

MULTIFUNCTION TROLLEY
(CHILDREN)

MUHAMMAD IZZAT SHAZALI BIN
MOHD RAMLI

UNIVERSITI MALAYSIA PAHANG

MULTIFUNCTION TROLLEY
(CHILDREN)

MUHAMMAD IZZAT SHAZALI BIN MOHD RAMLI

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

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2009

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS ♦

JUDUL: MULTIFUNCTION TROLLEY

SESI PENGAJIAN: 2009/2010

Saya, MUHAMMAD IZZAT SHAZALI BIN MOHD RAMLI (891124-14-5765)

mengaku membenarkan tesis Projek Tahun Akhir ini disimpan di perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis ini adalah hakmilik Universiti Malaysia Pahang (UMP).
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi / badan di mana penyelidikan dijalankan)

☒

TIDAK TERHAD

Disahkan oleh:

(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

Alamat Tetap:

No 103 Dataran Rapat Baru 11,
Taman Seri Berjaya,
31350, Ipoh
Perak.

MOHD AZRUL HISHAM BIN HJ MOHD ADIB
(Nama Penyelia)

Tarikh: 24 November 2009

Tarikh: 24 November 2009

CATATAN: * Potong yang tidak berkenaan.

- ** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.
- ♦ Tesis dimaksudkan sebagai tesis bagi Diploma secara penyelidikan atau disertai bagi pengajian secara kerja kursus.

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 the degree of Diploma of Mechanical Engineering

Signature :

Supervisor Name : MR AZRUL HISHAM BIN HJ MOHD ADIB

Position : TUTOR

Date : 24 NOVEMBER 2009

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.

Signature :

Name : MUHAMMAD IZZAT SHAZALI BIN MOHD RAMLI

ID Number : MB07082

Date : 24 NOVEMBER 2009

ACKNOWLEDGEMENTS

I would like to express my gratitude and appreciation to all those who gave me the courage to complete this report. A special thanks is due to my supervisor Mr. Azrul Hisham bin Hj Mohd Adib whose help, stimulating suggestions and encouragement helped me in all time of fabrication process and in writing this report.

I would also like to acknowledge with much appreciation the crucial role of the staff in Mechanical Laboratory, who gave me a permission to use the mechanical equipment and also the machine and to design the drawing and giving a permission to use all the necessary tools in the laboratory.

Many thanks go to the all lecturer and supervisors who have given their full effort in guiding the team in achieving the goal as well as their encouragement to maintain our progress in track. My profound thanks go to all classmates, especially to my friends for spending their time in helping and giving support whenever I need it in fabricating my project.

ABSTRACT

This report is about development of trolley that always seen used. This trolley is normal shopping trolley but added with few multifunction. It also a device which is important in order to ease transportation and to decrease the load when we want to lift or transport heavy items from one place to another. The idea of the fabricating of this trolley is based on student's creativity. The selection of suitable materials in the fabricating of this trolley is a loaded material which has minimum weight, long life-span and can detain heavy load. For this project, the material that Materials that had been use consist of many kind of material such as hollow steel, aluminium, plate steel and others. In this report, we'll also be having more to the fabrication of this trolley.

ABSTRAK

Laporan ini membentangkan tentang troli yang sering kali digunakan. Troli merupakan troli membeli belah yang biasa digunakan tetapi dengan tambahan beberapa fungsi lain. Ia juga suatu perkakas yang penting untuk memudahkan pergerakan dan meringankan beban ketika hendak mengangkat atau mengubah barang yang berat dari satu tempat ke satu tempat. Idea pembentukan troli ini berdasarkan kreativiti pelajar sendiri. Pemilihan bahan yang sesuai untuk digunakan bagi pembentukan troli ini merupakan bahan yang mempunyai berat yang ringan, jangka hayat yang tahan lama dan boleh menahan beban yang berat. Di dalam projek ini bahan yang dicadangkan ialah teriri daripada beberapa bahan yang berlainan iaitu 'hollow steel', aluminum, plate steel dan sebagainya. Dalam laporan ini juga akan lebih memfokuskan kepada pembentukan troli.

TABLE OF CONTENTS

	Page
SUPERVISOR’S DECLARATION	ii
STUDENT’S DECLARATION	iii
ACKNOWLEDGEMENTS	iv
ABSTRACT	v
ABSTRAK	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	xii
LIST OF FIGURES	xiii

CHAPTER 1 INTRODUCTION

1.1	Background	1
1.2	Problem statement	1
1.3	Objective	2
1.4	Scope	2

CHAPTER 2 LITERATURE REVIEW

2.1	Background	3
2.2	Design	5
2.3	Type of trolley	7
	2.3.1 Hospital trolley	7
	2.3.2 Baggage trolley	8
	2.3.3 Shopping trolley	9
2.4	Basic Part	10
2.5	Joining Method	11
	2.5.1 Metal Inert Gas (MIG) Welding	11

2.6	Drilling process	13
	2.6.1 Drill Press	13
2.7	Grinding Process	14

CHAPTER 3 METHODOLOGY

3.1	Design	15
	3.1.1 Concept A	15
	3.1.2 Concept B	16
	3.1.3 Concept C	16
	3.1.4 Final Concept	18
3.2	Fabrication	19
	3.2.1 Measuring	19
	3.2.2 Marking	19
	3.2.3 Cutting	20
	3.2.4 Finishing	20
	3.2.5 Joining	21
3.3	Basic Component	22
	3.3.1 Adjustable rod handle	22
	3.3.2 Wheel	23
	3.3.3 Basket Holder	24
	3.3.4 Trolley Holder	25
	3.3.5 Trolley plate	25
	3.3.6 Basket	26

CHAPTER 4 RESULTS AND DISCUSSION

4.1	Final Product	27
4.2	Multifunction uses	28

	4.2.1	Trolley	28
	4.2.2	Cart	29
	4.2.3	Basket	29
	4.2.4	Portable trolley	30
4.3		How to use	31
4.4		Analysis	32
	4.4.1	Stress analysis	32
	4.4.2	Displacement analysis	33
4.5		Discussion	35
CHAPTER 5		CONCLUSSION AND RECOMMENDATION	
5.1		Conclusion	36
5.2		Recommendation	37
		REFERENCES	38
		APPENDIX	39

LIST OF TABLES

Table No.	Title	Page
1	Concept selection table	17
2	Displacement analysis result	33

