESIGN

3.3.1 CONCEPT A

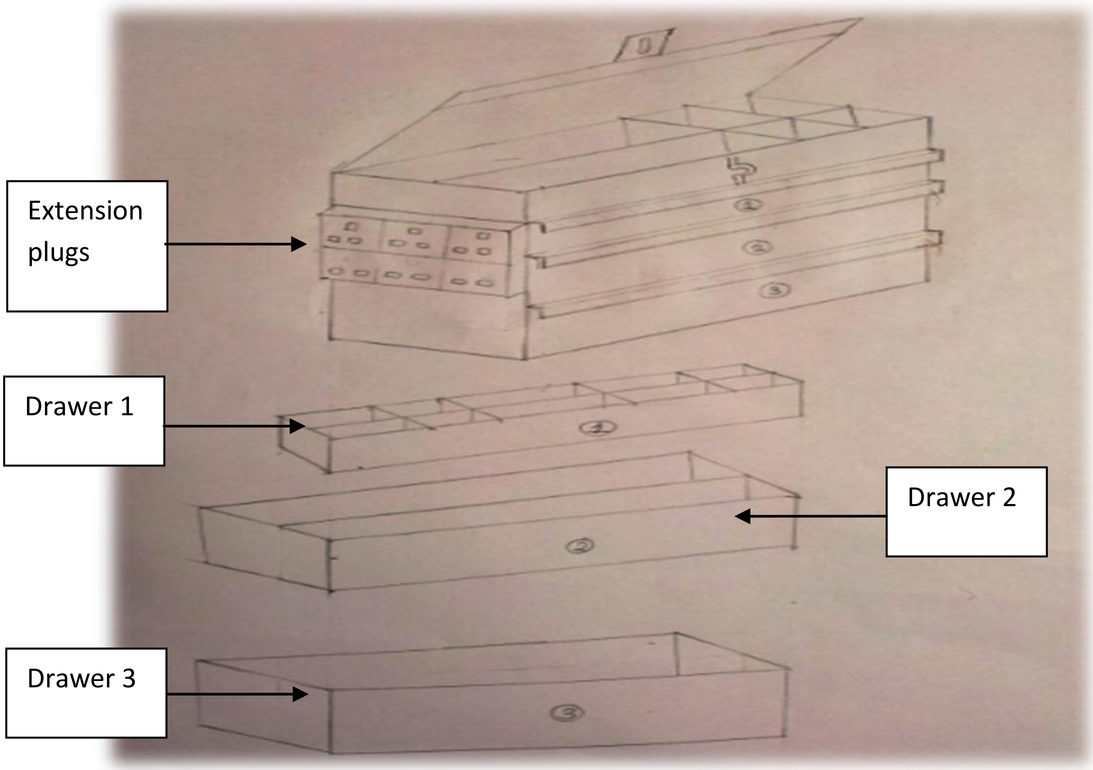

Figure 3.2: Concept A

Figure 3.2 shows the first concept design. It has three drawers where the first drawer have divided compartment to put small things such as nut, bolts, and nails. Second drawer acts a compartment to put tools which a wireman uses frequently such as screwdriver, wire stripper, test pen, long nose pliers, multimeter and so on. It also has a divided compartment so that the wireman can arranged his tools according to his ease. The third drawer is an optional drawer where the wireman can put things such as fuse, wires, and power tools as the third drawer is slightly deeper than the second drawer. There are extension plugs attached to the smart rack gadget as this will aid the wireman during his work when the power source is far from his working area. There are six plug sockets where three sockets for three pinned plugs and another three for two pinned plugs. The advantages of this smart rack gadget are it is durable which mean that it can handle the impact of the tools on it, storage capacity is big where more tools and things can be stored in it and it has a good appearance. The disadvantages of this smart rack gadget are it is difficult to move from one place to another as it is not moveable. It is also expensive as the size is bigger.

3.3.2 CONCEPT B

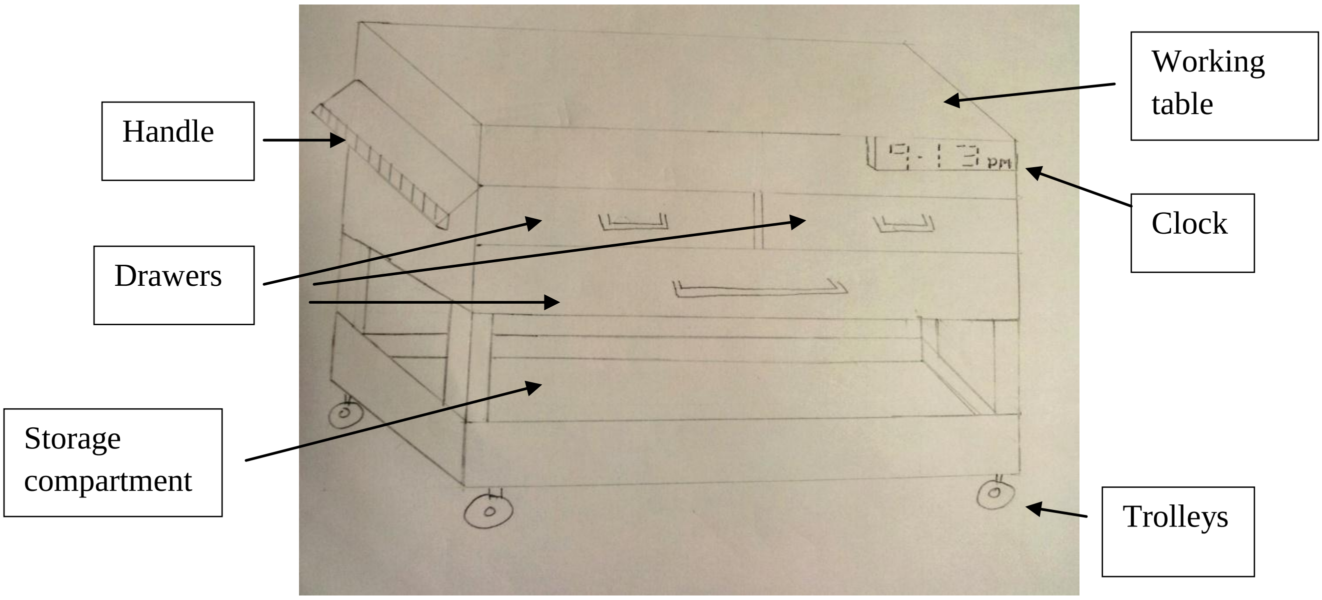

Figure 3.3: Concept B

Figure 3.3 shows second concept design. It is a bigger smart rack gadget compared to concept A as it have three drawers, working table, storage compartment, clock and trolley to mobilize from one place to another. The three drawers are place where the tools and equipment used by the wireman is stored where these three drawers have more storage capacity. The working table is introduced in this concept to ease the wireman for using the working table during his work or to put things for a while. He also can perform marking and measuring process on the table as well. The clock is installed in this smart rack gadget to provide exact time during a wireman working days so that he can plan his work according to time. Trolleys are fixed to this smart rack gadget so that it can be moved from one place to another. Below the drawers, there is a big storage compartment where the wireman can placed things such as bulbs, fuse, wires, and extension plugs. The advantages of this smart rack gadget are it has big storage capacity, durable and portable as well. It can withstand heavy load as its size is bigger. The disadvantages are it can only be used at ground level as the size of this smart rack gadget is big and it cannot be pushed up the stairs. It also is very expensive due to its big storage capacity and the design has a very dull appearance as it is huge and not attractive.

