KEMENTERIAN PENGAJIAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

POLITEKNIK MALAYSIA
SULTAN SALAHUDDIN ABDUL AZIZ SHAH

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

TROLLEY

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(08DBK20F2001)
NUR NUSAIBAH BINTI BUSRAH
(08DBK20F2004)
NISRINA ATHIRAH BINTI ABDUL LATIF
(08DBK20F2009)

CIVIL ENGINEERING DEPARTMENT
WOOD BASED TECHNOLOGY PROGRAMME

SESI 2: 2022/2023

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THIS REPORT WAS SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENTS FOR THE DIPLOMA IN WOOD-BASED TECHNOLOGY, DEPARTMENT OF CIVIL ENGINEERING, POLYTECHNIC SULTAN SALAHUDDIN ABDUL AZIZ SHAH.

CIVIL ENGINEERING DEPARTMENT

SESI 2: 2022/2023

DECLARATION OF ORIGINAL AND OWNERSHIP

1. We are third-year diploma students in Wood-Based Technology, Civil Engineering Department, Politeknik Sultan Salahuddin Abdul Aziz Shah.

2. We acknowledge that our trolley is not taken or copied from any party but rather the work or design of our group itself.

3. Made and truly acknowledged by the said

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ABSTRACT

A trolley is a piece of equipment used for lifting and transporting objects, whether heavy or light, from one location to another. The woodworking workshop facility at Polytechnic Shah Alam (PSA) needs a new trolley because the existing one has been damaged. The main objective of this project is to produce a trolley that will work adequately for carrying heavy items in the woodworking shop at PSA. The trolley was created to facilitate staff and student transportation of objects throughout the workshop. The project created a trolley with a centre separation, left and right barriers, and the capacity for substantial 4' x 8' wooden and wood composite boards. The trolley also doesn't have a barrier at the back that would make movement around the woodworking workspace easier and enable the placement of large-sized lumber. Initial data on the demand for the trolley was gathered through preliminary research, which included a pre-survey and fieldwork study. The time study technique was used to determine the actual duration of time spent using the new trolley. In order to gather feedback on the utilisation and efficacy of the trolley, post-survey questionnaires using "Google Form" were also done. 90% of respondents agreed that the trolley successfully addresses the primary challenges associated with moving big, heavy objects in the PSA Woodworking Workshop. The trolley's size and design, from the perspectives of the respondents, should be upgraded further if it is to be used for the PSA woodworking workshop in the future.

Keywords: trolley, PSA woodworking workshop, heavy woods, time study, material handling.

ABSTRAK

Troli ialah peralatan yang digunakan untuk mengangkat dan mengangkut objek, sama ada berat atau ringan, dari satu lokasi ke lokasi lain. Kemudahan bengkel kerja kayu di Politeknik Shah Alam (PSA) memerlukan troli baharu kerana troli sedia ada yang kini telah rosak. Objektif utama projek ini adalah untuk menghasilkan troli yang akan berfungsi secukupnya untuk membawa barang berat di kedai kerja kayu di PSA. Troli itu dicipta untuk memudahkan kakitangan dan pelajar mengangkut objek sepanjang bengkel. Projek ini mencipta troli dengan pemisah tengah, penghadang kiri dan kanan, dan kapasiti untuk papan komposit kayu dan kayu yang besar 4' x 8'. Troli juga tidak mempunyai penghalang di bahagian belakang yang akan memudahkan pergerakan di sekitar ruang kerja kerja kayu dan membolehkan penempatan kayu bersaiz besar. Data awal mengenai permintaan untuk troli itu dikumpulkan melalui penyelidikan awal, termasuk kajian pra-tinjauan dan kerja lapangan. Teknik kajian masa digunakan untuk menentukan tempoh sebenar masa yang digunakan menggunakan troli baharu. Bagi mengumpul maklum balas tentang penggunaan dan keberkesanan troli, soal selidik pasca tinjauan menggunakan "Borang Google" juga telah dibuat. 90% responden bersetuju bahawa troli itu berjaya menangani cabaran utama yang berkaitan dengan memindahkan objek besar dan berat dalam Bengkel Kerja Kayu PSA. Saiz dan reka bentuk troli, mengikut perspektif responden, perlu dinaik taraf lagi jika ia akan digunakan untuk bengkel kerja kayu PSA pada masa hadapan.

Kata kunci: troli, bengkel kerja kayu PSA, kayu berat, kajian masa, pengendalian bahan.

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SYMBOL LIST

Kg	Kilogram
m^3	Cubic meters
mm	Millimeters
cm	Centimeters
%	Percentage

LIST OF ABBREVIATIONS

PSA	Politeknik Sultan Salahuddin Abdul Aziz Shah
MDF	Medium density fiberboard
OSB	Oriented strand board
CADD	Computer-aided drafting and design
B.O.M	Bill of material

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The study was conducted on the need for a trolley to lift and carry the heavy timber or wood composite boards for usage in the wood workshop at Shah Alam Polytechnic (PSA) by students and staff. This study was conducted to determine the relevance of using a new trolley to replace the existing old trolley that no longer functions well. This trolley will be designed to be an appropriate size and can carry suitable loads better than the existing trolley used in the wood workshop, PSA. A trolley is a piece of equipment used to lift and carry a heavy or light object from one place to another. Trolleys are typically used in supermarkets, offices, stores, hospitals, restaurants, workshops, and homes. A trolley is usually made from strong and durable iron and has wheels that can carry heavy weight. Basically, trolleys are made from iron and plastic materials; however, they have a similar design on the market. The wood workshop is a place for product manufacturing and also a place for learning and teaching activities. The wood workshop is also a place where all tools and machines are stored for the carpenter's usage. Therefore, the aim of this project study is to produce a suitable trolley that can be utilized for the wood workshop activity. It is also intended to assist the students and staff in handling the heavy materials in the wood workshop. The trolley that will be manufactured is equipped with a left and right barrier and a divider in the middle to make it easier to insert heavy 4' x 8' wood panels. This trolley also does not have a barrier at the back so that large lumber can be placed and easier movement in the wood workshop for carpentry work activities. As a result, the trolley study was also intended to solve the issues of lifting and carrying the big objects in the wood workshop.

1.2 PROBLEM STATEMENT

The use of a trolley in the PSA Wood Workshop is very important because it is used to lift and carry panel materials such as MDF, chipboard, and plywood. This equipment is very important to carry the loads during the handling operation. The existing trolleys in the wood workshop are easy to maintain, durable, and strong, but quite heavy to control. In addition, the existing trolley has no safety features; there are no barriers on each side of the trolley that can cause the panels to fall. In addition, a lot of energy and time are needed when moving wood from the store to the machine. The risk of injury while carrying a trolley is very high when the trolley is carrying large and heavy wood. Lifting large, long, and heavy wood composite panels usually requires more human power. To overcome this problem, a new trolley needs to be developed that will have the function to lift and move the wood panel easily and safely and could also save time and energy.

1.3 OBJECTIVES

The objectives of this project are:

I. to produce a trolley that can facilitate carrying heavy wood in the PSA woodworking workshop. to determine the actual time needed to use a new trolley in the woodworking workshop by using the time study method.

1.4 SCOPE OF STUDY

This project will be implemented at the Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA) Wood Workshop. This project trolley has a weight of 160 kg/m3, is made of solid metal, and has panels with a ratio of 3:1. The size of this trolley is 1219.2 mm by 762 mm. The materials used in this project are steel, six rollers, and a solid square bar. The machines and tools that will be used in this project are table saw machines, measuring tapes, sandpaper, and sanding machines. The trolley has four rollers that can be rotated. After that, match the positions of the 2 rotatable rollers at the back on the handle and center and the 2 more rollers at the front. Then, install the roller using a bolt or thread rod to fasten it to the bottom of the trolley. The trolley is equipped with a limiter on the left and right sides and also a partition in the middle of the trolley to ensure the heavy panel can be placed in a slot-in manner, so large panels can be placed easily and carried around the workshop for carpentry work activities. Next, a pre-survey to obtain approval of the trolley after ablution and a post-survey to obtain feedback on the use of the trolley The time study method was conducted to obtain data from the student's speed using a trolley and without using a trolley.

CHAPTER 2
LITERATURE REVIEW

2.0 HISTORY OF THE TROLLEY

One of the first trolleys was introduced on June 4, 1937, the invention of Sylvan Goldman, owner of the Humpty Dumpty supermarket chain in Oklahoma. One night, in 1936, Goldman sat in his office, wondering how customers might move more groceries. He found a wooden folding chair and put a basket on the seat and wheels on the legs. Goldman and one of his employees, a mechanic named Fred Young, began tinkering. Their first trolley 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 Kosted, developed a method to mass-produce the carts by inventing an assembly line capable of forming and welding the wire. The cart was awarded patent number 2,196,914 on April 9, 1940 (filing date: March 14, 1938), titled "Folding Basket Carriage for Self-Service Stores." They advertised the invention as part of a new “no basket carrying plan." Goldman had already pioneered self-serve stores, and carts were part of the self-serve retail concept.

2.1 CONCEPT/THEORY OF TROLLEY

New and creative ideas usually result from observation to produce something new with the aim of simplifying work and ways, saving time and energy, and most importantly, avoiding wasting energy, time, and money. At the same time, the product quality should be at a higher level and safer than existing products. Discussions with friends can also have the effect of sparking new ideas. Research methods are also used to find suitable ideas or designs for the final project. The factors selected are such things as ease of operation, cost savings, energy savings, systematic operation, and a simple but attractive and effective design that can meet safety specifications and standards. (Anonymous, December 21, 2022)

2.2 TROLLEY IN THE MARKET

Figure 2.1: A few types of trolley

Various types of trolleys have been marketed in the local market as well as in the international market. Each trolley has its own abilities, uniqueness, and design features that have been customised according to the customer's request. This tool can carry the materials and move them easily from one location to another. Trolleys are available in two categories: two-wheeled and four-wheeled. Site, J. (n.d.)

