



## JABATAN KEJURUTERAAN MEKANIKAL

### DJJ 6143 PROJECT 2

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## **AUTOMATED LUGGAGE CARRIER**

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JUN 2020

**POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH**

**AUTOMATED LUGGAGE CARRIER**

**Laporan ini dikemukakan kepada Jabatan Kejuruteraan Mekanikal  
sebagai memenuhi sebahagian syarat penganugerahan Diploma  
Kejuruteraan Mekanikal.**

**JABATAN KEJURUTERAAN MEKANIKAL**

**JUN 2020**

## AKUAN KEASLIAN DAN HAK MILIK

**TAJUK : AUTOMATED LUGGAGE CARRIER**

**SESI : JUN 2020**

Kami, **1. MUHAMMAD HAZEEM BIN HAIZI (08DKM18F1111)**  
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Adalah pelajar tahun akhir **Diploma Kejuruteraan Mekanikal, Jabatan Kejuruteraan Mekanikal, Politeknik Sultan Salahuddin Abdul Aziz Shah**, yang beralamat di **Persiaran Usahawan, 40150, Shah Alam, Selangor**. (selepas ini dirujuk sebagai 'Politeknik tersebut').

Kami mengakui bahawa "Projek tersebut di atas' dan harta intelek yang ada di dalamnya adalah hasil karya/reka cipta asli kami tanpa mengambil atau meniru mana-mana harga intelek daripada pihak-pihak lain.

3. Kami bersetuju melepaskan pemilikan harta intelek 'projek tersebut' kepada 'Politeknik tersebut' bagi memenuhi keperluan untuk peanugerahan **Diploma Kejuruteraan Mekanikal** kepada kami.

Diperbuat dan dengan sebenar-benarnya diakui

Oleh yang tersebut;

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We are taking this golden opportunity to express our gratitude to those who have supported us during this project. During the project work, I am grateful for their aspiring guidance, invaluable constructive criticism and friendly advice.

We are truly thankful to them for sharing their genuine and enlightening thoughts on a variety of project-related issues.

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Last but not least, as the saying goes, he or she can never tell where their power ends, an instructor affects eternity. Thank you very much once again!

## **ABSTRACT**

Automated Luggage Carrier (ALC) is a project designed specifically for disabled people, housewives and aged citizen who lives at multi-storey terrace house or flats which doesn't have lift convenience. There are several difficulties faced by users which are not being able to carry a lot and heavy things all at once up the stairs. Besides that, time consumption happens when users are unable to bring all the things at once because they have to make multiple trips. Other than that, carrying heavy things causes muscle pain to the elderly group. ALC aims to fabricate a trolley for users to move things using less energy. Besides that, to innovate trolley which has Arduino programming to control the movement of ALC. Next, to test the functionality of the product. To test whether ALC saves time and is more stable than other trolley. ALC uses 12V battery, Arduino programming. ALC combines rocker bogie mechanism. 6, 12V motor 14kgfcm is attached to a lightweight frame with dimension 45cmx70cm dimension. Estimated weight that ALC could carry is 20kg. The 12V battery last 2-4 hours before having to charge again. Improvement that can be done to the Automated Luggage Carrier (ALC) is include a GPS application. Besides that, increase the capacity of weight carried by ALC to above 20kg. Other improvement that can be done to the ALC is increasing the lasting duration of battery when ALC is being used before having to charge again.

# **CHAPTER 1 : INTRODUCTION**

## **1.1 Research Background**

It is common to see people having back pain due to carrying heavy weight to a certain distance or up the staircase. Having trouble carrying heavy loads varies from young until aged people. Aged people face difficulties to carry heavy loads such as large amounts of groceries while young aged mostly students have problems carrying heavy school bags which causes back pain. This common problem could affect a human condition in the long term.

Hence, looking into the matter, we decided to create a trolley which would assist humans to overcome the problem. Our product design is an improvisation of an already existed product. It's called AUTOMATED LUGGAGE CARRIER (ALC). Two products are combined into one to help ease human work. Two products that were involved are 3 wheel stair climbing cart and rocker-bogie.