3.3.3 CONCEPT C

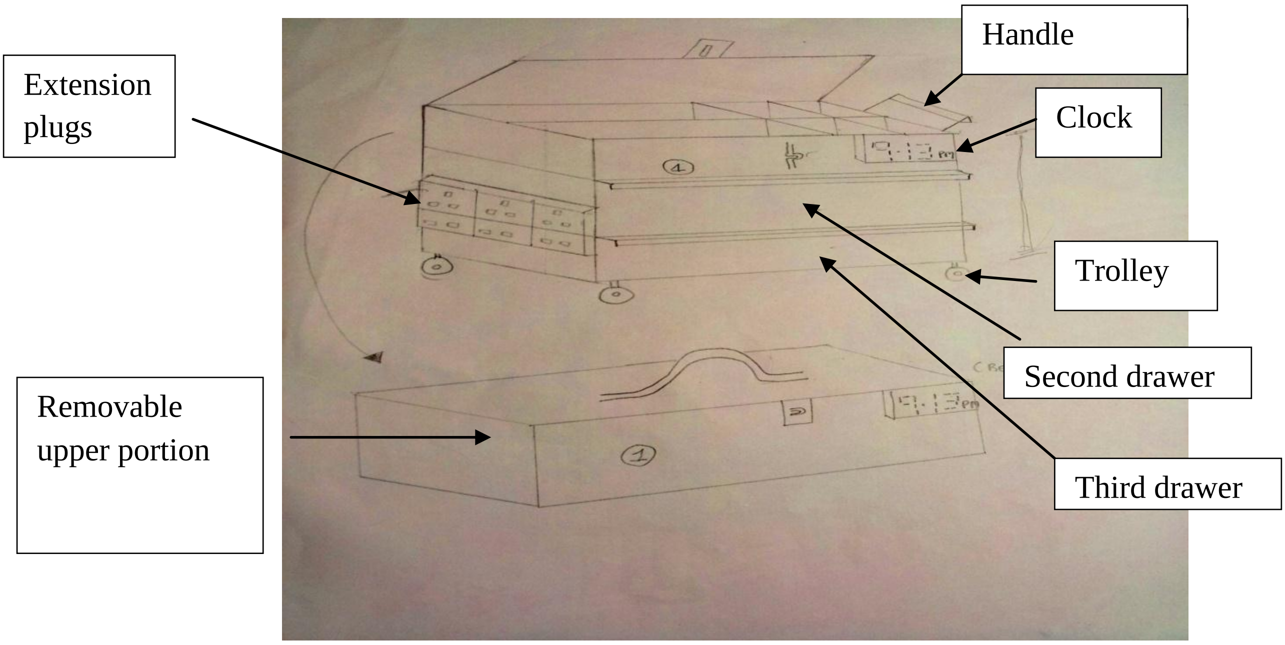

Figure 3.4: Concept C

Figure 3.4 shows the third concept design. It has three drawers where first drawer is a removable section as it is a small toolbox. The idea of a small toolbox is to provide a choice for the wireman to store his frequently used tools in this small tools box where it not only functions as a storage section but it also can be removed from the smart rack gadget for minor maintenance work. The wireman does not have to bring the entire smart rack gadget in order to perform a normal repairing with the help of this small toolbox. The second drawer and the third drawer are spacious partition to store tools and equipments. Clock system is installed to the smart rack gadget where it is situated at the small toolbox. Next, the smart rack gadget is transportable as it has trolleys. Extension plugs are fixed at the side of the smart rack gadget to ease the wireman when the power source is far from his working area. The advantages of this smart rack gadget are it can be move from one place to another as it is portable. It comes with small toolbox where it can be used for normal repairing work without bringing the whole smart rack gadget. This type of smart rack gadget has big storage capacity and it can withstand heavy loads too. Its design is very attractive and multifunction as well. It is durable and robust. However, the disadvantage of this smart rack gadget is it is quite expensive as it emphasizes on multifunctional concept.