Four-wheel trolley

This 4-wheeled trolley is commonly used in factories, grocery stores, etc. This trolley has two different sizes: large and small. The advantages of the 4-wheel trolley are that it is easy to carry and maintain. The design of the existing trolleys on the market makes it difficult to carry the large size of the board panel. (Anonymous, 2021)

Figure 2.2: Four-wheel trolley

This trolley is often seen in supermarkets such as Aeon Big, Giant, Mydin, and others. Among the advantages of the supermarket trolley are that it is large and can hold many goods. Supermarket trolleys come in two different sizes: small and large. (Anonymous, 2021)

Picture 2.3: Four-wheel trolley

2.3 DESIGN AND PRICES OF TROLLEY IN THE MARKET

The table below shows several types of trolleys with prices and sizes available on the market.

Table 2.1: Design size and price of trolleys in the market

SHAPE	SIZE	PRICE
A 	**Length: 88 cm** **Width: 58 cm** **Height: 64 cm**	**RM 68 – 99.99**
B 	**Length: 73 cm** **Width: 47 cm** **Height: 83 cm**	**RM 100 – 150**
C 	**Length: 50 cm** **Width: 30 cm** **Height: 60 cm**	**RM 108 – 120**

D 	**Length: 85 cm** **Width: 55 cm** **Height: 80 cm**	**RM 85 – 100**
E 	**Length: 49 cm** **Width: 31.5** **Height: 96 cm**	**RM 90**

Source: (Site, J. (n.d.)

Table 2.1: Design size and price of trolley in the market

Table 2.1 shows several types of trolley designs along with their shape, size, and price. All the types mentioned are four tyres available on the market. All types have different sizes and weights. Some have barriers, and some don't. Some have bigger tires, and some have smaller ones.

2.4 AVAILABLE TROLLEY SIZES IN THE MARKET

Based on the research that has been done on the old trolley, the size of the old trolley in the lifting part is 45 x 25 inches in length and width. There is also a handle suitable for holding and pushing the trolley, which measures 30 x 45 inches high and long. In addition, the trolley needs wheels to move; the wheel size used on the old trolley has a height of 4 inches (Site, J., n.d.).

2.10 EXISTING MATERIALS USED FOR TROLLEY IN THE MARKET

Figure 2.4: Steel

Steel is an alloy made up of iron with added carbon to improve its strength and fracture resistance compared to other forms of iron. Many other elements may be present or added. Stainless steels that are corrosion- and oxidation-resistant typically need an additional 11% chromium. Because of its high tensile strength and low cost, steel is used in buildings, infrastructure, tools, ships, trains, cars, machines, electrical appliances, weapons, and rockets. Iron is the base metal of steel. Depending on the temperature, it can take two crystalline forms (allotropic forms) body-centered cubic and face-centered cubic. The interaction of the allotropes of iron with the alloying elements, primarily carbon, gives steel and cast iron their range of unique properties. Common uses of stainless steel are standard forks and iron watch straps (Wikipedia Foundation, 2022). Steel is an alloy made up of iron with added carbon to improve its strength and fracture resistance compared to other forms of iron. Many other elements may be present or added. Stainless steels that are corrosion- and oxidation-resistant typically need an additional 11% chromium. Because of its high tensile strength and low cost, steel is used in buildings, infrastructure, tools, ships, trains, cars, machines, electrical appliances, weapons, and rockets. Iron is the base metal of steel. Depending on the temperature, it can take two crystalline forms (allotropic

forms), body-centered cubic and face-centered cubic. The interaction of the allotropes of iron with the alloying elements, primarily carbon, gives steel and cast iron their range of unique properties. Common uses of stainless steel are standard forks and iron watch straps (Wikipedia Foundation, 2022).

Figure 2.5: Plywood

Plywood is a material made from thin layers, or "layers," of wood veneers glued together with adjacent layers, with the wood grains rotated up to 90 degrees to each other. It is an engineered wood from the manufactured board family that includes medium-density fiberboard (MDF), oriented strand board (OSB), and particleboard. The density of plywood is approximately equivalent to the density of the timber species used to manufacture the product. The density of plywood is in the range of 500–650 kg/m3. Eucalypt hardwood plywood density can exceed 900 kg/m3, depending on the timber species used (Wikipedia Foundation, 2022).

Figure 2.6: Caster wheels

Casters are fixed wheels designed to be attached to the bottom of a larger object to allow the object to be moved. Casters are used in a variety of applications, including shopping carts, office chairs, toy carts, hospital beds, and material handling equipment (Anonymous, 2022; Wikipedia). Like simpler rigid casters, swivel casters incorporate mounted wheels that rotate freely at approximately 360°, thus allowing the wheels to roll in any direction. This allows the table to move in any direction easily without changing its orientation. Swivel casters are sometimes attached to the handle so that the operator can set their orientation manually (Caster, 2023, Wikipedia).

Figure 2.7: Trolley screw

A screw is a rod or cylinder with helical grooves, or "threads," on its surface. Its main use is as a nail-like fastener to hold two objects together. Fasteners of this type are often tightened using a screwdriver and further pinned with bolts that wrap around the screw shaft (Anonymous, 2021).

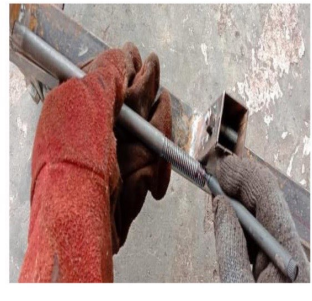


Figure 2.8: Sub roller

The pressure roller is a sub-assembly in the complete pressure roller assembly, used for repairs on the applicable braille. The Roller Sub is designed to meet a need in the rolling system market for a simple and reliable way to reduce friction. (Anonymous, 2019)

Figure 2.9: Finishing material

A protective coating is a layer of material applied to the surface of another material with the intent of inhibiting or preventing corrosion. A protective coating may be metallic or non-metallic. Protective coatings are applied using a variety of methods and can be used for many other purposes besides corrosion prevention. A protective coating is not necessarily limited to corrosion prevention. A protective coating can also be used to increase a material's wear resistance and aesthetic appeal. A protective coating can provide water resistance or electrical properties that the material did not have prior to the protective coating being applied. (Corrosionpedia, 2023)

Figure 2.9: Stainless Steel Hexagon Nylon Lock Nut

A nut is a type of fastener with threaded holes. Nuts are often used together with bolts to tighten several parts together. The two materials are assembled by a combination of thread friction (with small elastic deformation), slight stretching of the bolt, and compression of the parts that will tighten the components in the Multifunctional Stair Climber Trolley.

The use of hexagon-shaped nuts is chosen because this hexagon-shaped nut facilitates the process of loosening and tightening the nut. This is because this nut has six sides that give a complete detail angle that facilitates the process of tightening components using a torque wrench. If a nut with a shape of more than six sides is chosen, this nut does not provide a good grip, and a nut with a shape of less than six sides takes more time to make a complete rotation. The type of nut selected can maintain locking ability up to 250 °F (121 °C) (Anonymous, 2023 Wikipedia).

2.11 IMPORTANCE OF TIME STUDY IN MATERIAL HANDLING PROCESS

The definition of "time study" is an effort to determine the duration of work required by the employees in determining the duration of the work to be carried out. This study should be prepared when the work plan is launched. Using a clear time study, a given job will be completed well at a normal work rate in the current work environment (Anonymous, 2021).

Without time studies, each worker producing a product will not have a specific completion target. As a result, they often need to be on time to complete production. Manual handling operations carrying large logs can expose workers to risks related to efficiency as well as occupational safety. Large pieces of wood are difficult to move and burdensome to lift or move, and handling the sharp edges of pieces can result in contact stress and injury to workers (Anonymous 2021).

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The methodology of this project uses several phases, namely the initial research phase to show the pre-questionnaire and the data collected from the questionnaire. From the questionnaire, we found data that we want to use as evidence to carry out this project successfully. A fieldwork study that tells about the method of determining the time taken by students to lift wood from the store to the machine with several repetition processes In addition, it also shows several phases of the process to make the product, starting from the sketch until the product trolley is created until the product is finished.

3.1.1 FLOW CHART PROCESS

Table 3.1 shows the flow chart of trolley manufacturing

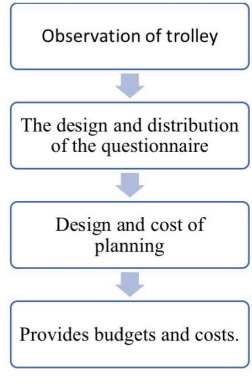


Diagram 3.1 : Showed the flow chart process.

3.2 PRELIMINARY STUDY

The target audience of this questionnaire is specifically students or lecturers who use the wood workshop at Polytechnic Shah Alam (PSA). A total of nine questions were stated to obtain a decision about the manufacture of a new trolley for use in the wood workshop.

3.2.2 PRE-QUESTIONNAIRE

This study was made with users in wood workshops for the use of trolleys by making a questionnaire about the needs of trolleys in wood workshops. This questionnaire is divided into two (2) parts, namely Part A and Part B. Part A is demographic information about the respondents, such as gender, age, race, department, program, and semester. Part B is about the level of trolley required to lift and carry heavy wood. Examples are as below:

1	2
Agree	Disagree

Table 3.2 shows the questionnaire before the trolley manufacturing process. This is to get feedback from the users of the workshop on having a trolley that can make it easier for students.