LIST OF FIGURES

Figure No.	Title	Page
2.1	Shopping Trolley	3
2.2	Plastic shopping trolley	5
2.3	Yilin shopping Trolley	6
2.4	Plastic hospital trolley	7
2.5	Steel hospital trolley	7
2.6	Trolley for bag	8
2.7	Children trolley	9
2.8	Trolley	9
2.9	Metal Inert Gas (MIG) Welding	11
2.10	Schematic of Metal Inert Gas (MIG) Welding	12
2.11	Drill Press Machine	13
2.12	Grinder	14
3.1	Portable trolley	15
3.2	Basket	15
3.3	Numerous partition trolley	16
3.4	Big space trolley	16
3.5	Final design	18
3.6	Measuring process	19
3.7	Marking process	19
3.8	Cutting process	20

3.9	Grinding process	20
3.10	Welding process	21
3.11	Drilling process	21
3.12	Inner side	22
3.13	Outer side	22
3.14	Fix wheel	23
3.15	Adjustable wheel	23
3.16	Vertical rod and horizontal plate	24
3.17	Holder	25
3.18	Plate	25
3.19	Trolley basket	26
4.1	Final product	27
4.2	Trolley	28
4.3	Cart	29
4.4	Basket	29
4.5	Portable trolley	30
4.6	Trolley	31
4.7	Cart	31
4.8	Portable trolley	31
4.9	Stress analysis result for maximum load 100N	32
4.10	Displacement analysis result for maximum load 100N	33
4.11	Properties of material	34

LIST OF SYMBOLS

A	Area	m^2
g	Gravity	ms^{-2}
m	Mass	kg
W	Total load on beam	kg or N
F	Concentrated force	N

\

LIST OF ABBREVIATIONS

MIG	Metal Inert Gas Welding
SMAW	Shielded metal arc welding
UMP	Universiti Malaysia Pahang
DC	Direct Current

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

In human life, there has many things has been developed to make human life easier. Same with trolley, people have develops to make it more function. From that, there has been creating shopping trolley to transport or pick things in supermarket without hard work with added to place baby in the trolley while shopping. From that purpose, shopping trolley for kids also has to produce.

1.2 PROBLEM STATEMENT

For this project, its have few problem statement;

- (i) Usually trolley in the market just focused for adult used.
- (ii) Usually trolley only focused on one function only

1.3 OBJECTIVE

The objective of this project is to develop and fabricate the suitable multifunction trolley for children.

1.4 SCOPE

For this project, its only limited on the following scope;

- (i) This project focused on making a trolley for primary school children.
- (ii) This trolley is a portable and multifunction trolley.
- (iii) The maximum load can be applied to this trolley is limited to 10 kg.

CHAPTER 2

LITERATURE REVIEW

2.1 BACKGROUND

One of the first shopping carts were introduced on June 4, 1937, the invention of Sylvan Goldman, owner of the Humpty Dumpty supermarket chain in Oklahoma City. One night, in 1936, Goldman sat in his office wondering how customers might move more groceries. He stared idly at a wooden folding chair. Put a basket on the seat and wheels on the legs. [1]



Figure 2.1: Shopping trolley

Source: webzoom.freewebs (2008)

Their first shopping cart was a metal frame that held two wire baskets. Since they were inspired by the folding chair, Goldman called his carts "folding basket carriers". Another mechanic, Arthur Koster, developed a method to mass produce the carts by inventing an assembly line capable of forming and welding the wire. They advertised the invention as part of a new "No Basket Carrying Plan." [1]

The invention did not catch on immediately. Men found them effeminate; women found them suggestive of a baby carriage. "I've pushed my last baby buggy," an offended woman informed him. After hiring several male and female models to push his new invention around his store and demonstrate their utility, as well as greeters to explain their use, shopping carts became extremely popular and Goldman became a multimillionaire. Goldman continued to make modifications to his original design, and the basket size of the shopping cart increased as stores realized that their customers purchased more as its size increased. [1]

Today, most big-box stores and supermarkets have shopping carts for the convenience of the shoppers. Recent studies determined that cart less retailers such as Sears and J.C. Penney have suffered slow sales in recent years. Retailers that do use shopping carts, Wal-Mart among them, have had booming sales. In large part this could be attributed to the ease of shopping made possible by the shopping cart. [1]

2.2 DESIGN

Trolleys are a type of material handling aid on wheels designed to hold and transport products, tools or supplies and reduce or eliminate the need for lifting. Depending on the types of materials to be transported - trolleys can be plastic, metal or wooden. Wheel type and size can also vary depending on the types of terrain the trolley is traveling over and the work environment and can be lockable.



Figure 2.2: Plastic shopping trolley

Source: made-in-china (2009)

Almost all shopping carts are made of metal or plastic and designed to nest within each other in a line to facilitate moving many at one time, and to save on storage space. The carts can come in many sizes, with larger ones able to carry a child. There are also specialized carts designed for two children, and electric mobility scooters with baskets designed for disabled customers. 24,000 children in the USA are injured each year in shopping carts. Some stores have child carts that look like a car or van with a seat where a child can sit. Such "Car-Carts" or "Beans", as some call them in the cart business, may offer protection and convenience by keeping the child restrained, lower to the ground, protected from falling items, and amused.[2]



Figure 2.3:Yilin shopping trolley

Source: indiamart (2006)

Shopping carts are usually fitted with four caster wheels which can point in any direction to allow maneuvering. However, when any one wheel jams, the cart can become difficult to handle. Many carts only have swivel caster wheels on the front, while the rear ones are on a fixed axle. An alternative to the shopping cart is a small handheld shopping basket. A customer may prefer a basket for a small amount of merchandise.

A collapsible utility cart has a basket pivotally mounted to a forward facing, C-shaped cart frame. Nowadays, trolley became the most important things in transport a product or tools from one place to another.[2]

2.3 TYPE OF TROLLEY

2.3.1 Hospital trolley

It was a trolley that to brought medicine in the room. It was made to make a easier way for the nurses to brought the medicine from room to the another room. Besides that, it has many partition of space that can put a number of different medicines in the trolley.



Figure 2.4: Plastic hospital trolley

Source: accesshealth (2008)



Figure 2.5: Steel shopping trolley

Source: hisupplier (2008)

2.3.2 Baggage trolley

Luggage carts or Trolleys are small vehicles pushed by travelers (human-powered) to carry individual luggage, mostly suitcases. There are two major sizes: One for big luggage and one for small luggage. Carts have usually two parts for carrying luggage: A small section (basket) for Carry on luggage at the same level as the handle, and a lowered large section for suitcases and large bags. The carts are provided in airports, large bus stations, Hotels or train stations for transporting luggage and may be free of charge. They are sometimes owned by the operator of the establishment. In some facilities carts may be provided by a contractor such as Smart Carte for a rental fee. Below shown example of baggage trolley that usually use in hotel or airport.[2]



Figure 2.6: Trolley for bag

Source: alibaba (2007)

2.3.3 Shopping trolley

A shopping cart (also called trolley, carriage, shopping carriage, buggy, bascart, & basket) is a cart supplied by a shop, especially a supermarket, for use by customers inside the shop for transport of merchandise to the check-out counter during shopping, and often to the customer's car after paying as well. Often, customers are allowed to leave the carts in the parking lot, and store personnel, referred to as cart attendants, return the carts to the shop.[6]



Figure 2.7: Children trolley

Source: toysandinteriors (2007)



Figure 2.8: Trolley

Source: germes-online(2008)

2.4 BASIC PART

Basically the basic or the main part that usually use for trolley are;

- (i) **Wheel:** Usually made from rubber that joined together with the bolt and nut with steel frame to ensure strength.
- (ii) **Body:** For outdoor use such as warehouse or workshop that requires full strength of body, wire frame or sheet metal body is used. Some trolley doesn't have any body on it on purpose.
- (iii) **Handle Bar:** Usually all the trolley must have handle to provide less effort while using the trolley due to heavy it's loading.