3.3.4 CONCEPT D

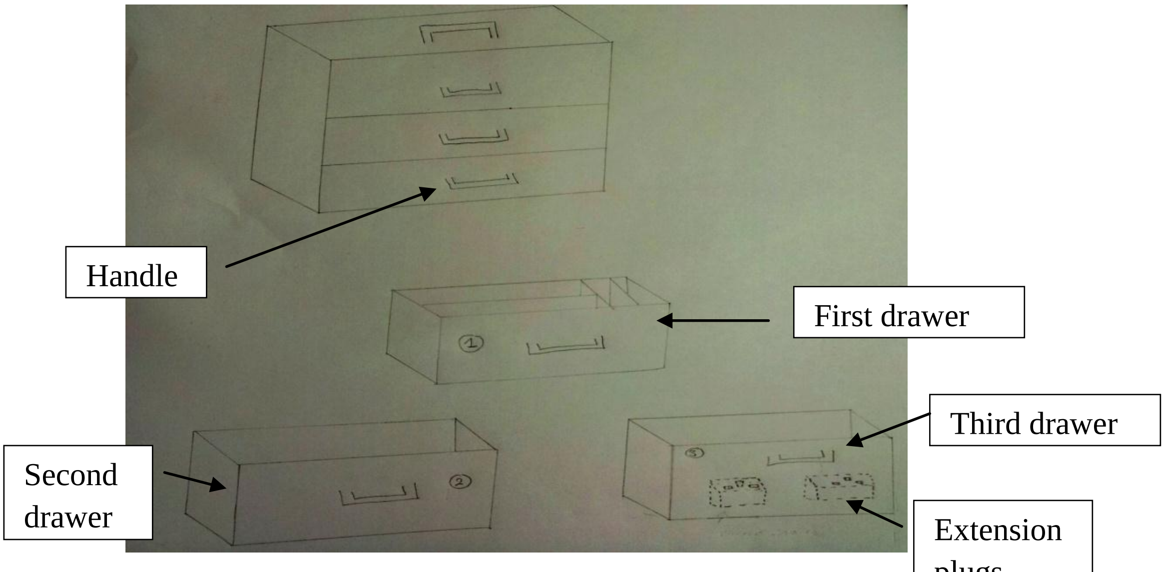

Figure 3.5: Concept D

Figure 3.5 shows the fourth concept design. It is also another design of smart rack gadget where it consist three drawers as well. The first drawer has divided compartment to put small things such as bolts, nuts and screws. The bigger divided sections in the first drawer are to store frequently used tools by the wireman where he may arrange them according to his ease. The second drawer is an open section where the wireman can put things such as wires, bulbs or power tools. The third drawer is a non functional as it contains extension plugs only. The extension plugs are directly installed in the third drawer to protect them from dirt and humid environment because dust may cause the lifespan of the extension plugs to reduce. It is still portable as the size of this smart rack gadget is small.

3.4 EVALUATION PROCESS

After all four concept designs have been sketched, the following process is to evaluate the sketching to sort out the criteria of each concept design. Firstly, screening process is done. Then, the evaluation process is ended with a scoring process. At this point, both of this evaluation process will conclude which concept designs should be developed.

3.4.1 CONCEPT SCREENING

Figure 3.6 below shows the concept screening process. All concept design will be evaluated based on the selection criteria which are storage capacity, size, durability, portability, appearance, cost and ability to withstand load. Figure 2.5 which is the cantilever smart rack gadget is used as the reference in the screening process. Design concepts which have the same selection criteria with the reference are given a (0) sign, (+) sign is given to concept design which has better criteria than the reference meanwhile (-) sign is given to concept design which has lower criteria than the reference. Then, the obtained (+), (0), (-) signs are sum up so that they can be calculated. The net score is calculated by subtracting the sum of (+) signs with sum of (-) signs. Later, the concept design is ranked based on the net score value. After the screening process, it shows that concept design concept design C ranked first followed by D, B and finally A.

Concept C and Concept D can be combined together in order to obtain a better result while concept A is dropped as it scored the least net score. Concept B can be forwarded together with combined Concept C and D to scoring process.

	Concepts				
Selection criteria	**A**	**B**	**C**	**D**	**Ref**
Durability	0	+	0	0	0
Cost	–	–	–	+	0
Appearance	+	–	+	+	0
Storage Capacity	+	+	+	+	0
Size	+	+	+	0	0
Portability	–	+	+	+	0
Ability to withstand load	+	+	+	–	0
Sum +'s	4	5	5	4	
Sum 0's	1	0	1	2	
Sum –'s	2	2	1	1	
Net score	2	3	4	3	
Rank	4	3	1	2	
Continue?	NO	YES	COMBINE	COMBINE	

Figure 3.6: Concept screening

3.4.2 CONCEPT SCORING

		Concepts			
		B		**CD**	
Selection criteria	**weight**	**Rating**	**Weighted score**	**Rating**	**Weighted score**
Cost	10%	2	0.2	4	0.4
Portability	15%	4	0.6	4	0.6
Durability	10%	4	0.4	4	0.4
Storage capacity	25%	3	0.75	4	1.0
Size	5%	2	0.1	3	0.15
Appearance	5%	4	0.2	3	0.15
Ability to withstand load	30%	3	0.9	3	0.9
Total score		3.15		3.6	
Rank		2		1	
Continue		No		Develop	

FIGURE 3.7: Concept Scoring

Figure 3.7 above shows the concept scoring process. The selected criteria will be weighted and given rating so that which concept design to be developed can be finalized. The score are calculated by multiplying the weight of the selection criteria with the given rating. The ratings are given based on the importance of the selection criteria. The total score is then added together in order to rank the concept design. From Figure 3.7 above, it shows that combined concept design CD scored the highest total score and ranked the first. As a result, concept design will be built up as the final concept.

3.5 FINALIZE CONCEPT

After obtaining the final screening and scoring result, the finalize concept is built up once all the criteria has been taken into consideration.

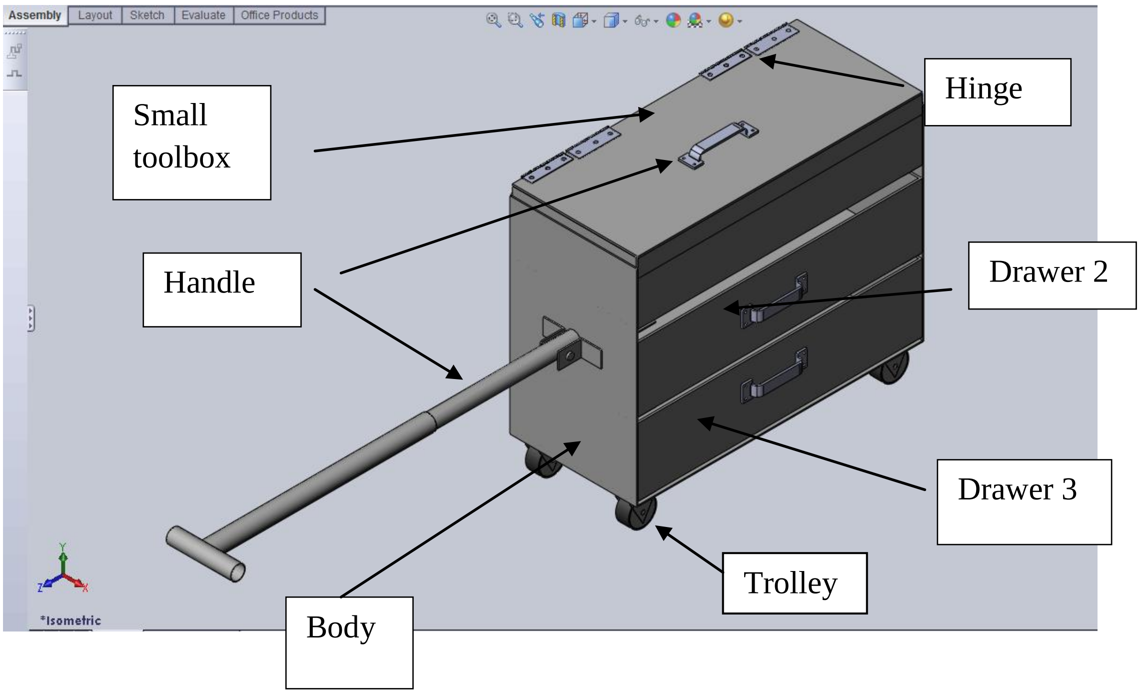

Figure 3.8: Finalize concept

Figure 3.8 shows the Solidworks drawing of the final concept that need to be fabricated. Based on the Figure 3.8 above, the finalize concept consist of two drawers and one small toolbox which is fixed at the upper portion of the smart rack gadget. The extension plugs are fixed into the third drawer. Trolley and holder are joined to the smart rack gadget so that the smart rack gadget is portable. Both second drawer and third drawer can be slide out thoroughly so that the second drawer and third drawer can used as secondary toolbox The advantages of this finalize concept are it is portable, have high storage capacity, the ability to withstand load is better. It is also robust and durable. The disadvantages of this finalize concept is that it is big.