NO	STATEMENT		
		1	2
1	I often find it difficult to lift and carry heavy wood in the woodshop		
2	The existing trolley in the wood workshop was damaged and was not suitable for lifting carrying heavy wood		
3	Students, especially male students, are often told by lecturers to lift and carry sticks en masse		

4	There should be a special trolley to carry wood around the workshop		
5	When using a trolley to lift and carry goods can save time		
6.	The resulting design is strong and suitable for lifting heavy wood		
7.	Supporting iron on the trolley used to support the wood		
8	Having a roller in the wood slot makes it easier to move the wood in		
9	If you increase the tires to 6, will the trolley become more stable when carrying heavy wood?		

Table 3.1: Showed manufacturing process of prototype trolley.

3.3 FIELD WORK STUDY

The fieldwork study was conducted at TIMTECH House and PSA Wood Workshop. This fieldwork study was conducted during a practical class at the PSA wood workshop.

Figure 3.1: The trolley used at Timtech House.

Figure 3.2: The trolley used in the PSA Wood Workshop.

Figure 3.3: The photos a, b, c, and d showed the field work activities in the Wood Workshop at PSA

3.4 PRODUCT MANUFACTURING

3.4.1 FLOW CHART PROCESS

Diagram 3.2 shows the flow chart for making a trolley. The beginning must provide materials until the provider of the finishing product.

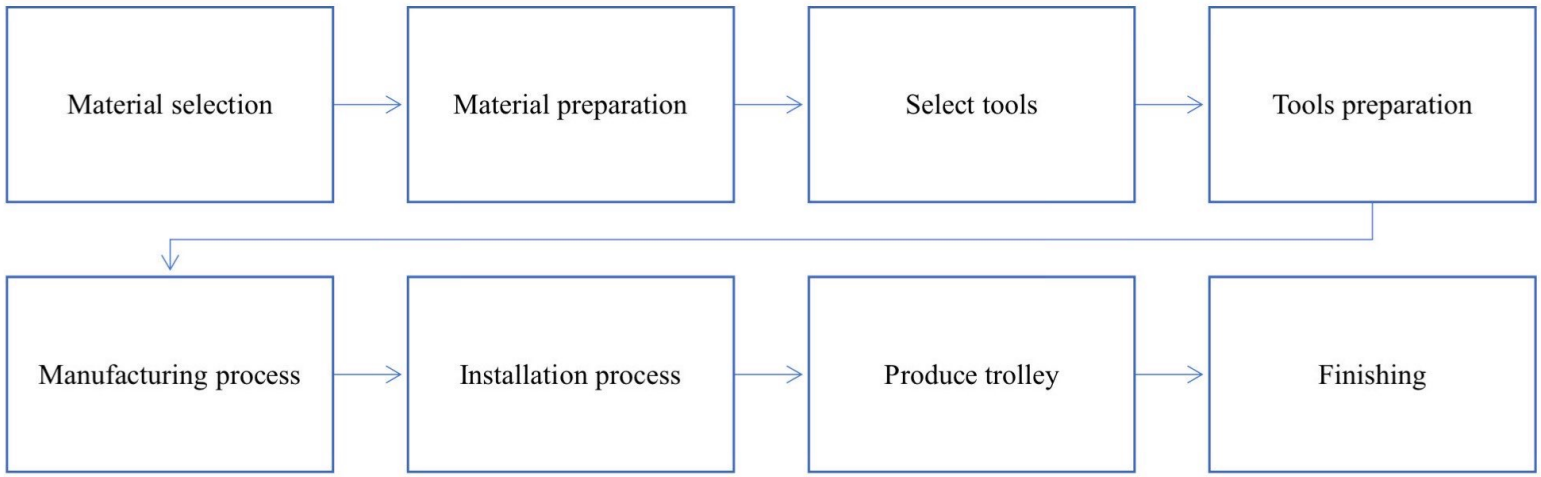


Diagram 3.2 Showed manufacturing process of trolley.

3.4.2 SIZE

Dimensions are an important aspect of the design to get an accurate engraving. The size of the trolley is 1219.2 mm by 762 mm (length x height). We made the size of this trolley to be reserved for lifting 4 feet by 8 feet of wood so that it would be easier for students to bring it to the machine from the store.

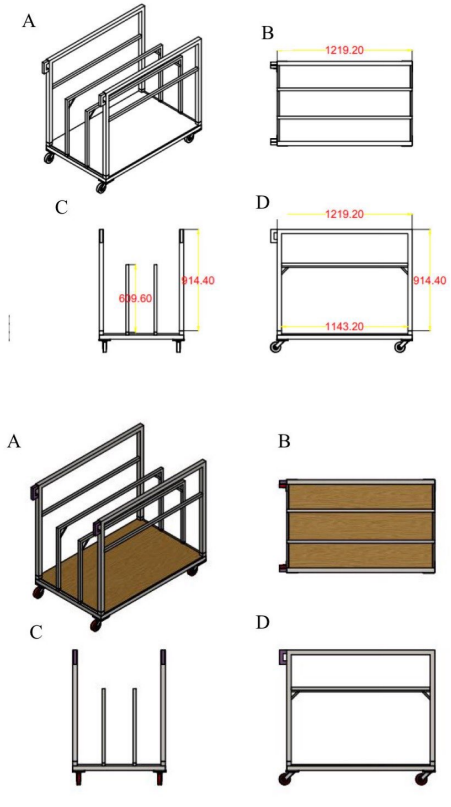


Figure 3.4: The picture shows a 2d drawing

3.4.3 PODUCT SKETCH

This is a preliminary sketch of the product. This sketch was created to give an early idea of what the product will look like in the ideation process.

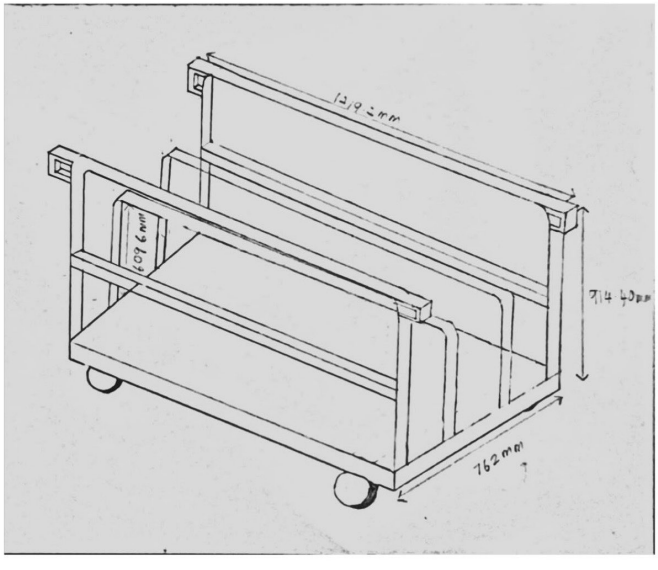


Figure 3.5: A sketch of the trolley will be produced in this project

3.4.4 CADD DRAWING

a) Side view

b) Side view

c) Top view

Figure 3.6: The photos of (a & b) showed the side views and (c) the top view of trolley

3.4.5 RAW MATERIAL SELECTIONS

The two main materials used in creating trolleys are various grades of hollow steel and plywood. Steel decreases in grade according to its size. For example, grade B is 38 mm by 38 mm, while grade C is 25 mm by 25 mm. This hollow steel is ideal for making trolleys because it is more durable and lighter than solid steel. Chose plywood because, in most engineered woods, plywood can be categorised as the most durable and strong. The thickest plywood I could find on the market is 12 mm.

3.4.6 BILL OF MATERIAL

Table 3.3 show the bill of material to make a trolley

[TROLLEY]

Assembly Type:	TROLLEY
Assembly Name:	
Material Ratio (mm):	
Approval Date:	
Part Count:	**14**
Total Cost (RM):	**$251.00**

Category	Part Name	Thickness	Width	Length	Materials	Qty	Units	Picture	Unit Cost	Cost
PART 1	SITE	12mm	4ft	4ft	PLYWOOD	1	1		MYR 48.00	MYR 48.00
PART 2	BEAM 1	1.5mm	25mm	25mm	HOLLOW	1	1		MYR 25.00	MYR 25.00
PART 3	BEAM 2	1.5mm	38mm	38mm	HOLLOW	2	2		MYR 41.00	MYR 82.00
PART 4	BRACKET JOINT				HOLLOW	4	4		MYR 12.00	MYR 48.00

PART 5	SUB ROLLER					6	6		MYR 8.00	MYR 48.00
										MYR -
Total						**14**				**MYR 251.00**

3.4.7 CUTTING DIAGRAM

3	1219.2mm	1219.2mm	1219.2mm	1219.2mm	

STEEL GRADE B

6 meter

762mm	762mm	914.40mm	914.40mm	

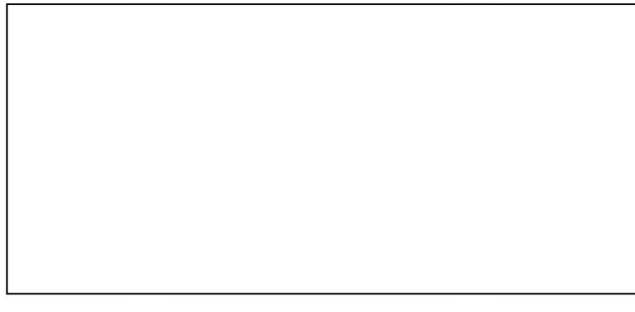
STEELGRADE B

6 meter

1219.2mm	1219.2mm	609.60mm	609.60mm	

STEEL GRADE C

6 meter



PLYWOOD

2ft x 4ft

3.4.8 CUTTING LIST

Part Name	Length	Width	Thickness	Quantity	Material
Holder 1	762mm	1219.2mm	38mm	2	Hollow
Holder 2	609.6mm	1219.2mm	38mm	2	Hollow
Frame Base	1219.2mm	762mm	38mm	1	Hollow
Base	1181.2mm	724mm	12mm	4	Plywood
Sub Roller	203.2mm			6	Hollow
Bracket Joint				4	Hollow

Table 3.4 cutting list project

3.4.9 PREPARING BUDGET AND COSTING

MATERIAL	QUANTITY	PRICE (RM)
Plywood	1	RM 40.00
Hollow Grade B	2	RM 82.00
Hollow Grade C	1	RM 25.00
Tyre	4	RM 46.00
Paint	1	RM 25.00
Expert	1	RM 200.00
Sub Roller	6	RM 48.00
Bracket Joint	4	RM 48.00
	Total	RM 514.00

Table 3.5 Preparing budget and costing

3.4.10 LIST OF MACHINE AND TOOL

MACHINE AND TOOLS	FUNCTION
1. Metal Circular Saw 	The tool is intended for cutting mild steel and stainless steel with appropriate saw blades.
2. Arc Welding Power Source 	Arc welding is commonly used to join materials.