The 3 wheel climbing cart is produced to make it easy to transport laundry, groceries and such things. The versatile cart is designed to easily climb stairs and curbs. The designs aren't very large and won't consume much space. The mechanism uses a trolley with a support wheel arrangement which will be used for support when at rest and will be suspended in air while the trolley is moved by lifting it. The interlinked wheel mechanism consists of 3 freely moving wheels. These wheels are connected to a connecting rod. There are 3 such connecting shafts for each wheel with a main rod connecting through a free moving bearing mechanism to the three rods. This mechanism allows for efficient stair climbing functionality. This functionality allows for easy movement of goods across stair cases.

What is rocker bogie? It is a suspension arrangement used in the Mars rovers and patented by NASA ( Bickler, 1988 ). Bogies are sub-assemblies of wheels that can have a pitch angle with respect to the frame. This configuration is useful to ensure that all the wheels of the robot (originally six) remain in contact with irregular grounds in unstructured environments. Rocker-bogie system consists of two main parts. This consists of two solid links and 3 wheels for both sides of the center platform of the robot. The larger link 1 with only one wheel and two joints is called the 'Rocker' and it is the forward part of one leg. The second link consists of two drive wheels at both ends called the 'Bogie' which is the rear part of the suspension design. One leg for our platform is made connecting Rocker and bogie links together by a pivot at one end of the rocker and middle of the bogie.

## 1.2 Problems

## Statement

1. A lot of effort is used to adjust the inclination of the trolley while being pulled up.
2. The wheel size of the stair climbing trolley is limited to its large diameter because of the star-shaped plate
3. The trolley as well have difficulties moving on uneven terrain or stairs and maintain stability at the same time

## 1.3 Research Objectives

*The objective of this research :*

1. To create a new design that will allow the trolley to be stable move up the stairs as well on uneven terrain
2. To create a design that will aid mobilization of objects while using less energy while pulling the trolley.
3. To create trolleys with smaller diameter wheels.

## 1.4 Research

## Questions

Due to the fact that we need to gather opinions from the public about wheelchair for bedridden patients, these questions will be asked in the form of Google Forms as a survey so that we will be able to collect the data required.

*This study will answer the following question :*

1. Is it difficult to carry a heavy load to a higher place by an individual?
2. Must the materials used for carrier luggage have to be strong and durable material to withstand heavy loads?
3. Will it require less force to move objects with this design?

## **1.5 Scope of Research**

*The scopes and limits to this research are :*

1. Can't be able to support object above 70kg
2. Less exposure to water
3. The trolley is space consuming

## **1.6 Chapter's Summary**

As for the conclusion for the first chapter, the ability and functions of the newly designed trolley is highly anticipated. The design is focused mainly to improve the mobilization of users that don't have lift convenience, save the time of theirs, and make the world a better place for them to live in.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

##### **ROCKER BOGIE**

Along with the Sojourner rover, the LSR-1 is representative of a class of NASA prototype planetary rovers based on a rocker-bogie mobility configuration. The LSR-1 vehicle has 20 cm diameter wheels and is approximately 100 cm in length, 70 cm wide, and 45 cm high. It is equipped with a three degrees of freedom manipulator, whose payload is not negligible in the rover mass distribution. Six independently driven wheels are mounted on an articulated frame. The frame has two rocker arms connected to a main body. Each rocker has a rear wheel connected to one end and a secondary rocker, called a bogie, connected to the other. At each end of the bogie is a drive wheel and the bogie is connected to the rocker with a free pivoting joint. The rockers are connected to the main body with a differential so that the pitch angle of the body is the average of the pitch angles of the rockers.

The Rocker-Bogie Mobility system was designed to be used at slow speeds. It is capable of overcoming obstacles that are on the order of the size of a wheel. However, when surmounting a sizable obstacle, the vehicle's motion effectively stops while the front wheel climbs the obstacle. When operating at low speed (greater than 10cm/second), dynamic shocks are minimized when this happens. For many future planetary missions, rovers will have to operate at human level speeds ( $\sim 1\text{m/second}$ ) Shocks resulting from the impact of the

front wheel against an obstacle could damage the payload or the vehicle. This paper describes a method of driving a rocker-bogie vehicle so that it can effectively step over most obstacles rather than impacting and climbing over them. Most of the benefits of this method can be achieved without any mechanical modification to existing designs - only a change in control strategy. Some mechanical changes are suggested to gather the maximum benefit and to greatly increase the effective operational speed of future rovers