3.6 BILL OF MATERIAL

Bill of material is to show the materials needed and also its dimension and quantity.

Table 3.1: Bill of Material (BOM)

Parts	Material	Dimension (mm)	Quantity
1	Galvanized iron	410 x 439	1
2	Galvanized iron	510 x 26	2
3	Galvanized iron	391 x 439	3
4	Galvanized iron	291x 13	2
5	Galvanized iron	292 x 13	2
6	Galvanized iron	298 x 150	1
7	Galvanized iron	137x 11	3
8	Galvanized iron	97 x 439	1
9	Hinge	65 x 40 x Ø 5	2
10	Hinge	35 x 20 x Ø 5	2
11	Handle	100 x 25 x Ø 5	3
12	Trolley	50 x 50 x Ø 40	4
13	Door lock		1

3.7 FABRICATION PROCESS

As the final outlook of the product is generated and the bill of material have been listed down. Next step is the fabrication process. This is a crucial process where it is all about turning raw material into finished product based on the finalize concept. There are various types of method of fabrication that can be carried out to fabricate the product. Among all the fabrication process, here are some examples fabrication process applied to fabricating the product.

a) Material selection

Galvanized iron 2.0mm is chosen as the raw material to fabricate the smart rack gadget. This raw material has been chosen for fabrication of smart rack gadget as it is very cheap, robust, can withstand impact and very suitable to be used to built a smart rack gadget.

Galvanized iron 2.0mm

Figure 3.9: Galvanized iron sheet metal

b) Cutting process using shearing machine

Based on the bill of material, the dimension of the raw material need to be cut from the sheet metal is measured and marked. Then, the sheet metal is cut consistent to dimension stated in the bill of material. The shearing machine is used to cut the sheet metal according to needed size.

Figure 3.10: Shearing machine

c) Cutting process using hacksaw

Some of the raw material cannot be cut using a shearing machine as the dimension of the part is very small. Thus, in order to solve this problem, a hacksaw is used to cut this small scaled part.

Figure 3.11: Hacksaw

d) Bending machine

After all the required parts have been cut out precisely, next process is to bend the parts into required shape and angle.

Figure 3.12: Bending machine

e) Drilling process

Drilling process has to be carried out so that joining process can be continued. Drill bit is used to drill the hole on the work piece. A centre punch is used to mark the work piece in order to guide the drill bit to drill the hole accurately.

Figure 3.13: Drill press

f) Grinding process

Grinding process is done to reduce the dimension of the work piece or to remove away the burr. Process of removing away the burr is called deburring process.

Figure 3.14: Grinding process

g) Welding process

After all the process of cutting, drilling, grinding is done. Now, the process of assembling the materials into product is done by using welding process. Arc welding have been chosen as the joining process as it is easy to be controlled and managed.

Figure 3.15: Arc welding

h) Joining process

Some of the parts that cannot be welded are joined onto the work piece by using riveting process. A rivet is put into the drilled hole and a riveter is used to join the parts.

Figure 3.16: Riveting process

i) Finishing process

As all the raw material have been assembled together. Finishing process is carried out to provide a better appearance to the product. Spraying method has been chosen as the final finishing

Figure 3.17: Finishing process

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter will further verify about the fabricated finalize concept. Explanation regarding about design of the product with more specific data such as details like weight and its working mechanism is provided as well. Cost analysis will be explained in this chapter.

4.2 RESULT

Smart rack gadget is painted in metallic blue and black mist. It consists of two drawers which are drawer two and drawer three. The upper portion of the smart rack gadget is a removable small toolbox. The second and third drawer acts as sections to put tools and equipment such as power tools, wires, fuse and so on. Trolley and a handle are fixed to the smart rack gadget in order to make the smart rack gadget portable.