3. Hammer

A hammer is used to straighten welded metal.

4. Magnetic Level Bar

A level is a tool used to determine whether a surface is horizontal (level) or vertical (plumb).

5. Welding torch

In oxy-fuel welding, a welding torch is used to weld metals. Welding metal results when two pieces are heated to a temperature that produces a shared pool of molten metal.

6. Welding Helmet

A welding helmet is a type of personal protective equipment used in certain types of welding to protect the eyes, face, and neck from flash burns, sparks, infrared and ultraviolet light, and intense heat.

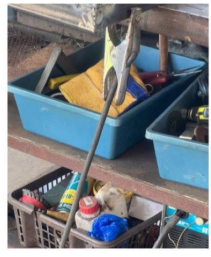
7. Chisel

chisel to shape or scrape hard materials such as metal.

8. Earth Clamp

An earth clamp is a tool that, via the earth cable, ensures the electrical circuit is closed between the welding power source and the piece to be welded.

9. Electrode Holder



The electrode holder's primary function is to hold and conduct current to an electrode during welding or cutting.

10. Metal Grinder

Portable grinders are handheld power tools that are used for grinding, cutting, or polishing.

11. Measuring Tape

A measuring tape is a flexible tool used for measuring length. It is made up of materials like fiberglass, cloth, plastic, and metal ribbon or strip.

12. Speed Square

Basic uses are marking common, hip, valley, and hip or valley jack rafters; laying out stair stringers; determining and marking angles; and making square cuts on boards.

13. Goggles

Goggles are the primary protectors intended to shield the eyes against liquid or chemical splashes, irritating mists, vapors, and fumes. They form a protective seal around the eyes and prevent objects or liquids from entering under or around the goggles.

14. Welding gloves

Welding gloves, or welding gloves, are gloves that are specifically made for the welding work process. The material of the welding gloves is made of leather or an asbestos-type material with good flexibility.

3.4.11 PRODUCT MAKING PROCESS

Step 1: Drawing production

The sketching and drawing process of a project is used as a guide and reference in creating the project, as found in the drawings that have been prepared. It also aims to simplify manufacturing work. Drawings are usually made manually at the concept sketch stage or computerized, that is, by using drawing tools or computer software. The resulting drawings are in 2D and 3D form so that the project illustration can be seen clearly from various angles and points of view. All measurements and selections of materials are in accordance with what has been planned and shown in the drawings.

Step 2: Measure and mark

The process of measuring and marking is done before the cutting work is done to get accurate measurements to facilitate the cutting process. The tool used as a marker pen is a triangle ruler, a tape measure, and so on. Work marking and measuring should be done accurately and carefully because slight inequities can affect the size of the product that will be produced.

Figure 3.7: Measure according to the specified size

Step 3: Cutting process

Some parts of the cutting process must be cut according to the cutting list. The metal circular saw is the tool used in the process.

Figure 3.8: Cut iron by using metal circular saw

Step 4: The process of scraping the sharp part of the metal

Scraping work is done using a hand grinder and a hand file. It is done to remove and flatten excess iron and weld spatter after the welding process. In addition, the work of rolling and scraping is aimed at finishing the work.

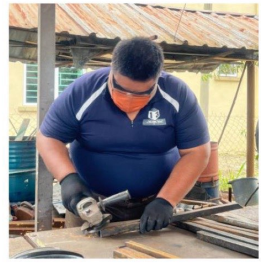


Figure 3.9 Scraping sharp iron after cutting with a grinder

Step 5: Welding process

Welding is a joining process in which metals are heated, melted, and mixed to produce a joint with properties similar to those of the materials being joined.

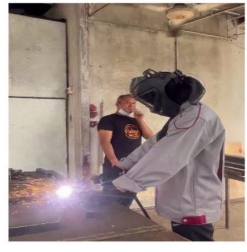


Figure 3.10 Join metal with welding method

Step 6: The process of making a trolley base

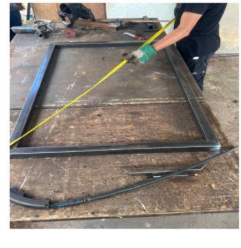


Figure 3.11 Metal base

Step 7: The process of installing brackets for trolley poles


Figure 3.12 Welding process

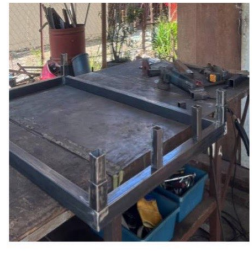


Figure 3.13 Installing a bracket to fasten the iron

Step 8: The process of installing

The process of installing brackets to attach the trolley pole post after the trolley base is welded and joined.


Figure 3.14 The process of installing each trolley pole

Step 9: The process of installing wheels

The process of installing the wheel by welding each corner of the wheel base.


Figure 3.15 The process of installing trolley tires

Step 10: The process of installing the sub roller

The process of installing the sub roller to make it easier for the user to push the wood through the slot-in method.

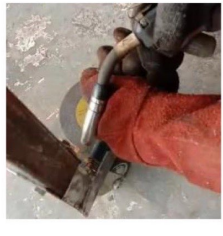



Figure 3.16 The process of installing the sub roller

Step 11: The process of smoothing iron using a grinder

The process of smoothing the iron using a grinder to get a neater surface before finishing.

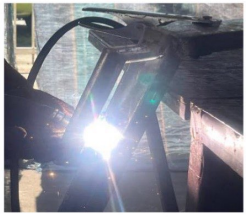



Figure 3.17 process of smoothing iron using a grinder

Step 12: The process of making finishing on plywood

The process of finishing plywood before attaching it to the trolley using varnish.


Figure 3.18 The process of making finishing on plywood

Step 13: The process of measuring and trying to install plywood on the trolley

The process of measuring and trying to fit the plywood on the cart to get the right size.

Figure 3.19 The process of measuring and trying to install plywood on the trolley

Step 14: The process of finishing the trolley.

The process of finishing the trolley using grey spray paint.

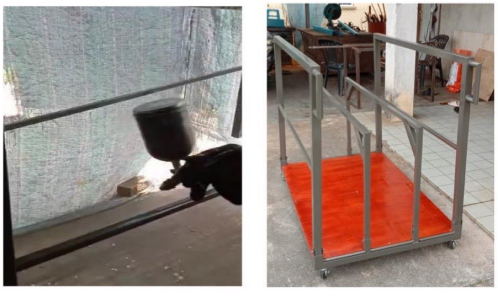


Figure 3.20 The process of finishing the trolley

Step 15: The process of placing a marker on the trolley.

The process of placing a marker on the trolley to distribute the incoming wood evenly.

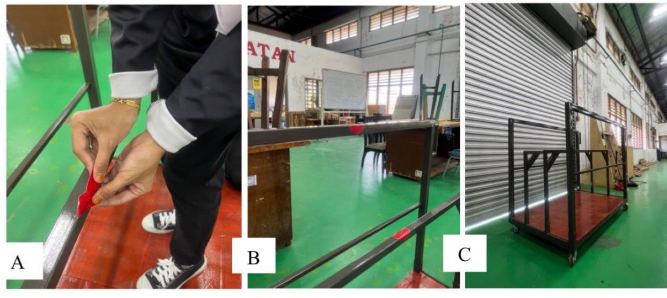


Figure 3.21 A, B and C are process of placing a marker on the trolley

CHAPTER 4

FINDING AND DATA ANALYSIS

4.1 PRELIMINARY STUDY METHOD

The study was conducted using 35 respondents from PSA students. There are several aspects that are the main focus, namely:

1) Respondent Demographics (gender, age, department and semester)

2) General view of the study

3) Respondent's perspective on "TROLLEY"

I. Design

II. Materials used

III. Advantage

IV. Function

4.1.1 ANALYSIS OF RESEARCH DATA

The process of analysing the research data will be shown in the form of a chart. The analysis of this trolley includes the existence of a new trolley in the PSA wood workshop. The result of the decision analysis and the data obtained will be presented in the form of a pie chart.

4.1.2 QUESTIONNAIRE STUDY (PRE-SURVEY)

In order to further strengthen the research conducted, the questionnaire method was used by involving polytechnic residents, especially students who use wood workshops. The data obtained will be presented in the form of a pie chart to facilitate the study and analysis of the information. The following is information related to the questionnaire that has been conducted:

Diagram 4.1 Difficult to lift wood

Diagram 4.1 shows that 72% agree about the difficulty of wanting to lift wood when there is no trolley in the wood workshop. While the number of people who do not agree is 28%, most of them are people who do not need a trolley like in other departments.