2.5 JOINING METHOD

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



Figure 2.10: Metal Inert Gas (MIG) Welding

Source: thefabricator (2008)

2.5.1 Metal Inert Gas (MIG) Welding

MIG (Metal Inert Gas) or as it even is called GMAW (Gas Metal Arc Welding) uses an aluminum alloy wire as a combined electrode and filler material. The filler metal is added continuously and welding without filler-material is therefore not possible. Since all welding parameters are controlled by the welding machine, the process is also called semi-automatic welding.[3]

There are two different MIG-welding processes, conventional MIG and pulsed MIG:

- (i) Conventional MIG uses a constant voltage DC power source. Since the spray transfer is limited to a certain range of arc current. This also limits the application of conventional MIG to weld material thicknesses above 4 mm. Below 6 mm it is recommended that backing is used to control the weld bead.
- (ii) Pulsed MIG uses a DC power source with superimposed periodic pulses of high current. In this way pulsed MIG is possible to operate with lower current and heat input compared to conventional MIG. This makes it possible to weld thinner sections and weld much easily in difficult welding positions.

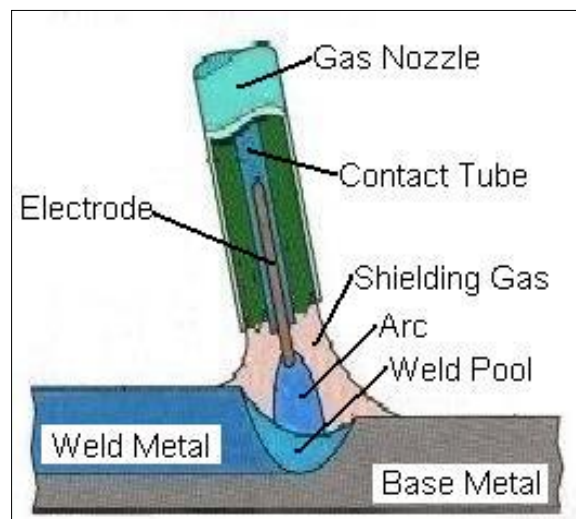


Figure 2.11: Schematic of Metal Inert Gas (MIG) Welding

Source: weldingengineer (2005)

Gas Metal Arc Welding (GMAW) is frequently referred to as MIG welding. MIG welding is a commonly used high deposition rate welding process. Wire is continuously fed from a spool. MIG welding is therefore referred to as a semiautomatic welding process.

2.6 DRILLING PROCESS

Drilling is easily the most common machining process.. Drilling involves the creation of holes that are right circular cylinders. This is accomplished most typically by using a twist drill, something most readers will have seen before. The chips must exit through the flutes to the outside of the tool. As can be seen in the figure, the cutting front is embedded within the work piece, making cooling difficult.[4]

2.6.1 Drill Press

A typical manual drill press is shown in the figure below. Compared to other powered metal cutting tools, a drill press is fairly simple, but it has evolved into a versatile necessity for every machine shop.

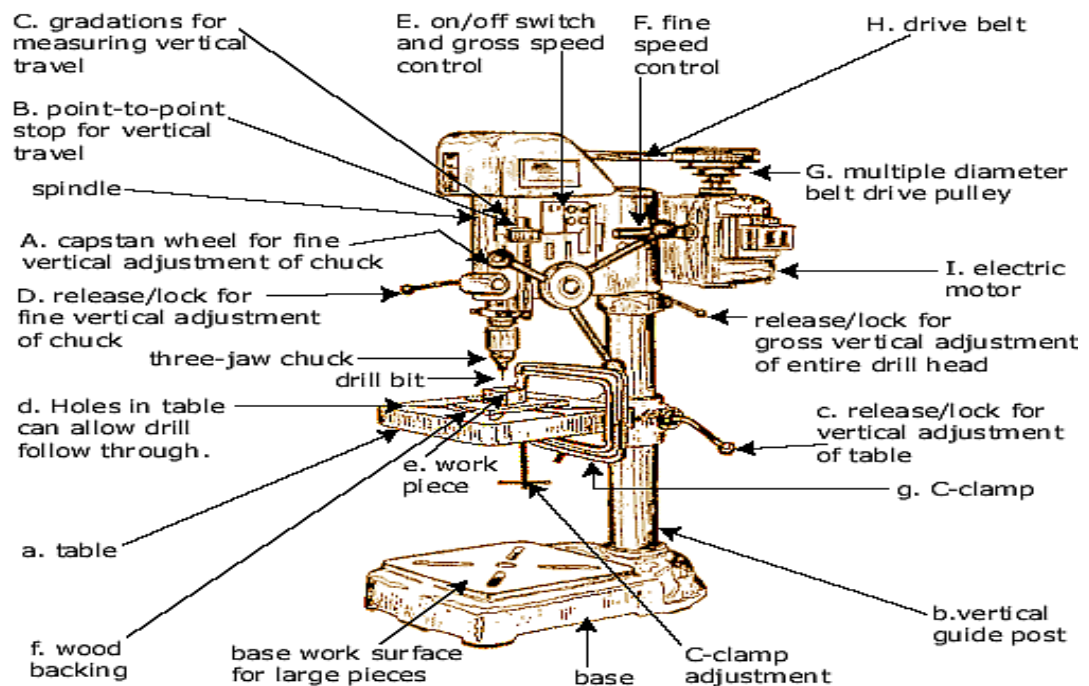


Figure 2.12: Drill Press Machine

Source: efunda (2007)

2.7 GRINDING PROCESS

Grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material. Information in this section is organized according to the subcategory links in the menu bar to the left.

In grinding, an abrasive material rubs against the metal part and removes tiny pieces of material. The abrasive material is typically on the surface of a wheel or belt and abrades material in a way similar to sanding. On a microscopic scale, the chip formation in grinding is the same as that found in other machining processes. The abrasive action of grinding generates excessive heat so that flooding of the cutting area with fluid is necessary.[5]



Figure 2.11: Grinder

Source: directindustry (2008)

CHAPTER 3

METHODOLOGY

3.1 DESIGN

Below shows the design that have been develop before choose the final product.