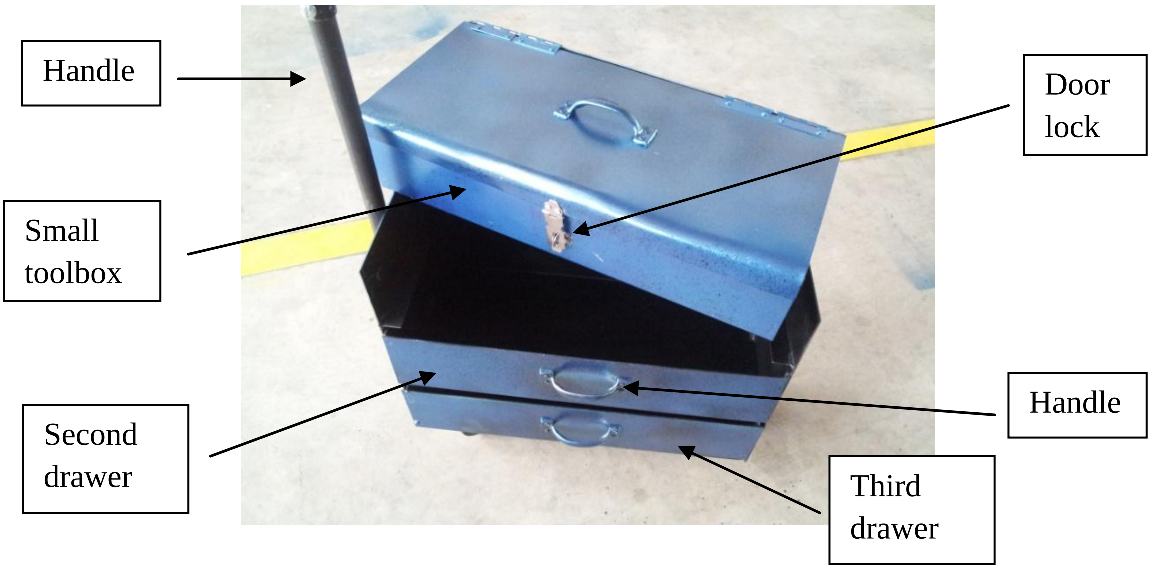

Figure 4.1: Top view

Figure 4.2: Interior view

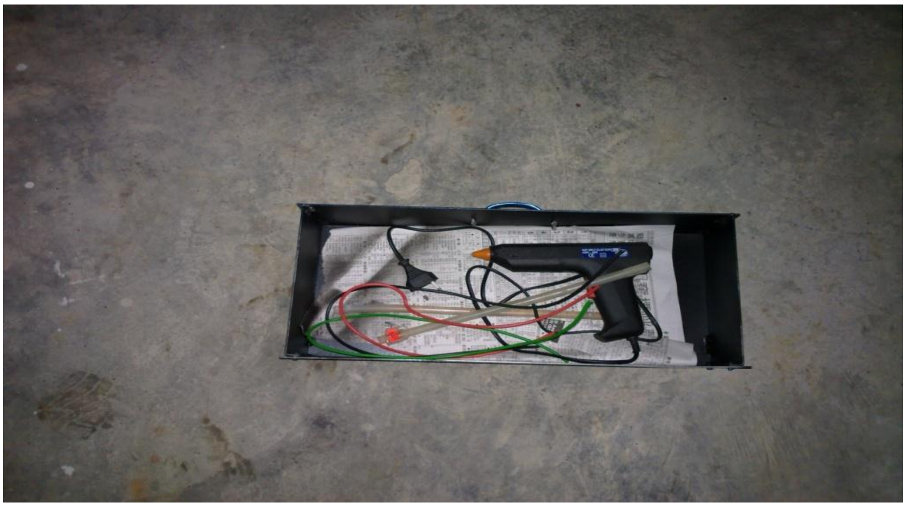

Figure 4.3: Second drawer view

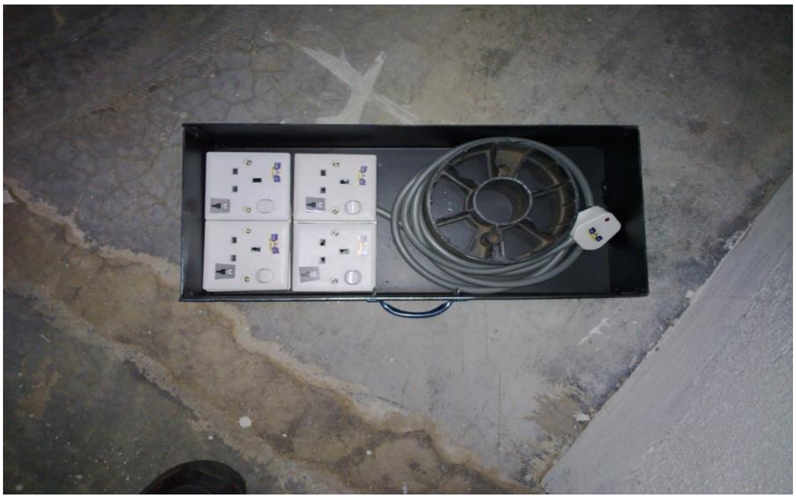

Figure 4.4: Third Drawer view

Figure 4.5: Full view

4.2.1 PRODUCT SPECIFICATIONS

The specifications of the product are listed in Table 4.1.

Table 4.1: Product specifications

Specifications	**Results**
Length	195 mm
Width	439 mm
Height	315 mm
Weight	15 kg (real weight)
Colour	Metallic Blue and Black mist
Number of drawers	2

Moment of inertia and mass estimation is calculated by using Solidworks software. The details of the calculation are shown in Figure 4.6.

```
Mass = 4615.09 grams

Volume = 4615090.03 cubic millimeters

Surface area = 2694803.23 millimeters^2

Center of mass: ( millimeters )
	X = -62.17
	Y = -26.70
	Z = 16.85

Principal axes of inertia and principal moments of inertia: ( grams * square millimeters )
Taken at the center of mass.
	 Ix = (0.00, -0.01, 1.00)   	Px = 71592853.48
	 Iy = (-0.08, -1.00, -0.01)   	Py = 128116604.68
	 Iz = (1.00, -0.08, -0.00)   	Pz = 158324253.68

Moments of inertia: ( grams * square millimeters )
Taken at the center of mass and aligned with the output coordinate system.
	Lxx = 158127785.64	Lxy = 2421868.40	Lxz = 254453.24
	Lyx = 2421868.40	Lyy = 128305440.67	Lyz = -631568.70
	Lzx = 254453.24	Lzy = -631568.70	Lzz = 71600485.54

Moments of inertia: ( grams * square millimeters )
Taken at the output coordinate system.
	Ixx = 162728679.07	Ixy = 10081781.45	Ixz = -4581123.69
	Iyx = 10081781.45	Iyy = 147451531.15	Iyz = -2708386.01
	Izx = -4581123.69	Izy = -2708386.01	Izz = 92725348.35
```

Figure 4.6: Solidworks estimation

4.2.2 FRICTION ANALYSIS

Friction is a force which resists the relative motion of solid surfaces, fluid layer and materials that slides against each other. There are two types of friction which are static friction and kinetic friction.

Static friction is a friction between two solid objects which are not moving relative to each other. Static friction must be overcome in order to move an object. This type of friction also can prevent an object from sliding down a sloped surface. Coefficient of static friction always denoted as µs. The formula for static friction is:

(Friction force) = (Coefficient of static friction) (Normal Force)

where the value of coefficient of friction between rubber and concrete 1.0 (dry) and 0.3 (wet).

Kinetic friction is a friction that occurs between two objects when they move relatively to each other and rub together. The coefficient of kinetic friction is given symbol μk. The value of coefficient of kinetic friction will always be less than coefficient of static kinetic. The formula to find friction using coefficient of kinetic friction is:

(Friction force) = (Coefficient of kinetic friction) (Normal Force)

where Coefficient of kinetic friction between concrete and rubber is 0.8 (dry).

Based on data above,

N = mg,

(Static friction force) = (Coefficient of static friction) (Normal Force),

(Kinetic friction force) = (Coefficient of kinetic friction) (Normal Force),

(R.C. Hibbeler, 2009)

Where**:**

m = mass (15 kg)

g = gravity (9.81 ms-2)

Coefficient of static friction = 1.0,

(Serway, Raymond A. & Robert J. Beichner, 2006)

Coefficient of kinetic friction = 0.8,

(Serway, Raymond A. and Robert J. Beichner, 2006)

Thus,

Friction force = (15 kg) (9.81 ms-2) (1.0)

= 147.15 N (Static friction)

Pulling Force - Friction force= (15 kg) (9.81 ms-2) (0.8)

200 N - Frictional force = 117.72 N

= 82.28 N (Kinetic friction)

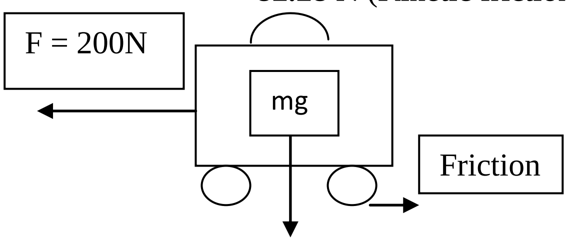

Figure 4.7: Free body diagram

4.2.3 COST ANALYSIS

Cost analysis is an important analysis as this will determine the price of the smart rack gadget. The price of the produce is calculated by referring to material used in fabrication process excluding labour cost, machining cost and others. The estimated price is detailed in Table 4.2.