Diagram 4.2 the trolley is already damaged

Diagram 4.2 shows that 82% agree that the existing trolleys in the workshop are damaged and not suitable for use. While 18% have said they do not agree, these are those who are not from the department that uses the wood workshop.

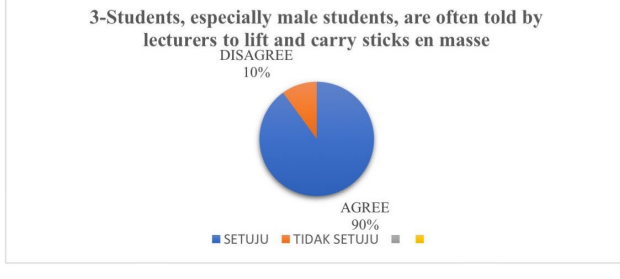


Diagram 4.3 Lifting wood does not use a trolley

Diagram 4.3 shows that 90% agree with the statement about male students who often lift wooden panels from female students. Most of this percentage is male. While 10% disagreed about only male students lifting wooden panels,

Diagram 4.4 should be a trolley around the wood workshop

Figure 4.4 shows that as many as 80% agree with the existence of a trolley around this wood workshop to make it easier for students to carry it from the store to the machine when practical is done. While 20% disagree, and this is from other departments that do not use trolleys,

Diagram 4.5 A trolley can save time

Diagram 4.5 shows that 85% agree about saving time when using a trolley to carry panel wood, and 15% disagree because they are from students who do not use a trolley.

Diagram 4.6 design is strong and suitable

Diagram 4.6 shows that 45% agree and 55% disagree. This is because they couldn't find a new cart image to use as a cart to carry wood in the wood workshop.

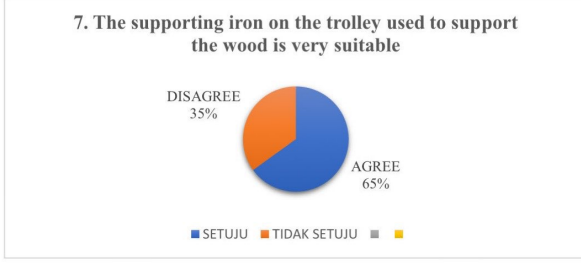


Diagram 4.7 The supporting iron on the trolley used to support the wood

Figure 4.7 shows that 65% agree to put supporting iron on the trolley and 35% disagree. This is because they may feel that the support iron will make the trolley unbalanced.

Diagram 4.8 trolley has a roller

Diagram 4.8 shows that 65% disagree with the above statement because they are not sure that the presence of the roller will make it easier for the wood to slot into the trolley, while 35% agreed to put the roller on the trolley.

Diagram 4.9 increase the tires to 6, the trolley will be more stable

Figure 4.9 shows that 55% do not agree to put six tyres on. This is because the cause of instability on the trolley will occur when putting six wheels on it, while 45% agreed.

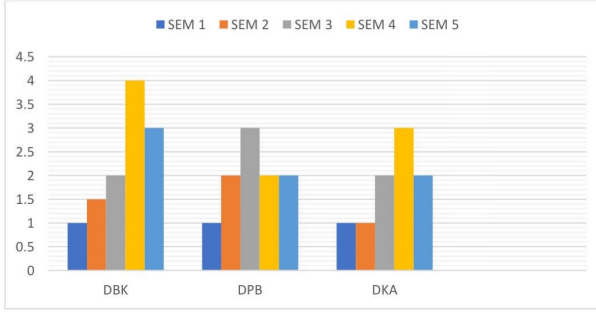
4.2.3 RESPONDENT'S ANSWER

Table 4.1 show the respondent's answer:

1	2
Agree	Disagree

NO	STATEMENT		
		1	2
1	I often find it difficult to lift and carry heavy wood in the woodshop	72%	28%
2	The existing trolley in the wood workshop was damaged and was not suitable for lifting carrying heavy wood	82%	18%
3	Students, especially male students, are often told by lecturers to lift and carry sticks en masse	90%	10%
4	There should be a special trolley to carry wood around the workshop	80%	20%
5	When using a trolley to lift and carry goods can save time	85%	15%
6.	The resulting design is strong and suitable for lifting heavy wood	45%	55%
7.	Supporting iron on the trolley used to support the wood	65%	35%
8	Having a roller in the wood slot makes it easier to move the wood in	35%	65%
9	If you increase the tires to 6, will the trolley become more stable when carrying heavy wood?	45%	55%

4.2.4 DATA COLLECTIONS



Graph 4.1 Data collection

According to the questionnaire that was given last semester to the core respondents who use the woodworking workshop at Sultan Salahuddin Abdul Aziz Shah Polytechnic about the importance of our trolley to lift and carry heavy wooden panels around the workshop, we were able to analyse that 72% of the respondents agreed that they find it difficult to carry heavy wooden panels in the wood workshop. 82% also agreed that the existing trolley in the wood workshop is broken and does not work well. 90% agree that students, especially men, are always asked by lecturers to carry heavy wooden panels in groups. Only 20% of respondents agreed that wood workshops should have their own trolleys to carry heavy wooden panels. This is because the students who answered are not from courses that use workshops and trolleys for their practical use. 85% of respondents agree that trolleys save them time lifting and carrying heavy equipment. 55% disagreed about the cart's design being strong enough to carry heavy wood. This is because they cannot describe a trolley that is ready to be used as a trolley to lift the load of panel wood. 65% agree that a partition on a trolley used for leaning wooden panels is very suitable. 65% of respondents disagreed about the design of the roller that is placed in front of the trolley to facilitate the wooden panel being placed as an entry slot. That's why we agreed not to use rollers. 55% do not agree to add 6 caster wheels to make the trolley more stable because if we have 6 caster wheels, the 2 in the middle cannot work properly, therefore we agree to only use 4 tyres like other normal trolleys.

4.3 FIELD WORK STUDY

4.3.1 THE DISADVANTAGES OF EXISTING TROLLEY IN WOOD HANDLING PROCESS

Based on a detailed study of the old trolley, there are some disadvantages or weaknesses that have been identified, among which is that the trolley does not have barriers on the sides and in the middle to facilitate the user's ability to carry large-sized wood easily and not fall. In addition, the old carts could not carry large quantities of wood. The absence of a trolley in the PSA wood workshop is also one of the disadvantages because it is very important and can save manpower to bring wood from the store to the machine. (Anonymous, 2022)

4.3.2 TIME STUDY METHOD

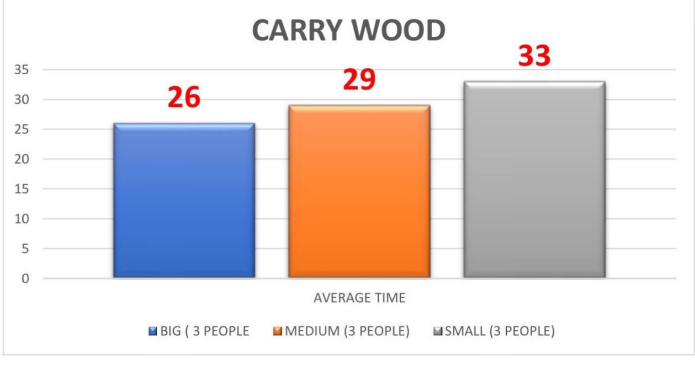
Figure 4.1: Determination of trolley usage using the time study method

Several problems related to material handling have been identified. Therefore, the trolley will be designed to solve the issues. A pilot study of the use of the prototype trolley will be conducted to compare the new and prototype trolleys in the wood workshop. The time study method will be done through observation, and the actual time will be taken during the material handling and recorded by using the stopwatch.

The preliminary study was done during the fieldwork activity and obtained the time needed to carry the wood panel from the store to the nearest machine, which took 27 seconds and required three (3) helpers during the process. Meanwhile, the movement in between the machines took 35 seconds or more. Therefore, by having a new, suitable trolley, hopefully it will save time and reduce manpower.

4.4 DATA COLLECTION TIME STUUDY METHOD WITHOUT TROLLEY

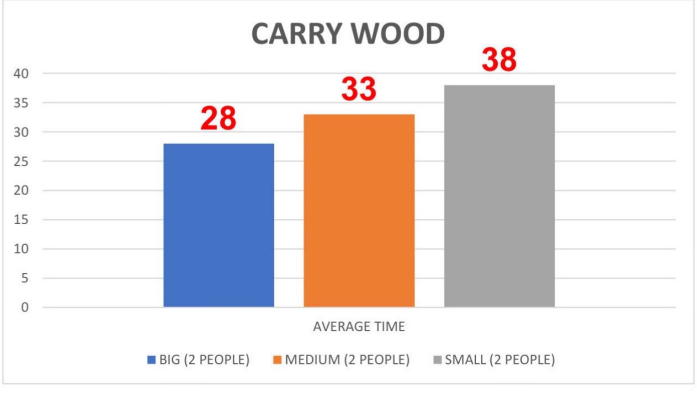
3 PEOPLES



Graph 4.2 Data analysis time study

In graph 4.2, the data has been taken without using a trolley. The data mentioned above used three students to lift 4'x8' wood at the PSA wood workshop. As you can see, the data that takes a long time is for small students because their energy is less than that of medium and large students.

2 PEOPLES



Graph 4.3 Data analysis time study

In graph 4.3, the data has been taken without using a trolley. The data mentioned above used two students to lift 4'x8' wood at the PSA wood workshop. As you can see, the data that takes a long time is for small students because their energy is less than that of medium and large students.