### **STAIR CLIMBER TROLLEY**

A typical hand trolley consists of two wheels located at the bottom of the trolley. The two handles are provided to support the frame and apply human effort. Handles are used to push or pull the trolley. The size, shape, and position of handle are very according to requirement. Mostly the shape of the handle is l-shape. The wheels are mounted on a shaft supported by a bearing. The material used to make trolleys is different according to the working load. To carry heavy load the trolley is made from stainless steel and to carry moderate load trolley made from mild steel. The load is mounting on top of the trolley. In some cases a rectangular box is provided to carry the load. The material for the rectangular box is very according to the working load. Sometimes holes, or square slots are provided to reduce the weight and such kind of trolley is used for light weight application. The types of trolley used are wheeled trolley, folding trolley, kitchen trolley, and motorized trolley

Stair climbing trolley is designed to lift the high weight with less human effort. Conventional hand trolley is designed to move on flat surfaces but it cannot move

on irregular surfaces or on stairs. In the stair climbing trolley more than two wheels are provided. These combinations of wheels work as a single unit. In the stair climbing trolley three wheels are connected to the shaft by means of triangular plate or straight rod. Such a trolley is very useful in civil construction, transferring books in the library and also used at home. When people are injured at that time to lift loads by using such a trolley is very easy.

## **2.2 DESIGN OF TROLLEY**

**Prepared By Dannishwaran A/L S Anbalagan**

A lightweight truck is provided with handles which may be secured in an upright operative position at the ends of the truck or may be rapidly and easily stored in an inoperative position by pivoting the handle from its secured position and sliding it along rails provided under the truck's platform.

In carrying out the invention there is provided a frame, including a body , which is U-shaped, the body including parallel side arms I provided at their forward ends with rectangularly disposed feet , which serve a double purpose, in that they prevent merchandise from sliding off the truck lengthwise

The side arms are connected by a rear cross bar. Near to the cross bar, the side arms are supplied with loop-shaped grips. The side arms are joined together by a rear connection, an intermediate connection is secured in the depending parts of the bracket, and wheels are mounted to turn on the ends of the axle, outwardly of the side arms and outwardly of the depending parts of the bracket. Skids are provided, and include runners disposed below the side arms of the body.

A hand truck comprising a load supporting platform having a top panel, end walls and sidewalls below the top panel, a caster mounted below each corner

of the top panel, a substantially rectangular handle at each end of the truck and having laterally spaced legs joined at their ends by upper and lower cross-bars.

Accordingly, the present invention relates to a collapsible hand truck comprising skeletal frame means, said frame means including parallel sides, upper bracket means on the top of each side, lower bracket means on the bottom of each side, and top end.

## **2.3 TROLLEY PREFERENCE**

**Prepared By Muhammad Hazeem Bin Haizi**

The luggage may be of any type desired, such as an overnight case for clothes or a briefcase for papers. The trolley mechanism is easily adaptable for use with any of these cases. The case should be suitably reinforced in order to withstand the weight of other luggage piled on top of it.

The case should also preferably be made of scuff resistant material, particularly the side of the case which faces the ground when used as a trolley. it is desirable that the wheels be retractable within the case when not being used. To accomplish this objective, one end of the case is provided with a spaced pair of recesses preferably at the end to which the support arms are connected.

It will be apparent that it is most desirable to provide a barrier between the recess and the interior of the luggage case to enhance the security of the case and to prevent the contents of the case from interfering with operation of the wheel.

According to the present invention, a wheeled portable case is provided with a rigid frame selectively engageable with a face of the case such as, in the preferred embodiment, the lid of the case. Upon selective disengagement of the frame from the case face, the rigid frame may be aligned in coplanar relationship with a pair of rigid, coplanar frame support arms pivotally connected to and adjacent one end of the case. The support arms may be disposed substantially perpendicularly to the face of the luggage case and the rigid frame aligned therewith. Locking means retaining the rigid frame and the support arms in coplanar alignment.

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### **3.1 Introduction**

On this chapter, the focus will be on methodology. What is methodology? Based on our understanding, it is a sequence of processes that has been and is being done continuously. Methodology as well is useful to present data in order to show the progress of a project or experiment is going on.