Table 4.2: Price estimation

Part	**Dimension/Unit**	**Price**
Galvanized iron	4575mm X 2482mm	RM 144.20
Trolley	50 x 50 x Ø 40	RM 34.00
Handle	3 unit	RM 3.00
Door lock	1unit	RM 3.60
Screws	8 unit	RM 1.00
Hinge	5 unit	RM 3.00
Spray	3 unit	RM 42.50
	Total price	**RM 231.20**

4.2.4 STRESS ANALYSIS

Solidworks software is used to generate the data regarding about fracture analysis using Simulation Xpress software. This software is used to study the maximum load that can be applied to a handle. The result of the study is shown as in contour form in Figure 4.8.

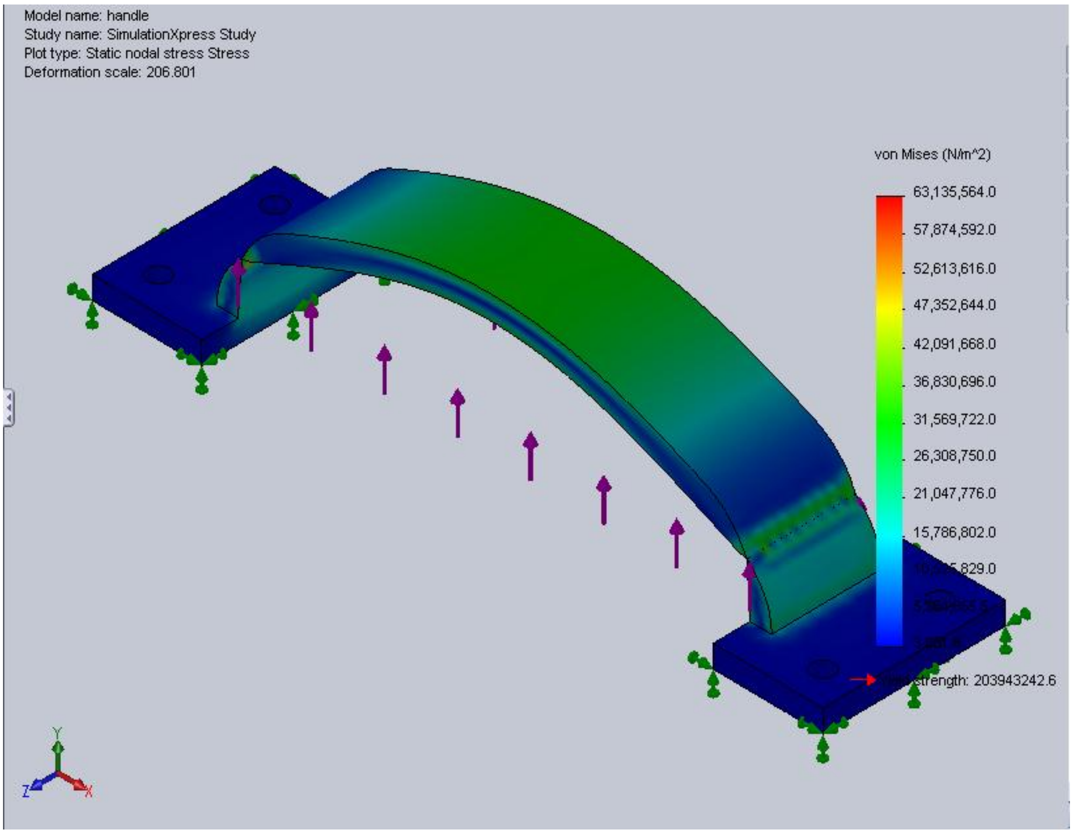

Figure 4.8: Stress analysis of the handle

Based on the Figure 4.8, the blue colour shows the lowest stress application, green colour shows medium stress application on the handle. Meanwhile, red and orange colour shows the highest application of stress on the handle which may result to fracture of the handle. Thus, it can be concluded that the handle can withstand the stress that applied on it and it is safe for use and can support the whole weight of the small toolbox.

Table 4.3: Result of stress analysis of the handle

Name	Type	Min	Max
Stress	Von Mises Stress	3861.8 N/m^2	6.31356×10^7 N/m^2

Table 4.4: Tensile test analysis of the handle

Property Name	Value
Elastic modulus	5.43×10^{11} N/m^2
Poisson's ratio	0.45 NA
Mass density	12870 kg/m^3
Tensile strength	3.569×10^8 N/m^2
Yield strength	2.0394×10^8 N/m^2

4.3 DISCUSSION

The advantages and disadvantages of the smart rack gadget will be listed down and be clearly explained, the problem faced during fabrication and defects that occurs during fabrication will also be specifically mentioned.

4.3.1 ADVANTAGES AND DISADVANTAGES

There are several advantages and disadvantages of the product. The advantages of the product are as below:

i. Easy to arrange the tools and equipment in an organized manner.

ii. The smart rack gadget is portable. Thus, it is easier to bring the smart rack gadget from one working area to another.

iii. The storage capacity is high as the provided drawers are wide and deep so more tools and equipment can be placed in the smart rack gadget.

iv. The smart rack gadget has high ability to withstand load. Therefore, it will not spoil due to heavy load of tools and equipment regarding that the maximum load of the smart rack gadget is not exceeded.

v. The smart rack gadget comes with a small toolbox where this toolbox can be used during normal maintenance or repairing works without having to bring the whole smart rack gadget to the working area.

vi. The smart rack gadget possesses extension plugs which can be used at place where the power source is far from the working area.

vii. The smart rack gadget is durable, impact resistance and rust resistance.

However, the smart rack gadget does also have several disadvantages such as:

i. The size of the smart rack gadget is big which make its appearance to be dull.

ii. The smart rack gadget will not be portable if the trolley is broken or wear out due to friction.

iii. The smart rack gadget is heavy which this may cause discomfort during handling it.

.