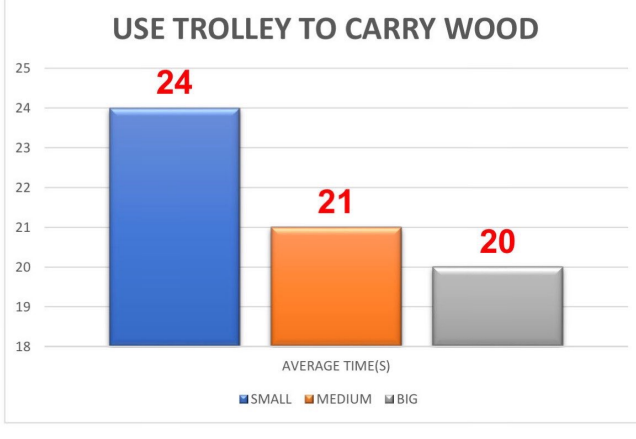
4.5 DATA COLLECTION TIME STUDY METHOD USING TROLLEY

Figure 4.2 2 people using trolley (big)

Figure 4.3 2 people using trolley (medium)

Figure 4.4 2 people using trolley (small)

USING TROLLEY



Graph 4.4 Data analysis testing product

Graph 4.4 shows the product testing data that has been taken using a trolley. The data mentioned above uses two students to use the trolley, including small, medium, and large students. The result of this testing is that it can save the time and energy of students by lifting

wood to the machine from the store. So, after seeing this trolley, it can be effective for students to use it during practise or so on.

4.6 **QUESTIONNAIRE STUDY (POST-SURVEY)**

This second questionnaire study was done to show that this trolley achieves the objective of the study and works well. The response from the students is very important to show that this trolley project has been successfully implemented.

1	2
Agree	Disagree

Table 4. 2 shows the results of a survey of the trolley after use.

NO	STATEMENT		
		1	**2**
1	Is the design of the trolley suitable for lifting goods?		
2	Does this cart work well?		
3	Is this cart suitable for use in a wood workshop?		
4	In your opinion, does this trolley make it easier for students and lecturers to lift and carry wood around the workshop?		
5	Is it suitable for this trolley to be made from grade b iron material to be used to lift and carry kayi?		
6.	The rollers on the front and back of the trolley make it easier for the wood to go into the slot. Do you agree?		

7.	Will the trolley handle make the trolley easier to control?		
8	The size of the trolley is ideal for lifting and carrying 4' x 8' panel wood.		
9	This trolley can save time and energy for students and lecturers to lift and carry heavy panel wood. Do you agree?		

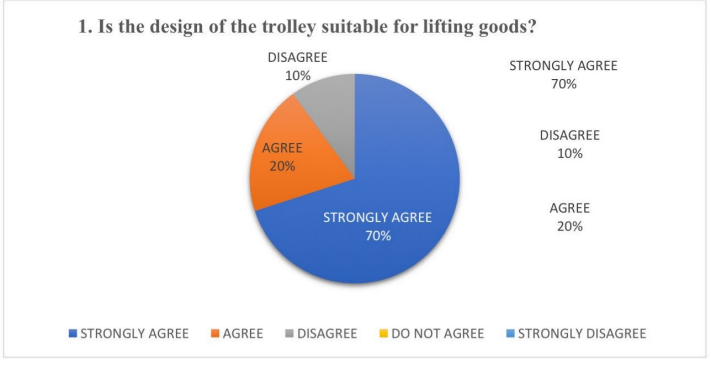


Diagram 4.10 Design trolley

The diagram above shows the response analysis from the respondents about the trolley design being suitable for lifting and carrying panel wood. From the analysis, a total of 90% (36 people) of respondents agreed. While a total of 10% (4 people) among the respondents answered "disagree,".

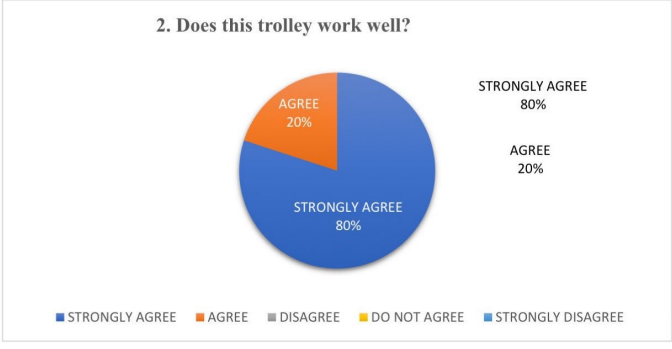


Diagram 4.11 trolley work well

The diagram above shows the analysis of responses from respondents about the trolley working well. From the analysis, a total of 80% (32 people) of respondents strongly agreed. While 20% (8 people) of the respondents answered "AGREE,"

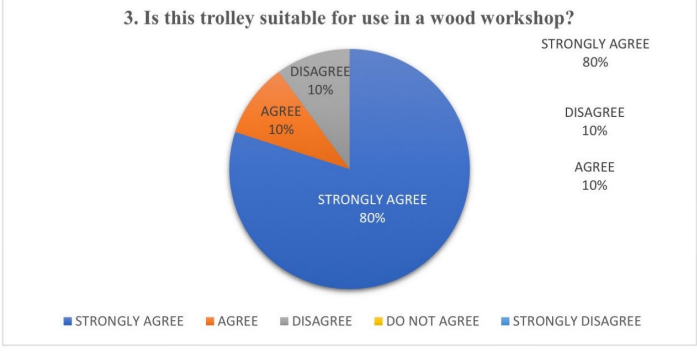


Diagram 4.12 suitable to use in a wood workshop

The diagram above shows the analysis of responses from respondents about the suitability of trolleys for use in workshops. From the analysis, a total of 90% (36 people) of respondents agreed. While a total of 10% (4 people) among the respondents answered "disagree,".

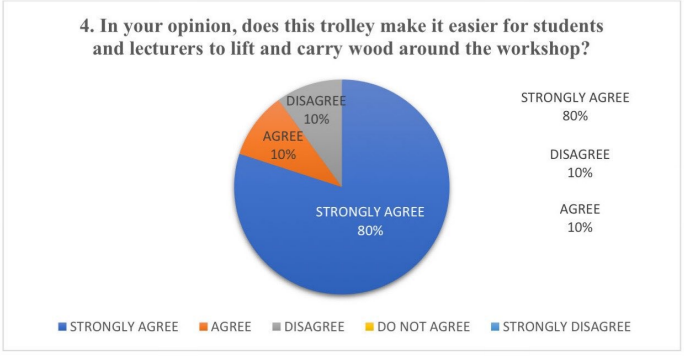


Diagram 4.13 make it easier for people

The diagram above shows the analysis of responses from respondents about the convenience of trolleys for students and lecturers to lift and carry panel wood. From the analysis, a total of 90% (36 people) of respondents agreed. While a total of 10% (4 people) among the respondents answered "disagree.".

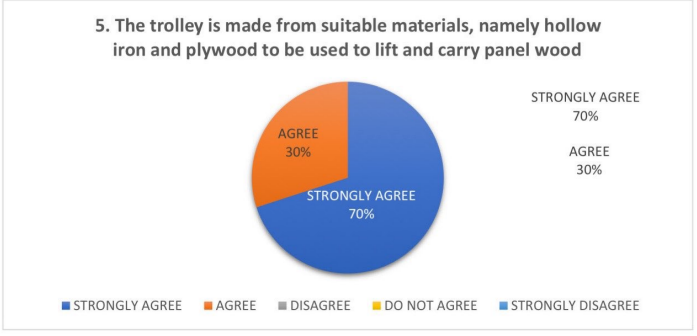


Diagram 4.14 suitable materials

The diagram above shows the analysis of responses from respondents about the materials used to make our trolleys. From the analysis, a total of 90% (36 people) of respondents agreed. While a total of 10% (4 people) among the respondents answered "disagree,".

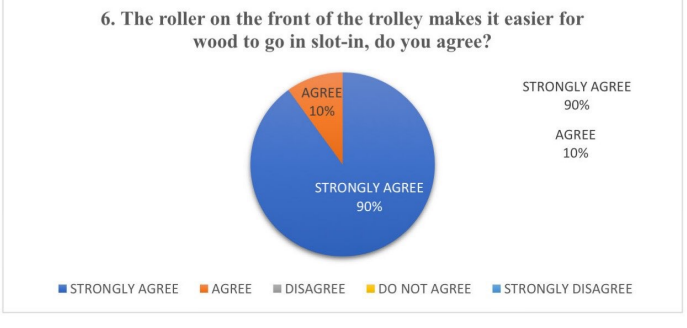


Diagram 4.15 easier for wood to slot-in

The diagram above shows the respondents' response analysis about the roller in front of the trolley to facilitate the wooden slot-in. From the analysis, a total of 90% (36 people) of respondents strongly agreed. While a total of 10% (4 people) among the respondents answered "AGREE,".

Diagram 4.16 easier to control the trolley

The diagram above shows the response analysis from the respondents about the trolley handle making it easy to control the trolley. From the analysis, a total of 100% (40 people) of respondents strongly agreed.

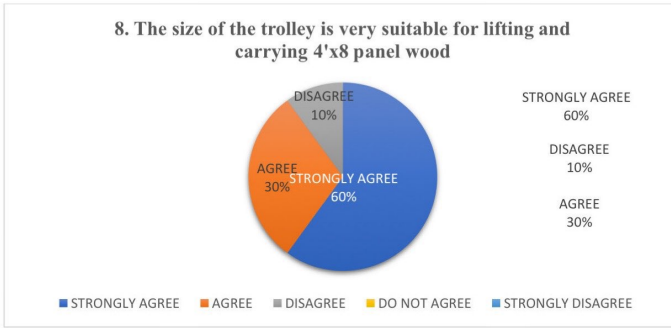


Diagram 4.17 size trolley suitable for carrying 4'x8' panel wood

The diagram above shows the analysis of the responses from the respondents regarding the suitability of the trolley to lift and carry the 4' x 8' panel wood. From the analysis, a total of 90% (36 people) of the respondents agreed. While a total of 10% (4 people) among the respondents answered "disagree,".