In this chapter, we'll be showing methods of our walkthrough throughout preparing the Automated Luggage Carrier (ACL) for the Final Year Project. There'll also be information provided in depth to make sure there is clear understanding of the project that has been done.

### 3.2 Flow chart of Process

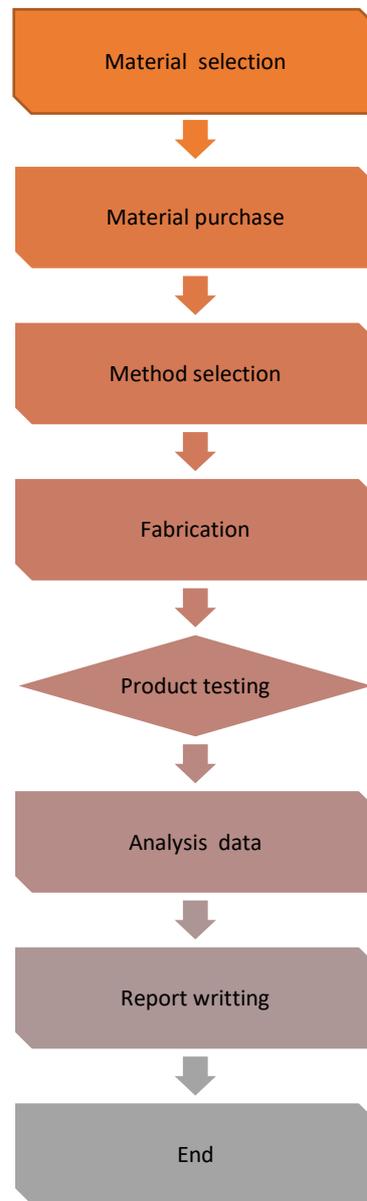


Figure 3.2.1- Flow Chart of Process

### **3.3 Flow Chart**

**Prepared By Muhammad Hazeem Bin Haizi**

#### **3.3.1 Material selection**

Some research online to decide suitable material for the project. It is crucial to decide the correct material to avoid wastage of money. We looked through several websites to decide the price of the material because materials for our project can be obtained through online shopping. Several webs were surfed to make sure to decide the best selling price. Material selection has to be done correctly in order to prevent risk, dysfunction of ALC.

- **PVC pipe**

PVC pipes are commonly used for manufacturing sewage pipes, water mains and irrigation. PVC possesses very long-lasting properties. PVC pipes have clear environmental advantages over traditional materials. As PVC is a low carbon plastic, PVC pipes require less energy and fewer resources to manufacture. Due to their low weight, less energy is used when transported. PVC pipes last long with a minimum of maintenance.

#### **Advantages of PVC pipe**

1. PVC pipes are easy to install
2. lightweight
3. strong
4. durable
5. easily recyclable, making them cost-efficient and sustainable

### **3.3.2 Material purchase**

Material purchase is also an important step after material selection. All materials were bought at the hardware shop except for the electrical components. The materials were bought at a very affordable rate since materials such as PVC pipes, bolts and nuts are all cheap in price. The electrical components were quite expensive, but it was bought through a trusted seller, Cytron company. It is crucial to make sure the materials are at its best quality so that the project won't be affected. Better to have it bought at a higher rate with best quality rather than having to buy multiple times because of low quality. It is important to ensure there is not wastage of money, time so that the work goes on accordingly.

### **3.3.3 Method selection**

There were a few suggestions of the method to connect all the parts which includes centrifugal casting and MIG welding. This was a method of selection as mild steel was the material selected for the main frame. After discussion, the main frame is done with PVC pipes as it is lighter and suitable for the project. Thus, the method is gluing and screwing is finalised after discussion. The PVC pipes are connected with PVC glue. Later on drilled and used nuts and bolts at all intersections to ensure strong hold of the frame.

### 3.3.4

### Fabrication

Aged citizens, house wives, people who live in double storey houses, apartments without lifts are mainly focused when building the trolley. Thus, uneven terrain, moving up the stairs while carrying things are the main purpose of the trolley.

The fabrication of the main parts and electrical components are connected through glueing, screwing and also using nuts and bolts. The main frame of the ALC is glued together with PVC glue followed by using nuts and bolts to strengthen the connection. Screws were used to connect the basket to the frame, and as well to connect the tyres to the main frame.