4.3.2 TYPE OF DEFECT

There are plenty of defects that occur during the fabrication of the smart rack gadget. Some of the defects occur due to the error of machine while others are mainly due to lack of fabrication skills. The types of defects in the product are as below:

i. The welding process cannot be carried out neatly as the electrode tend to stick with the sheet metal causing the welded part to been seen clearly even though finishing process is done. This problem mainly arises due to lack of welding skills and problem with handling the welding machine.

ii. There are some gaps between drawers and small toolbox. This defect occurs due to inaccurate measurement of distance between the drawers and small toolbox.

4.3.3 PROBLEM FACED

There are also several problems faced during the fabrication process. Material selection was one of the biggest problems. In order to find the most suitable raw material for the smart rack gadget, research and information are searched through reliable source. Wrong selection of material will cause a lot of difficulties during fabrication process and will lead to more trouble in the future.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This final chapter emphasizes on conclusion and recommendation regarding the fabricated project. The conclusion covers the throughout conclusion of all the process involved in producing the smart rack gadget and pictures the overall cycle of the project. Recommendations are given in order to improve the product in future.

5.2 CONCLUSION

As a conclusion, the objectives of this project are achieved as the designed smart rack gadget is multifunction and portable as well. The smart rack gadget will help to make the work of a wireman easier as it will not only function as place to put tools and equipment but also as a multifunction rack gadget as well. The smart rack gadget can be brought to all the working area of a wireman as it is moveable from one place to another. The small toolbox also will aid the wireman during simple repairing and maintenance work where the wireman can put his required tools and equipment in this small tool box rather than to bring the whole smart rack gadget to his working place. I have faced a lot of troubles and obstacles while I am fabricating this smart rack gadget. The breakdown of several important machines such as MIG welding machine and Bending Machine at Pekan Mechanical lab has given enormous amount of pressure. I was struggling with time in order to finish up my project right on time. I have given all of my hard work, knowledge that I have gained so far and mechanical skills that I have developed to manufacture this product. I have learned a lot along the way I am fabricating this smart rack gadget related to machining skills, self discipline and time management.

5.3 RECOMMENDATION

There are some recommendations and ideas that can be applied onto the smart rack gadget in order to improve the function of the product and make the smart rack gadget more useful. The recommendations are as below:

i. Design

   The design of the smart rack gadget can be develop to make its appearance far better than now. The aesthetic value of the smart rack gadget can be increased by applying better paint onto the smart rack gadget to make it more eye-catching. The size of the smart rack gadget also might be reduced so that it is lighter and easier to be managed.

ii. Raw material

   The weight of the smart rack gadget can be reduced if materials such as zinc or aluminium are used to make it. The durability and ability to withstand resistance can be increased as well.

iii. Function

   The smart rack gadget can be introduced extra function such as it can be used as a ladder, there a working table installed to the product. Slots for putting multimeter, walkman or i-pod are built on it to provide satisfaction to the wireman.

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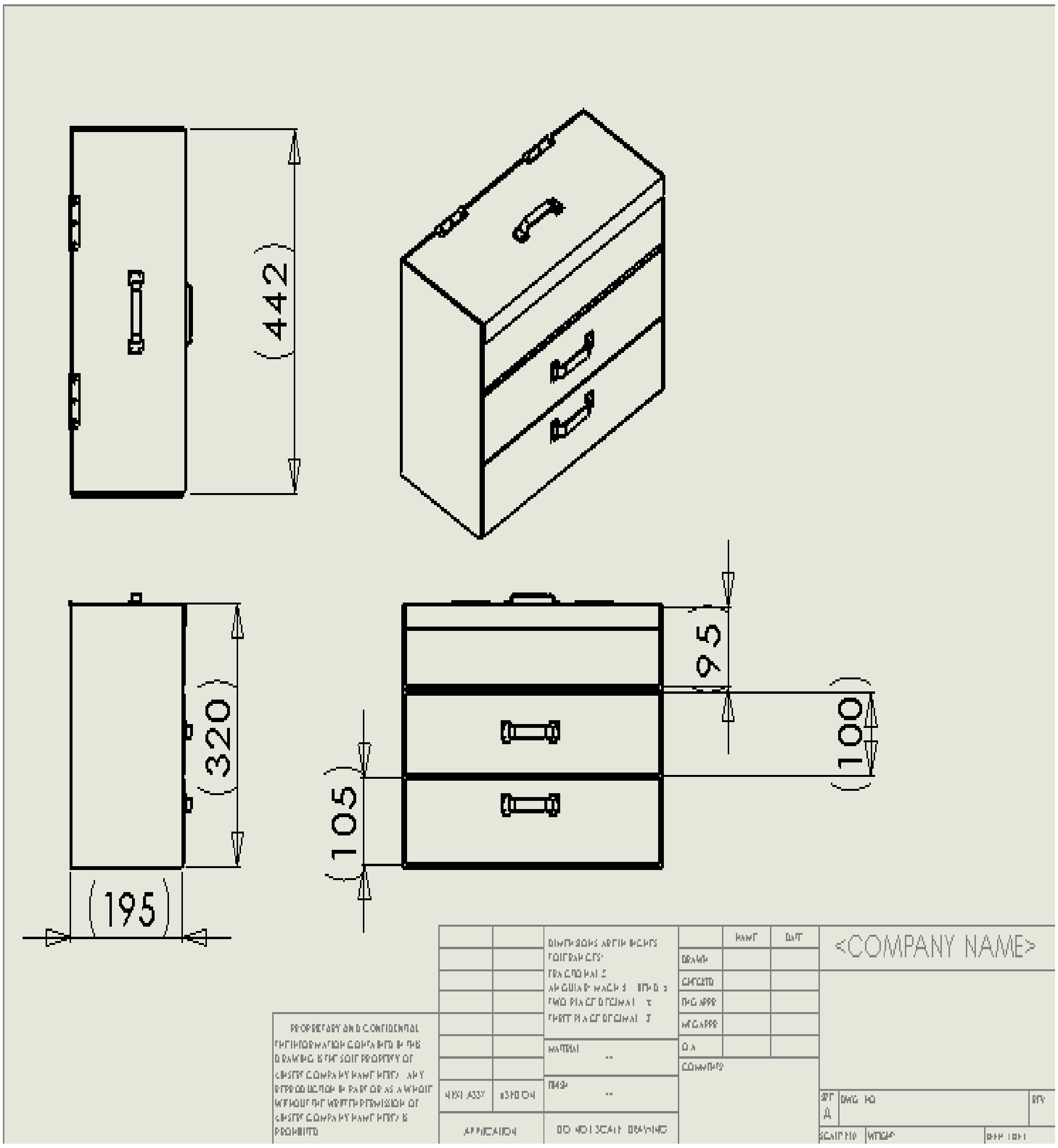
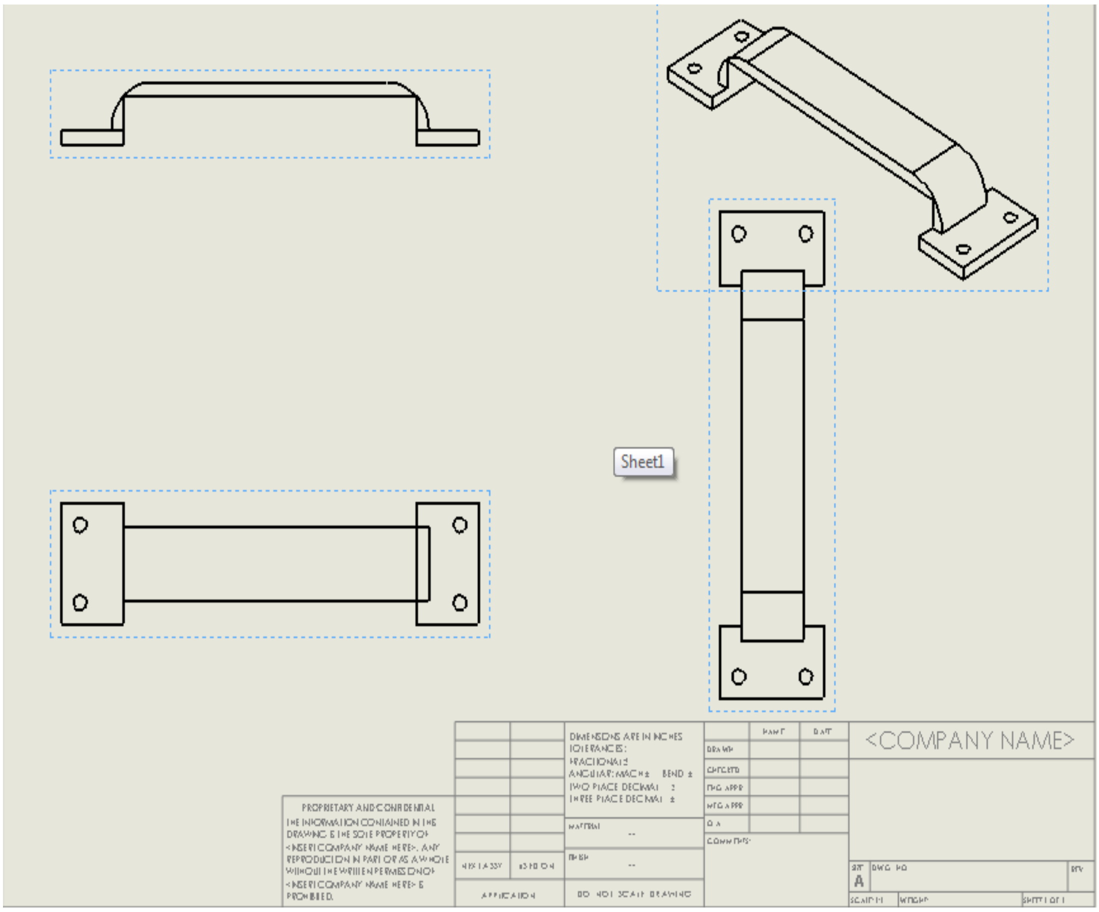
APPENDIX A