3.1.1 Concept A

This concept was design for a portable and easy use and it also can use small space to store the trolley. Besides that, it have two functions in one product that this can use as basket & trolley.

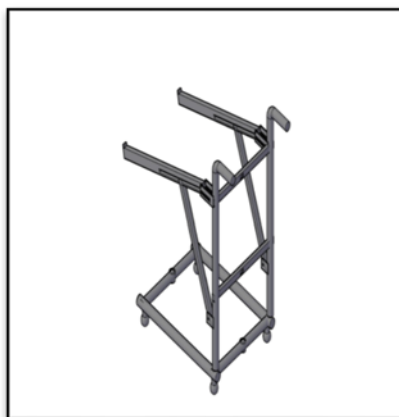


Figure 3.1: Portable trolley



Figure 3.2: Basket

3.1.2 Concept B

For this concept, it was design that have has 4 partitions for variety use but it must use big space to store it.

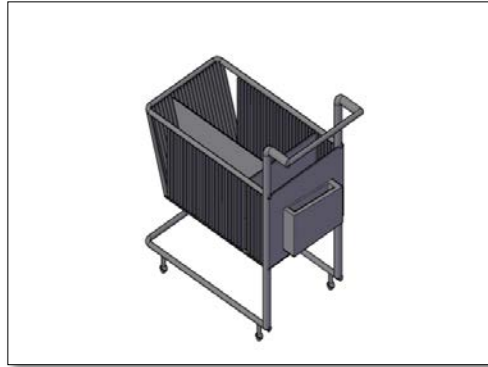


Figure 3.3: Numerous partition trolley

3.1.3 Concept C

For this concept, it can store a lot of thing but it have to use big space to store it and other disadvantage is it only has one function.



Figure 3.4: Big space trolley

Table 3.1: Concept selection table

Selection Criteria	Concepts		
	Concept A	Concept B	Concept C
Lightweight	/	x	X
Easy to use	x	/	/
Multifunction	/	/	X
Load required (10 kg)	/	/	/
Ease of manufacture	/	/	/
Portability	/	x	X

3.1.4 Final concept

Base on the table show above, I have come out with this design. This also the most suitable trolley that can be produce.

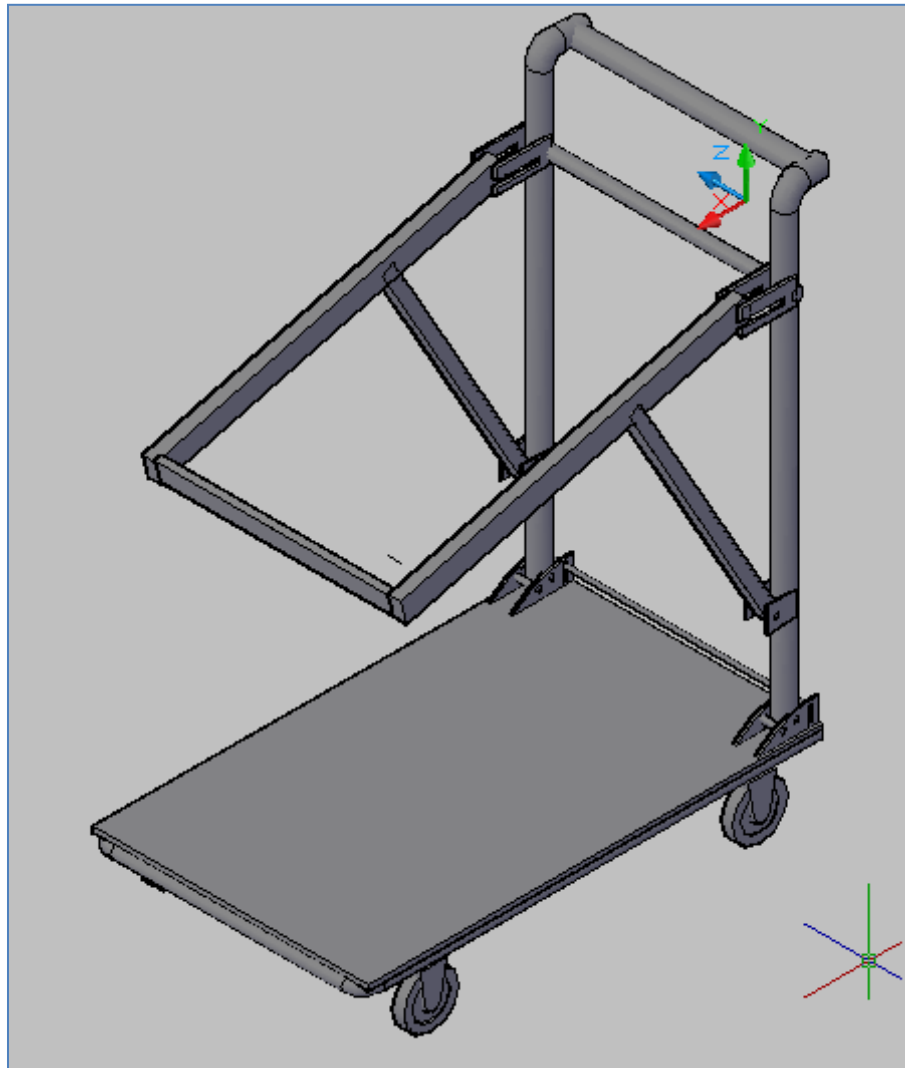


Figure 3.5: Final design

3.2 FABRICATION

This will show the steps had been use to complete this product. Besides that, it also showed the equipment that had been use.

3.2.1 Measuring

All the material are measure using measuring tape before being cut based on design specification.



Figure 3.6: Measuring process

3.2.2 Marking

Marking process is function to give more precision before start the cutting process.



Figure 3.7: Marking process

3.2.3 Cutting

For cutting process, hand saw and ben saw are use to cut the material. Hand saw is use in cut hollow steel or thin plate whereas ben saw are use to cut solid steel plate and others.



Figure 3.8: Cutting process

3.2.4 Finishing

For the finishing process there are two type of process that we use. The first process is grinding process. In this process all the rough surfaces are grind to make the surface smooth. After that is painting process function to make it more attractive.



Figure 3.9: Grinding process

3.2.5 Joining

Joining process is a process to join two type of material. Welding and drilling process are use in this process. For drill, it was use in making hole and marked holein order to place bolt and nuts. For welding, it has two type of welding which is MIG and ARCA welding. Below shows picture for drill and weld process.



Figure 3.10: Welding process



Figure 3.11: Drilling process

3.3 BASIC COMPONENT

This shows the basic component that have in this trolley.