Some small components could be installed with screws, such as the Arduino board, engine and bearing. Bearing will be mounted on a handle to ensure that wheels spin as quickly as possible with as little friction. The ACL must use it because the ACL uses six wheels at any rate. A DC motor will also be installed on the luggage carrier of an electric motor is an electrical machine that converts electrical energy into mechanical. Motor drivers are used to increase the low current to high current required by the motor. Total of 4 motors were used.

For ALC, arduino programming is used to program the movement of the ACL. The basic movement of the ACL will be moving forward since it's designed to aid the movement of objects on inclined areas or stairs. Thus, the arduino board will be the main control system in the ACL. Followed with that, two motor drivers are installed. Motor drivers are to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. An on off button will be installed on the handle to ensure the trolley can be turned on and off according to the user's will.

Lead Acid Battery might be installed because ACL is a multi-use trolley. It is essential to have a good source of energy and rechargeability to ensure there is enough electricity is provided for the movement of ALC.

### **3.3.5 Product testing**

Test run is carried out to determine the weight ALC could withstand. Started off with 5kg and then gradually increased by 5kg. While testing, it can carry up to 15kg. The ALC is tried out on smooth, rough, uneven surfaces and also up the stairs. It moved well with the motors without any breakdown happening. The ultrasonic sensor was also tested out and it can sense the user up to 14cm.

### **3.3.6 Product analysis**

The process of evaluating data using analytical and logical reasoning to examine each component of data provided. The analysis process is important to pinpoint the strength and weakness of the product. Thus, further improvement for the ALC can be made in near future. Data is gathered from the product testing and then analysed based on criteria which are focused on such as maximum load, durability and longevity of battery. Later on discussion and conclusion are made from the data.

### **3.3.7 Report writing**

Report writing is a compulsory step for every project. It is done to compile the work process, data of materials, cost and also outcome of the project which will guide if there is better improvement to be done in future. The report makes sure the information is not messed up but in order and compact. The ALC report writing is based on the steps done from start until end including data analysis.



### 3.5 Design Description

**Prepared By Muhammad Hazeem Bin Haizi**

The normal 3 wheel trolley doesn't have motors to move the wheels. It's manually driven by humans. A healthy mid aged individual might be able to carry or pull a normal trolley at first, but after some period of time, they'll experience pain at their hand or face tiredness. So, it'll be even more troublesome for aged people, housewives, those who live at a flat to move things up the stairs.

The Automated Luggage Carrier is designed to help these groups of people. It is designed to move a lot of things at one time up the stairs. Its independently moving wheels ensure it has better stability while moving up the stairs, as well as moving on uneven terrain. Individuals don't really pay attention to the health effect either short or long term they might face from carrying heavy loads.

They could experience :

1. Back sprain
2. Muscle sprain
3. Wrist injuries
4. Elbow injuries
5. Slipped disk, worst case if the person isn't careful

The Automated Luggage Carrier is designed to move household things, groceries. It is designed to sustain for a long period of time. All of the components and parts are easily accessible in case there is a breakdown.

### **3.6 Accessories Selection**

**Prepared By Dannishwaran A/L S Anbalagan**

#### **Ultrasonic**

**sensor**

The ultrasonic sensor is fixed in the front of the Automated Luggage Carrier. It is an optional use for the user. In case they don't want to pull the trolley, they can use the ultrasonic sensor to follow them. It is yet to perfection, the sensor will be able to be used on stairs as the trolley can't stabilize on its own on stairs. The sensor can be used on horizontal terrain or slightly uphill terrain.

#### **Push**

**button**

The push button will act as the control point. It'll be placed on the top of the handle. The ALC will move when pressed and stops when let go.

### **3.7**

**Cost**

**&**

**Materials**

Materials	Quantity	Price per piece(RM)
PVC pipe	3 metre of PVC pipe	22.00
Arduino board	1	15.50
Motor driver	1	131.00
Motor	1	68.00
Rubber tyre	6	12.00
Lead Acid Battery	1	50.00
Bearing	6	68.82
PVC joint	6	6.20

The total cost estimated for the project is RM 373.52

### 3.8 Operational Methodology

Prepared By Dannishwaran A/L S Anbalagan



#### 1. Gluing

All the PVC pipes are cut according to desired length. Marked and assembled before gluing to make sure all pieces fit. To ensure there are no mistakes after the final assembly. Then once confirmed, the parts are glued using PVC glue. Smaller parts are glued first to make it easier to assemble the remaining larger ones. All parts are let to dry for at least 10 min so the glue is hardened and the PVC is completely stuck to each other.