APPENDIX B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DIMENSIONS ARE IN INCHES
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APPLICATION
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SIGITHASAN A/L NAGANTHERAM DIPLOMA IN MECHANICAL ENGINEERING 2011 UMP

DESIGN AND FABRICATION OF SMART RACK GADGET

SIGITHASAN A/L NAGANTHERAM

Report submitted in partial fulfilment of the requirements
for the award of Diploma in Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2011

SUPERVISOR'S DECLARATION

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

Signature:
Name of Supervisor: EN ZULKIFLI BIN AHMAD @ MANAP
Position: LECTURER
Date: 23 DECEMBER 2011

STUDENT'S DECLARATION

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

Signature:
Name: SIGITHASAN A/L NAGANTHERAM
ID Number: MB09014
Date: 23 DECEMBER 2011

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I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I acknowledge the sincerity of my parents, who consistently encouraged me to carry on my higher studies in Malaysia. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my committee members. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRACT

The objective of this thesis is to design and fabricate a smart rack gadget for the use of wiremen that is portable and multifunction as well. This smart rack gadget is multifunctional as it possesses extra features such as a removable small tool box and extension plugs. The smart rack gadget can be used to store tools and equipment which used by wiremen such as test pen, wire stripper, Phillips screwdriver and so on. The smart rack gadget can uphold a maximum load of 25 Kg. The material selected for fabrication process is Galvanized iron sheets as it is cheap and easy to be fabricated. Other materials that are used in fabricating this smart rack gadget are handle, lock, and door slot, fasteners such as screws and rivets. The process have been involved in this project are cutting, bending, drilling, welding, riveting, and finishing. Solidwork Simulation Xpress software is used to simulate the stress analysis which occurs at critical part of the smart rack gadget such as the handle. Friction analysis is carried out to find the friction force that occurs at the trolley. Lastly, the objective of the project is achieved since the new smart rack gadget is portable and multifunction as well. It would ease the work of wiremen during their working hours.

ABSTRAK

Objektif projek ini adalah untuk mereka dan membuat satu kotak peralatan untuk juruelektrik yang mudah alih dan mempunyai fungsi-fungsi yang lain. Kotak peralatan ini mempunyai fungsi seperti kotak peralatan kecil yang boleh dikeluarkan dan soket dan palam lanjutan. Kotak peralatan ini boleh digunakan untuk menyimpan peralatan yang digunakan oleh juruelektrik. Kotak peralatan ini boleh menampung berat maksimum sebanyak 25 Kg. Bahan yang digunakan untuk membuat kotak peralatan ini adalah besi galvanized kerana besi ini amat murah dan senang untuk dibentuk. Bahan lain yang digunakan untuk membuat kotak peralatan ini adalah pemegang, pengunci pintu, pengikat seperti skru dan rivet. Proses yang terlibat dalam membuat kotak peralatan ini adalah pemotongan, kimpalan, pembentukan, rivet dan cat. Solidwork Simulation Xpress digunakan untuk menganalisa beban maksima yang boleh ditanggung oleh pemegang. Analisa geseran telah dikira untuk memgetahui nilai geseran di antara roda dan lantai. Akhir sekali, objektif projek ini telah dicapai. Kotak peralatan ini boleh memudahkan kerja juruelektrik untuk menyusun dan meletakkan peralatan yang digunakan olehnya.

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