3.3.1 Adjustable rod handle

For adjustable rod handle it consists of three main parts to make it function.

(i) Spring

To allow the rod steel can go up after step by user.

(ii) Steel rod

Use to the user for step to remove the trolley handle upward and downward.

(iii) Rod

Function as stopper to stop the trolley handle from moving downward.



Figure 3.12:Inner side



Figure 3.13:Outer side

3.3.2 Wheel

For wheel it has different type for the back wheel and front wheel. It design like that because to make the user easier when control the trolley.

- (i) For back wheel it was fixing to the plate because it will not move straight if it was adjustable.



Figure 3.14: Fix wheel

- (ii) For front wheel, it uses bearing to make it adjustable and make the trolley more free to rotate.



Figure 3.15: Adjustable wheel

3.3.3 Basket holder

Basket holders are function to make the basket more stable and can firm in the trolley.

(i) Vertical rod

Vertical rod function as a pillar for the horizontal plate to permanently stand to hold the basket. It also can be remove to make the trolley more portable.

(ii) Horizontal plate

Vertical rod function as a holder for the basket. When the basket hangs on it, the vertical rod will stop load from basket from fall.



Figure 3.16: Vertical rod and horizontal plate

3.3.4 Trolley holder

For trolley holder it are use for the user to move the trolley. It was consist of one rod.



Figure 3.17: Holder

3.3.5 Trolley plate

Trolley plate is use to pick a big thing such as baggage, box or other else.



Figure 3.18: Plate

3.3.6 Basket

This basket is use for transport things from one place to another. It must use basket holder to hang it and it also can be remove.



Figure 3.19: Trolley basket

CHAPTER 4

RESULT AND DISCUSSION

4.1 FINAL PRODUCT

As the conclusion, the multifunction trolley have been produced that has three function. The main function is use as a normal trolley that we always seen in and the other two functions is use as a cart and basket.



Figure 4.1: Final product

4.2 MULTIFUNCTION USES

As we know, this trolley has multifunction use to make it more useful to the user. This shows all the function for this trolley.

4.2.1 Trolley

For the main use it was use as normal trolley that can move things. This trolley only can accommodate light things such as book, toy, stationery and others. The reason it invented like that because it was design especially for children. Maximum load that can be carrying by this trolley is 10 kg.



Figure 4.2: Trolley

4.2.2 Cart

It was use to carry a heavy things such as box, luggage, and other else. For that purpose the vertical rod and horizontal plate must remove. This can keep load until 25kg maximum.



Figure 4.3: Cart

4.2.3 Basket

This basket can be remove from the trolley and can be as usual basket for bring things in small place that can't bring trolley.



Figure 4.4: Basket

4.2.4 Portable trolley

The trolley can be fold and can store in a small space. It was fold by step at the rod steel and removes the trolley holder to the plate. Before that, remove the vertical rod and horizontal plate to the holder.



Figure 4.5: Portable trolley

4.3 HOW TO USE



Figure 4.6: Trolley

Step 1

Put the basket on the horizontal plate.



Step 2

Pull the vertical rod and automatically the horizontal plate will go down to the trolley holder.

Figure 4.7: Cart



Figure 4.8: Portable trolley

Step 3

Step on the steel rod and push down the trolley holder to place the trolley in safe place.

4.4 ANALYSIS

4.4.1 Stress Analysis

The stress analyses have been tested to the vertical plate by using COSMOSX simulation. The maximum loads that have been applied are 100 N using uniform distribution. The stress analyses result shows in figure 4.9. The maximum stress is for this trolley is $2.133 \times 10^7 \text{ N/m}^2$

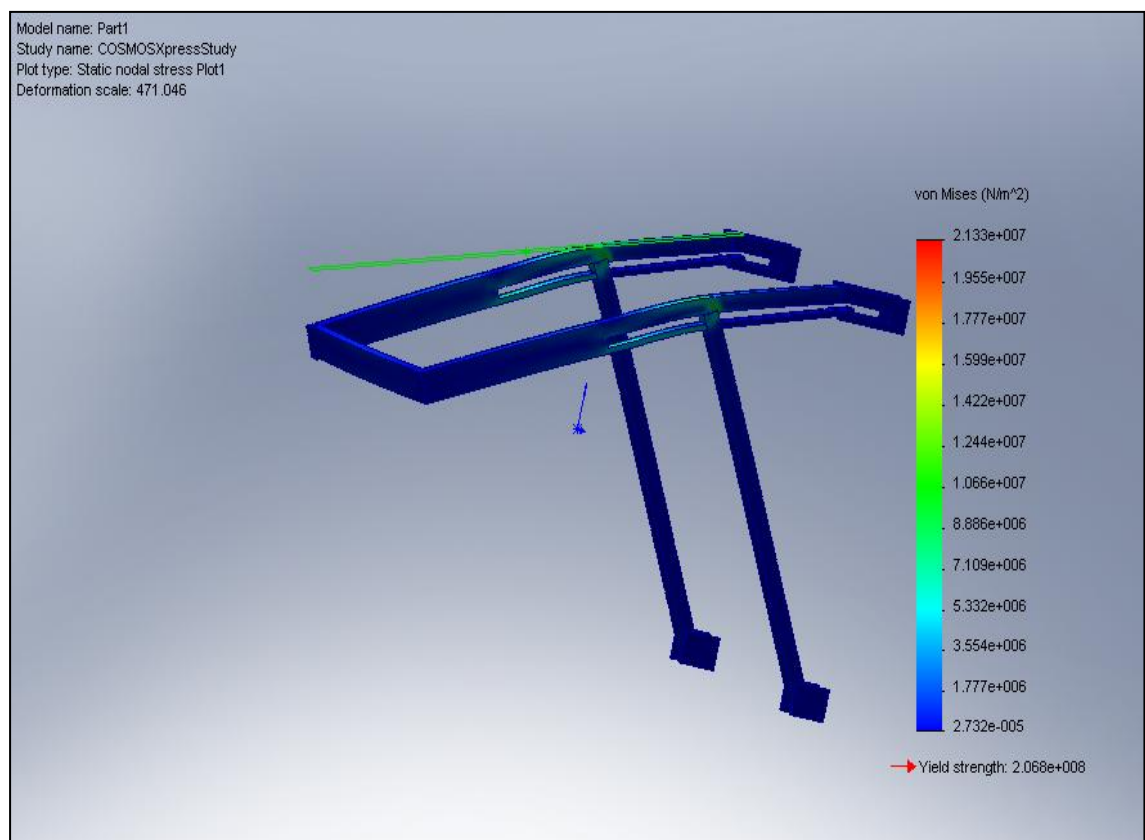


Figure 4.9: Stress analysis result for maximum load 100 N

4.4.2 Displacement Analysis

The displacement analyses have been tested to the vertical plate by using COSMOSX simulation. The maximum loads that have been applied are 100N using uniform distribution. The displacement analysis result shows in figure 4.9 and table 4.1.