#### 2. Threading & screwing.

After the main frame is done, all the intersection and other required parts are marked beforehand with a marker to ensure no mistakes. Once satisfied, the marked parts are drilled. It's connected with nuts and bolt. Bolt is used for parts which move. Screws are used to connect permanent parts to the frame. It's to ensure to strengthen the connection of each part.

### 3.9 Gantt Chart

Planning	
Execution	

WEEKLY PLANS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Project briefing															
Material purchase															
Measuring & cutting PVC															
Spray															
Glue & screw															
PITEX & myIppo application															
PITEX video															
Product testing															
Improvement															
Analysis															
Finish final report															

### **3.10 SUMMARY**

The conclusion for this project is that the process of building trolleys has taught us about handling a project and exposed us to a real work field surrounding. Besides that, this will bring a lot of benefits to all the users of luggage carriers. The design which is user-friendly will bring convenience to users in terms of mobilization and self-independence without having to depend too much on them. There is still room for improvement for every invention which in fact will enhance the knowledge that we gained from this project.

## **CHAPTER 4**

### **RESULT ANALYSIS**

#### **4.1 INTRODUCTION**

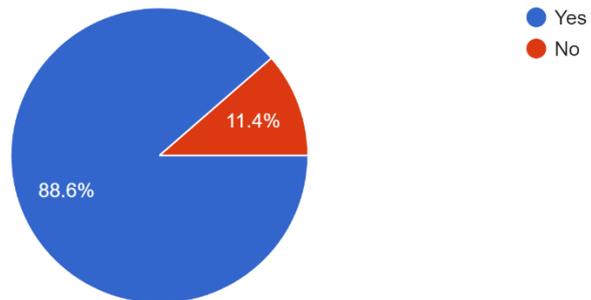
In this chapter, we will include the responses we obtained based on the questions on google form. The project will be done based on society's daily needs so that the product will meet its requirement. This is to ensure all the objectives and scope of research are achieved. We analyse every single data that we obtained to ensure that this project is successful.

## 4.2 ANALYSIS

Prepared By Muhammad Hazeem Bin Haizi

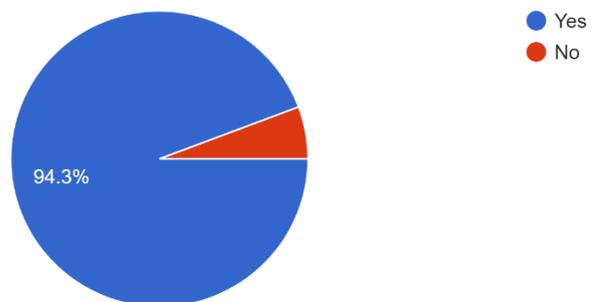
Have you ever had back pain when lifting heavy stuff?

35 responses



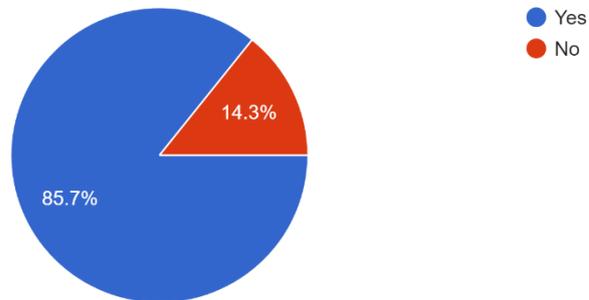
Is it difficult to lift heavy load to higher place by individual?

35 responses



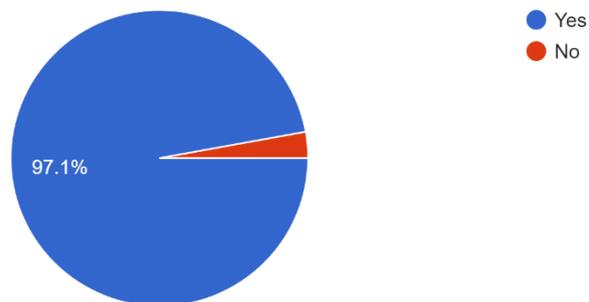
Do you agree that there is no specific design of carrier luggage at home for human to lift or take heavy equipment to one specific spot?