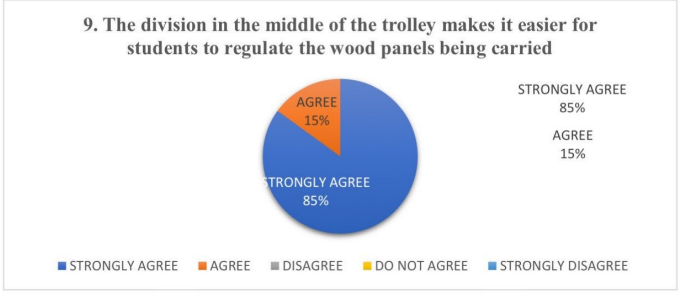


Diagram 4.18 The division in the middle of the trolley makes it easier for students to regulate the wood panels being carried

The diagram above shows the analysis of responses from respondents about the division in the middle of the trolley to make it easier for students to regulate the wooden panels they carry. From the analysis, 100% (40 people) of respondents answered "AGREE." The diagram above shows the analysis of responses from respondents about the division in the middle of the trolley to make it easier for students to regulate the wooden panels they carry. From the analysis, 100% (40 people) of respondents answered "AGREE."

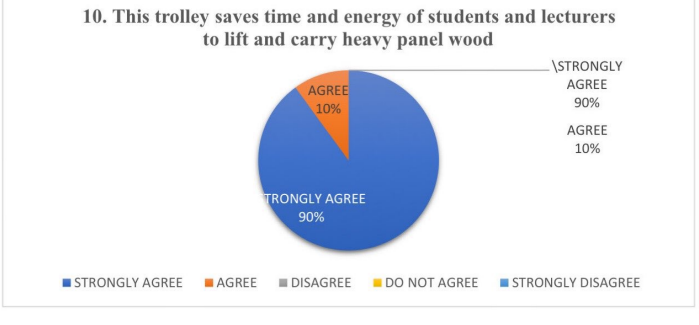


Diagram 4.19 save time and energy

The diagram above shows the analysis of responses from respondents about saving time and energy for students and lecturers to lift and carry wood panels. From the analysis, 100% (40 people) of respondents answered "AGREE."

4.6.1 RESPONDENT'S ANSWER

Table 4.3 show the respondent's answer:

1	2	3
Disagree	Agree	Strongly agree

Table 4.3 show the respondent's answer

NO	STATEMENT			
		1	**2**	**3**
1	Is the design of the trolley suitable for lifting goods?	10%	20%	70%
2	Does this cart work well?	0%	20%	80%
3	Is this cart suitable for use in a wood workshop?	10%	10%	80%
4	In your opinion, does this trolley make it easier for students and lecturers to lift and carry wood around the workshop?	10%	10%	80%
5	Is it suitable for this trolley to be made from grade b iron material to be used to lift and carry kayi?	0%	30%	70%
6.	The rollers on the front and back of the trolley make it easier for the wood to go into the slot. Do you agree?	0%	10%	90%
7.	Will the trolley handle make the trolley easier to control?	0%		100%
8	The size of the trolley is ideal for lifting and carrying 4' x 8' panel wood.	10%	30%	60%

9	The division in the middle of the trolley makes it easier for students to regulate the wood panels being carried	0%	15%	85%
10	This trolley can save time and energy for students and lecturers to lift and carry heavy panel wood. Do you agree?	0%	10%	90%

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

As a result of the tests carried out on the trolley, it can be concluded that this trolley has achieved the objective of the study, which is to lift, move, and carry heavy goods, especially 4'x8' panel wood in the PSA wood workshop. The trolleys do not have barriers on the sides and middle, making it easier for users to carry large pieces of timber and boards. By using the time study method, the time taken when using a trolley to carry a heavy and large load is reduced, and using a trolley also successfully reduces manpower. This trolley is also proven to be durable because the material used to make it is rust-resistant, in addition to the use of thick plywood, which is proven to be among the strongest engineered woods on the market.

5.2 RECOMMENDATION

The use of trolleys is designed to help reduce the energy consumption of humans when lifting and moving heavy objects from one place to another. Here are some things that are suggested to further improve the study that will be done on the trolley to find out the level of effectiveness:

- The use of lighter material to reduce the weight of the trolley makes it easier to control.
- Cheaper material is also important to reduce the cost of trolleys.
- Must prioritise the safety of users who use it.
  The design must be more user-friendly, so it can be easily carried or used at any place possible.