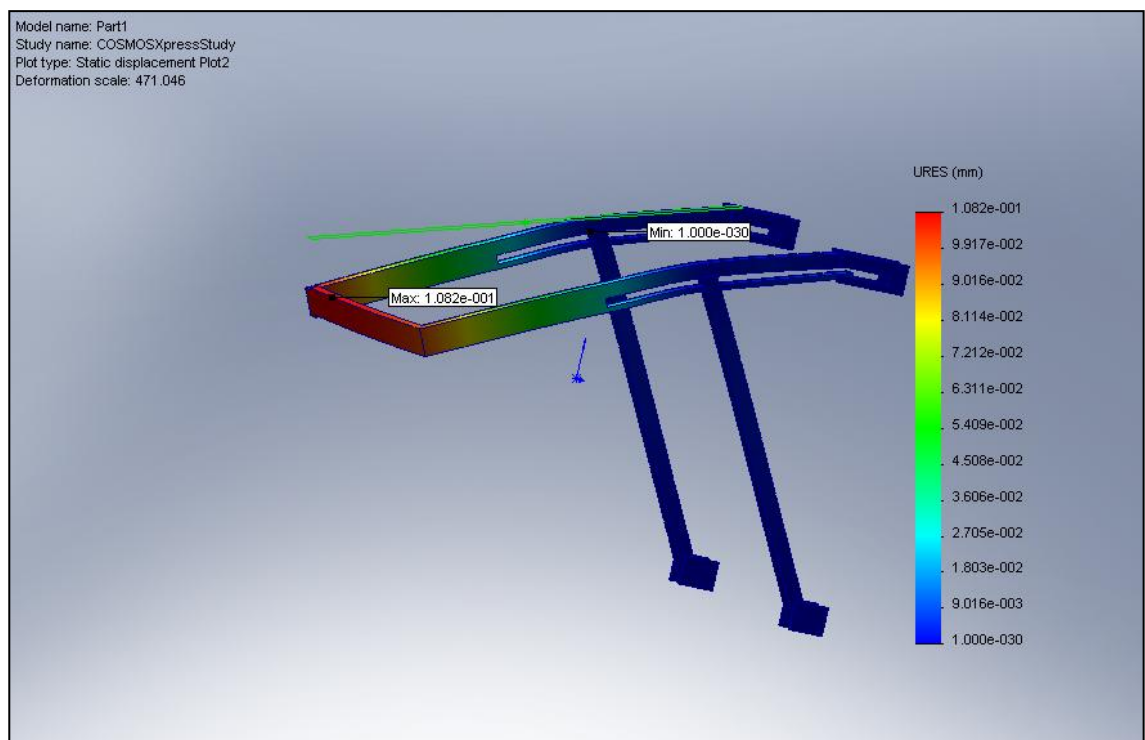


Figure 4.10: Displacement analysis result

Table 4.1: Displacement analysis result

Type	Load (Max)	Max
Resultant displacement	100N	0.00561974 mm

Typical properties of some common engineering materials						
Material	Unit Weight, w (kN/m^3)	Modulus of Elasticity, E (GPa)	Shear Modulus G (GPa)	Yield Stress σ_y (MPa)	Ultimate Stress σ_{ult} (MPa)	Poisson's ratio μ
Steel (Mild)	77	200	79	250	400	0.27
Steel (High carbon)	77	200	79	345	450	0.27
Cast iron	72.3	103	41	—	700(c) 200(t)	0.25
Copper	80.6	117	41	245	345	0.33
Aluminium alloy	27	70	40	300	450	0.33
Brass	82.5	103	40	100	270	0.35
Concrete	22	14	—	0	30(c)	0.1
Timber	6	11	—	—	50(c)	—

Figure 4.11: Properties of material

Source: Mechanics of material, McGraw - Hill

4.5 DISCUSSION

In this project, several observations have been done with respect to the fabrication of the multifunction trolley for children. The outcome of multifunction trolley was to achieve the objective of this project. All the component or part for multifunction trolley for children was function in good condition for example the adjustable horizontal rod and vertical plate can be easily removes. Besides that, the adjustable rod handle also can functioning

However, this product was too heavy according to the unsuitable material used in the fabrication process. Steel was perfect in strengthness, but the weight of this material makes this metal not suitable with the multifunction trolley. Besides that, this material can be corrosion if it surface exposed with oxygen and water. The painting method can be used to prevent this problem.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

As a conclusion, we have discovered the most suitable trolley that can be produced for children. This product has three functions in one item which is function as a trolley, basket and cart. These products also have a cheaper cost compare to the other product that had been exist in the market based on the quantity of the material that used in this product. Besides that, during the fabrication process, there was a lot of practical practice has been learn in order to use it in future works. Finally, the objective of this project that is to develop and fabricate the suitable multifunction trolley for children has been achieved.

5.2 RECOMMENDATION

Based on the product that has been produce, there is a lot improvement can be held to make the product more functionable. The following recommendation can be made to improve the project.

- (i) All material should be lightweight and hardy.
- (ii) Make the product for the adult use also.
- (iii) Improve their stability to add trolley load.
- (iv) The rod must be water proof to prevent rod surface become rusty.