35 responses



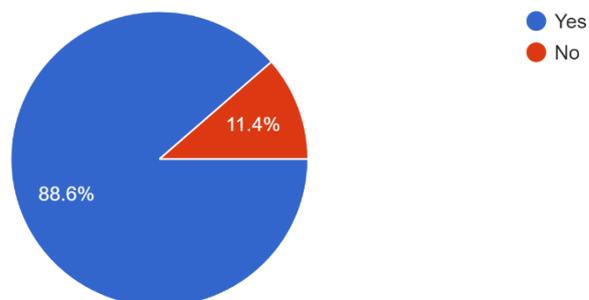
Do you think that by develop ACL(Auto carrier luggage) will ease and help people who have no ability to lift heavy load?

35 responses



Do you agree that materials that we used for carrier luggage have to be strong and durable material to withstand heavy loads??

35 responses



### **4.3 Product Testing**

**Prepared By Dannishwaran A/L S Anbalagan**

The product mainframe is PVC pipes. It is a lightweight material. Pipes is used as the mainframe where PVC pipe has yield strength from 500 – 9990 psi. The tensile strength of PVC pipe is from 2080-7790 psi which can support moving of daily household things. PVC is cheaper compared to other materials which the survey was made on. The ALC can carry objects up to 20 kg after the test and analysis is conducted on the structure. It can be concluded that the stated objective was achieved and implemented effectively.

### **4.4 Conclusion**

Through this project, it helps develop creativity and critical thinking among us in figuring out solutions to any problems. Problems related to existing projects can be solved through some modifications and fabrications applied to the current design. Innovations made on ALC carrier luggage are not just convenient to the disabled people, housewives and aged citizens. The ‘push button’ feature on the ALC will ease the individual to assist the movement of carrier luggage. The process would save a lot of time and energy compared to last time. There is still room for improvement which can be added to this project to make it more effective, durable and user-friendly. This project has a big potential in the market and should be commercialized for advanced research and development.

## **CHAPTER 5**

### **DISCUSSION , CONCLUSION AND UPGRADE PLAN**

#### **5.1 Introduction**

In this chapter, the focus is on explaining about discussion, conclusion and possible improvement that can be made to ALC. This will be done based on the data and analysis from the test run for this project. Thus, the discussion will be explained on the test run. To finalize, conclusions will be made with upgrades included.

#### **5.2 Discussion**

With references and observations made on the data obtained, the first improvements that should be made to this product is the material of the mainframe. The initial material chosen for the main body frame was stainless steel. Even Though it is light, to connect each part will be significantly difficult since it involves welding. As for PVC, it's much lighter which will reduce the weight of ALC overall and help achieve the scope of the project. Plus, it is much cheaper and eco-friendly. The connecting of each part is made easier as it can be pulled apart if there is mistake done.

The next improvement can be made for the ultrasonic sensor. The current distance for the sensor is 14m. It is a very short range and users will face difficulty

while having the ALC move automatically because of the limited range of distance. At least 1m should be made as the distance from the ALC sensor to the user.

For the battery, 12V can be substituted with 24V bat because there are four motors. Each of its torque is 30Nm. Additionally to the weight of frame, objects carried, the ALC will move slower. 24v can provide more power for the ALC to move smoothly.

### **5.3 Conclusion**

It helps to improve creativity and critical thinking among us through this project to find out solutions to any problems. It is capable to solve the problems related to existing projects by certain modifications and fabrications implemented to the current design. Automated Luggage Carrier innovations are not only useful for disabled people to lift the load, but also for housewives and elderly citizens living in multi-story terrace houses or flats that do not have lift convenience. The carrier luggage has Arduino programming that helps users to get their stuff carried by the trolley while applied the motor. Compared to other carrier luggage, the process would save a lot of time and energy. To make it more efficient, durable and user-friendly, there is still space for improvement that can be applied to this project. This project will have enormous market value and should be promoted for advanced research and development.

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## **APPENDIX**