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APPENDIX 1

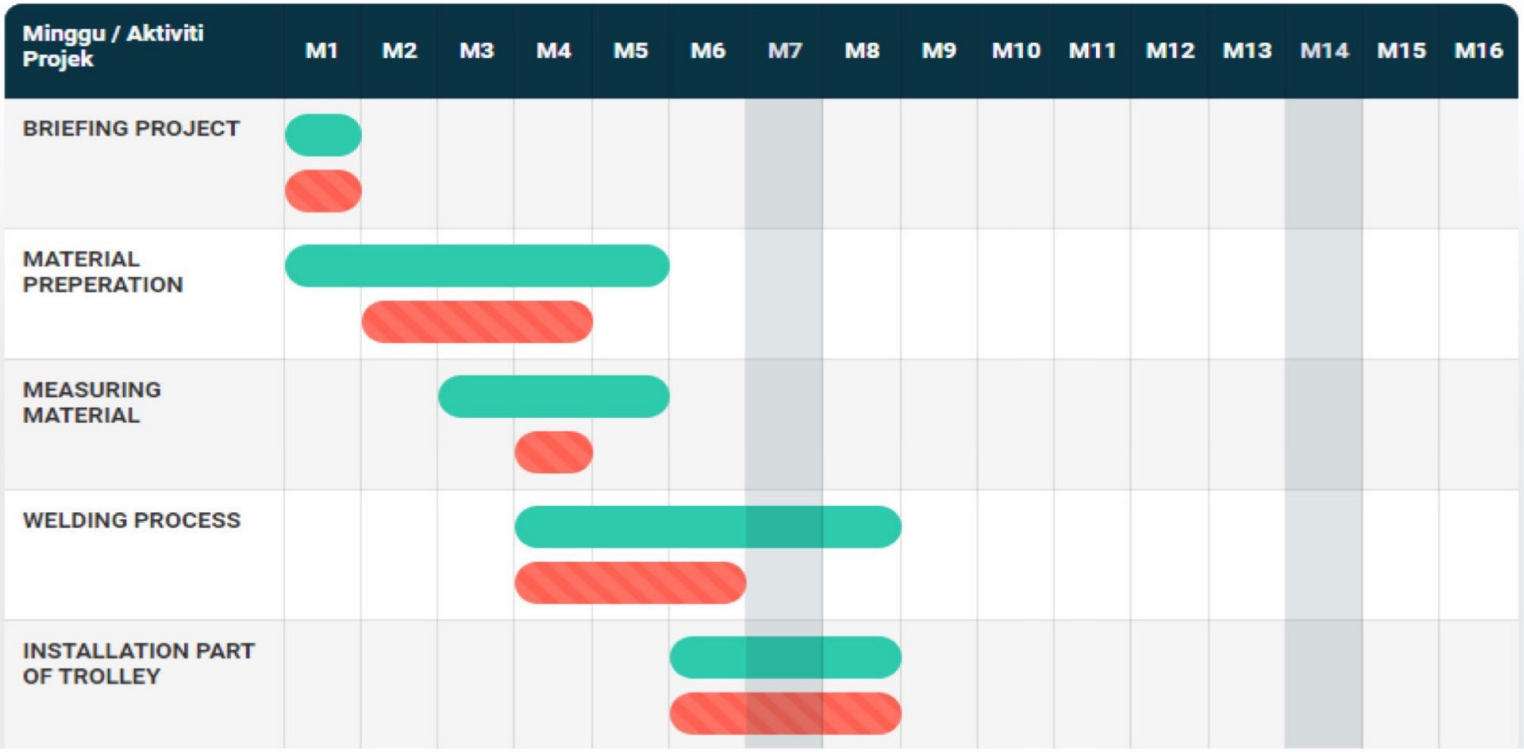
GANTT CHART REPORT WRITING


7 Draft report 2
8 Final Report
9 Log book
10 Submission Report

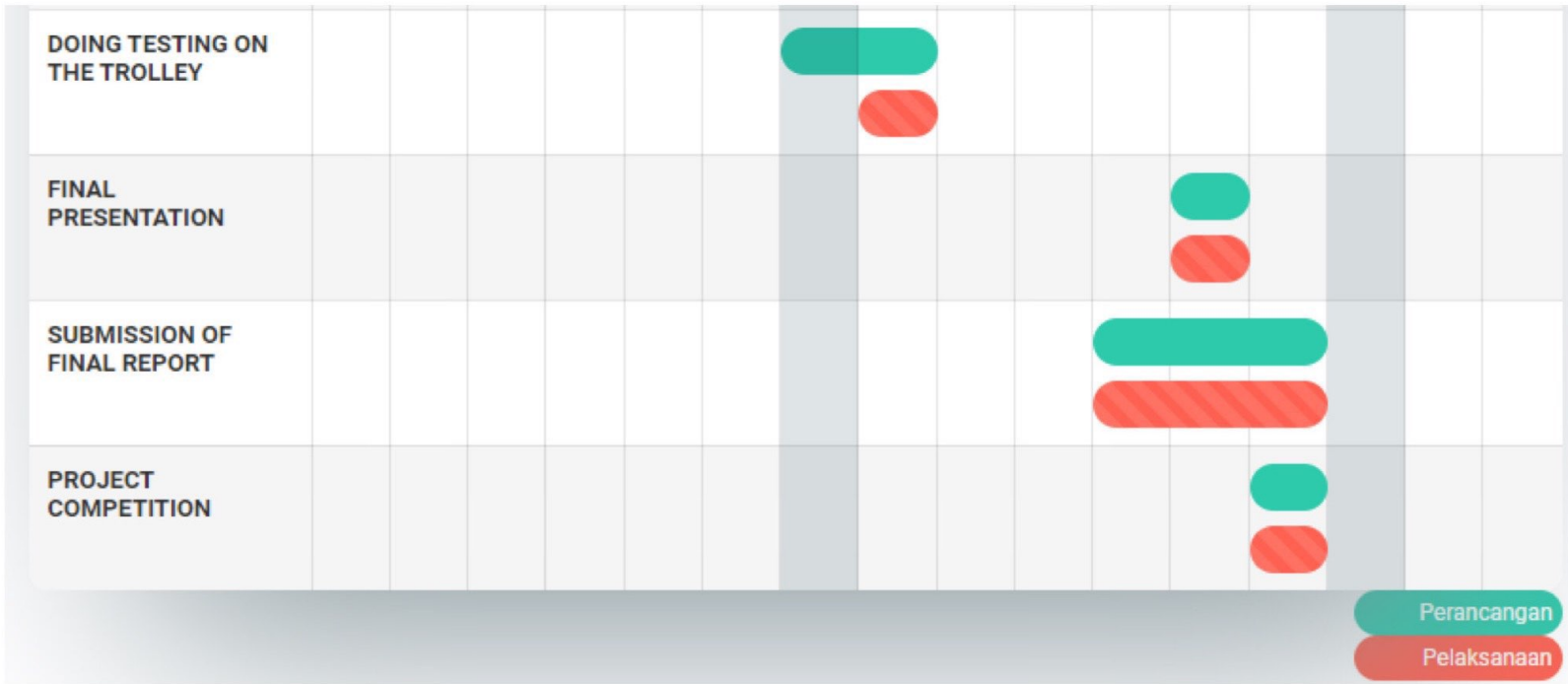
APPENDIX 1

GANTT CHART WORKING PROCESS

SESI : 2 : 2022/2023
JABATAN: JKA
KODKURSUS: DCW50243
TAJUK PROJEK : TROLLEY



APPENDIX 1


DOING TESTING ON THE TROLLEY
FINAL PRESENTATION
SUBMISSION OF FINAL REPORT
PROJECT COMPETITION
Perancangan
Pelaksanaan

APPENDIX 2

BAHAGIAN A
Demografi

1. Jantina

- ◯ Lelaki
- ◯ Perempuan

2. Umur

- ◯ 19 - 25
- ◯ 26- 30
- ◯ Other: _____

3. Kaum

- ◯ Melayu
- ◯ Cina
- ◯ India

4. Jabatan

- ◯ JKA
- ◯ JKE
- ◯ JKM

5. Program

- ◯ DBK
- ◯ DKA
- ◯ DPB
- ◯ Other: _____

APPENDIX 2

BAHAGIAN B
Soalan tahap keperluan troli untuk mengangkat dan membawa kayu yang berat
1. Setuju
2. Tidak setuju

1.Saya sering merasa susah untuk mengangkat dan membawa kayu yang berat di bengkel kayu

- SETUJU
- TIDAK SETUJU

2.Troli yang sedia ada di bengkel kayu telah rosak dan tidak sesuai untuk mengangkat dan membawa kayu yang berat

- SETUJU
- TIDAK SETUJU

3-Pelajar terutamanya pelajar lelaki sering disuruh oleh pensyarah untuk mengangkat dan membawa kayu beramai-ramai

- SETUJU
- TIDAK SETUJU

4. Perlunya ada troli yang khas untuk mengangkat membawa kayu di sekitar bengkel

- SETUJU
- TIDAK SETUJU

DESIGN TROLLEY

APPENDIX 2

5. Semasa menggunakan troli untuk mengangkat dan membawa barang dapat menjimatkan masa

- SETUJU
- TIDAK SETUJU

6.Reka bentuk yang dihasilkan adalah kukuh dan bersesuai untuk mengangkat kayu yg berat

- SETUJU
- TIDAK SETUJU

7.Besi penyandar pada troli tersebut digunakan untuk menyandar kayu adalah sangat bersesuaian

- SETUJU
- TIDAK SETUJU

8. Trolley mempunyai roller di bahagian depan untuk slot in kayu dapat memudahkan pergerakan kayu masuk

- SETUJU
- TIDAK SETUJU

9 - sekiranya menambahkan tayar menjadi 6, troli akan bertambah lebih stabil ketika membawa kayu berat

- SETUJU
- TIDAK SETUJU

Cadangan anda

Your answer

APPENDIX 3

BAHAGIAN A

Demografi

Jantina

- ◯ Lelaki
- ◯ Perempuan

KELAS DBK

- ◯ DBK 1
- ◯ DBK 2
- ◯ DBK 3
- ◯ DBK 4
- ◯ DBK 5

1. Rekabentuk troli adakah bersesuaian untuk mengangkat barang?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

2. Adakah troli ini berfungsi dengan baik?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

APPENDIX 3

3. Adakah troli ini sesuai digunakan di bengkel kayu?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

4. Pada pandangan anda, adakah troli ini memudahkan pelajar dan pensyarah mengangkat dan membawa kayu di sekitar bengkel?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

5. Troli dibuat dari bahan yang sesuai iaitu besi hollow dan plywood untuk di gunakan mengangkat dan membawa kayu panel

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

6. Roller yang terdapat di bahagian depan troli memudahkan kayu untuk masuk secara slot-in adakah anda bersetuju?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

APPENDIX 3

7. Adakah pemegang troli akan memudahkan troli di kawal?'

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

8. Saiz troli sangat sesuai digunakan untuk mengangkat dan membawa kayu panel 4'x8

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

9. Pembahagian di tengah troli memudahkan pelajar untuk mengawalselia kayu panel yang dibawa

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

10. Troli ini menjimatkan masa dan tenaga pelajar dan pensyarah untuk mengangkat dan membawa kayu panel yang berat

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

11. Berikan pendapat anda secara keseluruhan berkenaan troli ini.

Your answer

APPENDIX 4

3 PEOPLE

NO	BIG (3 PEOPLE) (Second)
1	23.8
2	23.78
3	23.79
4	23.77
5	23.7
6	23.72
7	23.69
8	23.66
9	23.64
10	23.6
TOTAL	**237.15**
AVERAGE	**23.715**

NO	SMALL (3 PEOPLE) (Second)
1	27.9
2	27.88
3	27.85
4	27.75
5	27.8
6	27.77
7	27.8
8	27.75
9	27.77
10	27.75
TOTAL	**278.02**
AVERAGE	**27.802**

NO	MEDIUM (3 PEOPLE) (Second)
1	25.45
2	25.43
3	25.38
4	25.4
5	25.35
6	25.49
7	25.43
8	25.42
9	25.39
10	25.35
TOTAL	**254.09**
AVERAGE	**25.409**

APPENDIX 4

2 PEOPLE

NO	MEDIUM (2 PEOPLE) (Second)
1	26.9
2	26.85
3	26.83
4	26.81
5	26.84
6	26.8
7	26.79
8	26.8
9	26.83
10	26.77
TOTAL	**268.22**

		AVERAGE	**26.822**

NO	BIG (2 PEOPLE) (Second)
1	24.8
2	24.76
3	24.79
4	24.74
5	24.76
6	24.73
7	24.69
8	24.74
9	24.71
10	24.68
TOTAL	**247.4**
AVERAGE	**24.74**

NO	SMALL (2 PEOPLE) (Second)
1	30.3
2	29.96
3	29.93
4	29.9
5	28.97
6	28.93
7	28.91
8	28.91
9	28.89
10	28.9
TOTAL	**293.6**
AVERAGE	**29.36**

APPENDIX 4

DATA COLLECTION TIME STUDY METHOD

	BIG		
No.	PUSH FROM STOR (Second)	PICK UP FROM STORE (Second)	PUSH TO THE MACHINE (Second)
1	8	6.38	6.7
2	7.85	6.4	6.69
3	7.8	6.35	6.55
4	7.32	6.34	6.47
5	7.01	6.25	6.36
6	6.98	6.18	6.31
7	6.6	6.16	6.3
8	6.4	6.15	6.27
9	6	6.09	6.15
10	5.98	6.1	6.1
Total	69.94	62.4	63.9
Average	6.994	6.24	6.39

APPENDIX 5

MEDIUM

No.	PUSH FROM STOR (Second)	PICK UP FROM STORE (Second)	PUSH TO THE MACHINE (Second)
1	10.88	7.01	10.78
2	10.73	6.65	10.65
3	10.65	6.98	10.62
4	10.59	6.9	10.56
5	10.47	6.88	10.51
6	10.4	6.54	10.51
7	10.33	6.45	10.43
8	10.3	6.35	10.31
9	10.31	6.28	10.12
10	10.24	6.19	10.08
Total	104.9	66.23	104.57
Average	10.49	6.623	10.457

APPENDIX 5

SMALL

No.	PUSH FROM STOR (Second)	PICK UP FROM STORE (Second)	PUSH TO THE MACHINE (Second)
1	11.8	14	11.06
2	11.76	13.85	11.01
3	11.73	13.81	10.85
4	11.64	13.76	10.84
5	11.52	13.66	10.8
6	11.45	13.61	10.75
7	11.42	13.57	10.67
8	11.38	13.53	10.55
9	11.34	13.46	10.48
10	11.28	13.39	10.37
Total	115.32	136.64	107.38
Average	11.532	13.664	10.738