REFERENCE

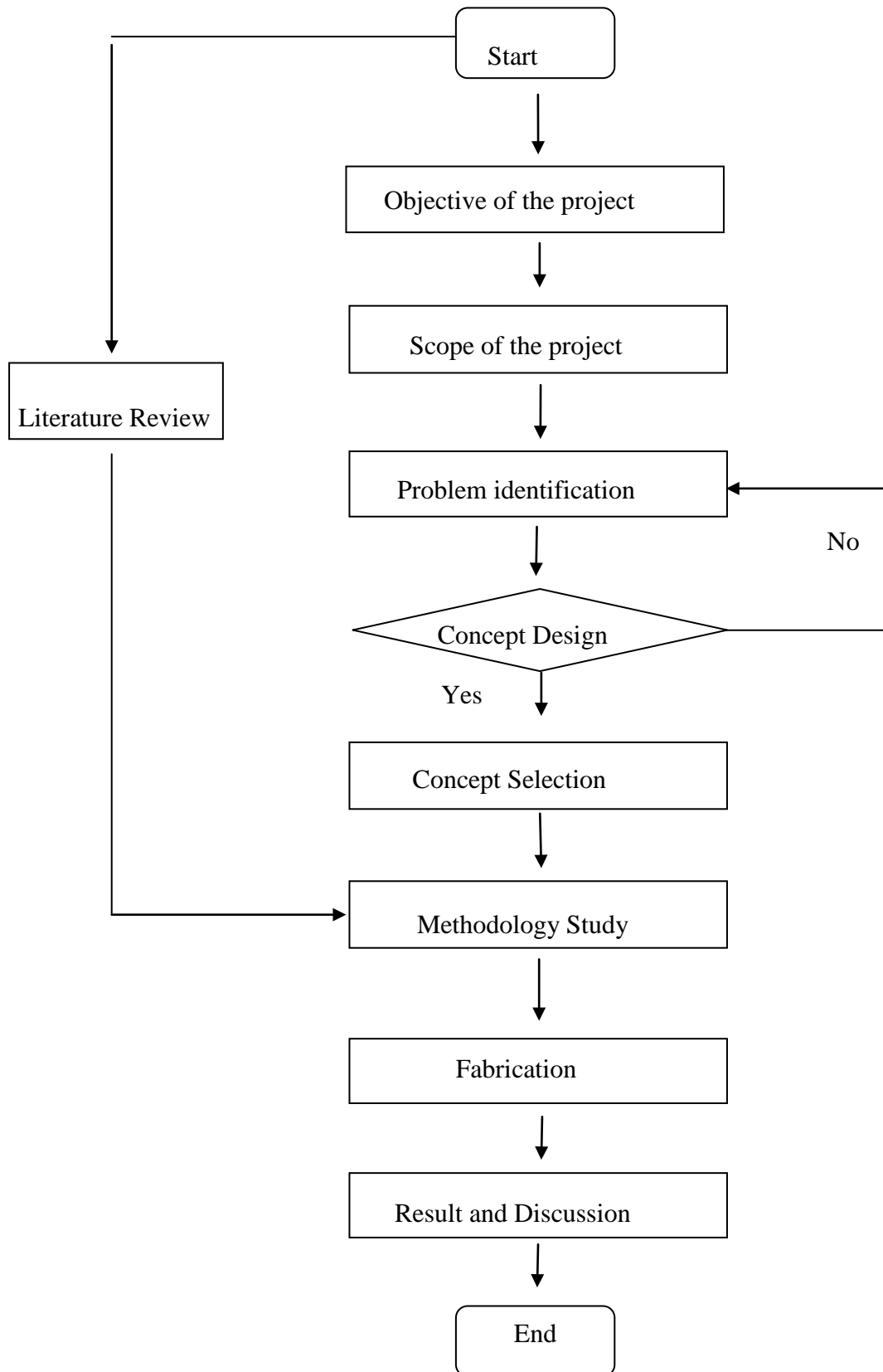
INTERNET

- 1) http://en.wikipedia.org/wiki/Shopping_Cart-Related_Injuries_to_Children, dated on Ogos 7th, 2009
- 2) http://en.wikipedia.org/wiki/Shopping_cart, dated on September 28th, 2009
- 3) http://en.wikipedia.org/wiki/Gas_metal_arc_welding, dated on Sept 15th, 2009
- 4) <http://www.efunda.com/processes/machining/drill.cfm>, dated on 15th, 2009
- 5) <http://www.efunda.com/processes/machining/grind.cfm>, dated on Oct 15th, 2009
- 6) <http://www.toysandinteriors.com/trolley/kids>, dated on Oct 2nd 2009

BOOK

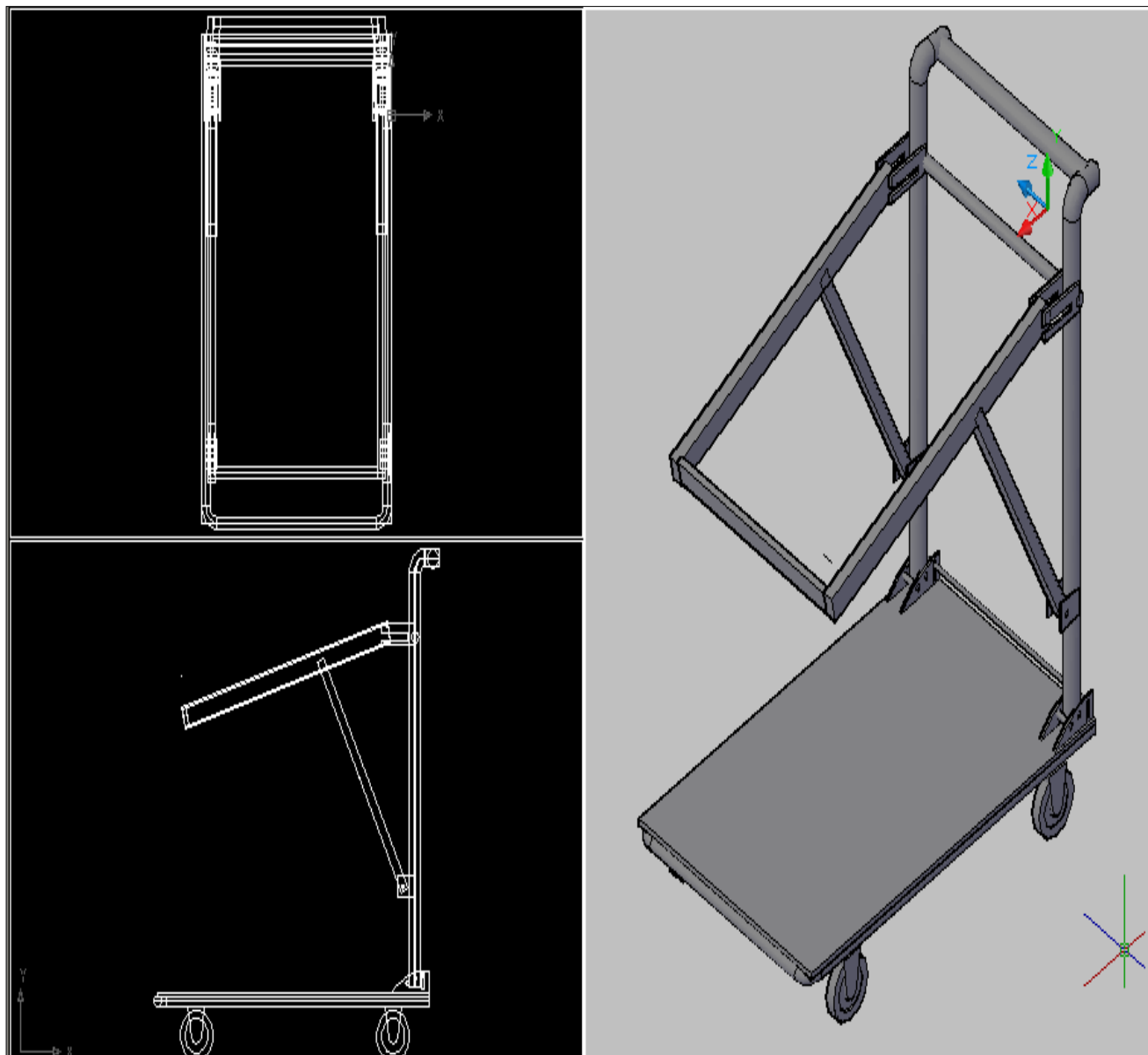
- 1) **Dieter, G. E** (3 ed.). Mechanical Metallurgy, New York: McGraw-Hill. (1989).
- 2) **Dr John G. Nee, CMfg E.** Fundamentals of tool design 4th Edition. (2001)
- 3) **A.M Howatson, P.G. Lund and J.D Todd**, “Engineering Tables and Data” (2003)

APPENDIX

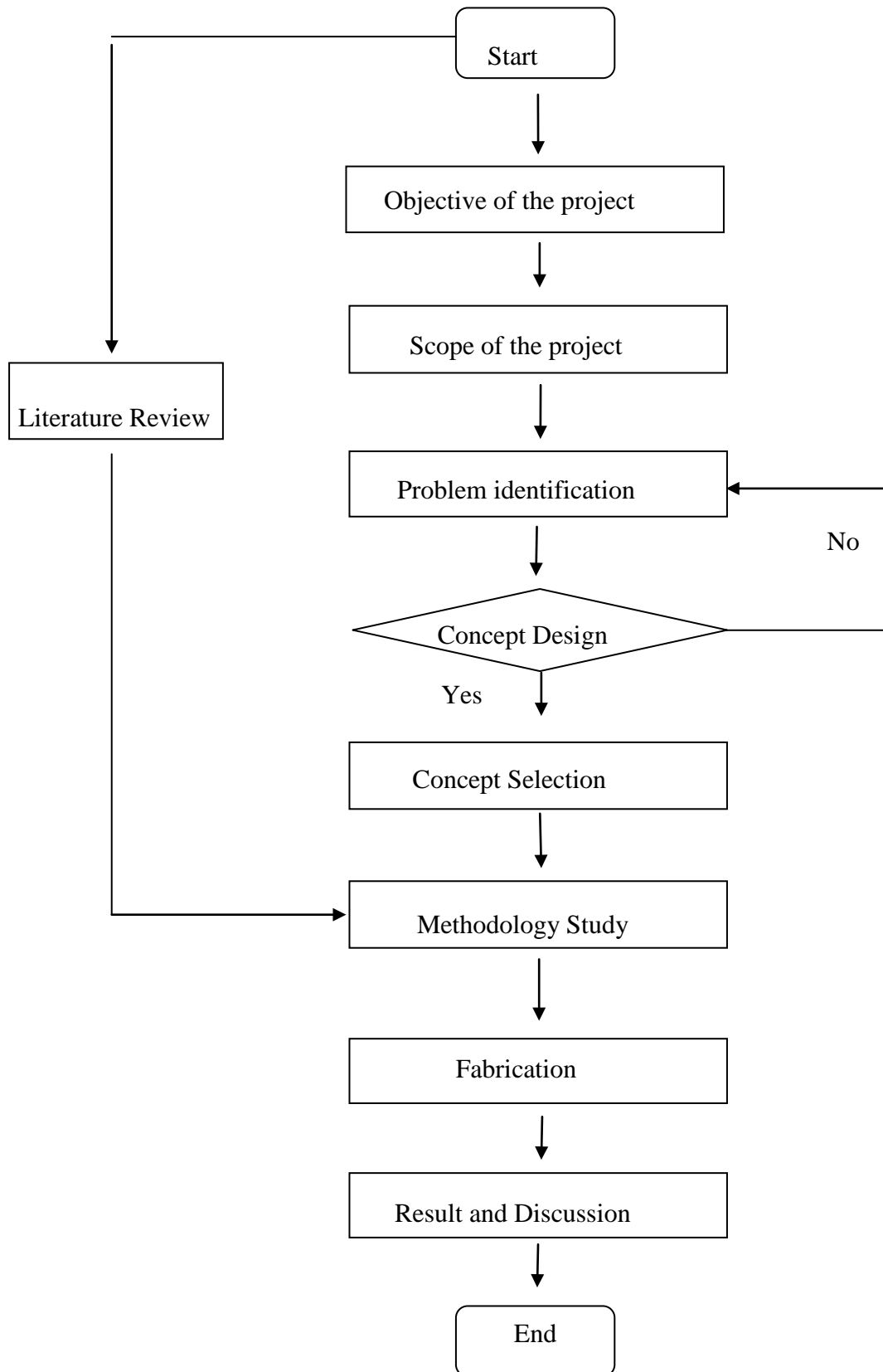
PROJECT FLOW

STAINLESS STEEL MATERIAL PROPERTIES

Properties	Carbon Steels	Alloy Steels	Stainless Steels	Tool Steels
Density (1000 kg/m ³)	7.85	7.85	7.75-8.1	7.72-8.0
Elastic Modulus (GPa)	190-210	190-210	190-210	190-210
Poisson's Ratio	0.27-0.3	0.27-0.3	0.27-0.3	0.27-0.3
Thermal Expansion (10 ⁻⁶ /K)	11-16.6	9.0-15	9.0-20.7	9.4-15.1
Thermal Conductivity (W/m-K)	24.3-65.2	26-48.6	11.2-36.7	19.9-48.3
Specific Heat (J/kg-K)	450-2081	452-1499	420-500	
Electrical Resistivity (10 ⁻⁹ W-m)	130-1250	210-1251	75.7-1020	
Tensile Strength (MPa)	276-1882	758-1882	515-827	640-2000
Yield Strength (MPa)	186-758	366-1793	207-552	380-440

DRAWING

APPENDIX

PROJECT FLOW

STAINLESS STEEL MATERIAL PROPERTIES

Properties	Carbon Steels	Alloy Steels	Stainless Steels	Tool Steels
Density (1000 kg/m ³)	7.85	7.85	7.75-8.1	7.72-8.0
Elastic Modulus (GPa)	190-210	190-210	190-210	190-210
Poisson's Ratio	0.27-0.3	0.27-0.3	0.27-0.3	0.27-0.3
Thermal Expansion (10 ⁻⁶ /K)	11-16.6	9.0-15	9.0-20.7	9.4-15.1
Thermal Conductivity (W/m-K)	24.3-65.2	26-48.6	11.2-36.7	19.9-48.3
Specific Heat (J/kg-K)	450-2081	452-1499	420-500	
Electrical Resistivity (10 ⁻⁹ W-m)	130-1250	210-1251	75.7-1020	
Tensile Strength (MPa)	276-1882	758-1882	515-827	640-2000
Yield Strength (MPa)	186-758	366-1793	207-552	380-440

DRAWING