HUMAN TRANSPORTER (E-Porter)

by

Amir Afiz Bin Mohamed Nizan

Dissertation submitted in partial fulfilment of

the requirements for the

Bachelor of Engineering (Hons)

(Mechanical Engineering)

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Universiti Teknologi PETRONAS

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Mechanical Engineering Programme
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR OF ENGINEERING (Hons)
(MECHANICAL ENGINEERING)

Approved by,

_____
(MS. HOW MENG GIT)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

JULY 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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AMIR AFIZ BIN MOHAMED NIZAN

ABSTRACT

The function of a human transporter is basically used for transferring a single person from one place to another in a short period of time**.** It is a device that acts as an alternative to traditional transportations options like cars and motorcycles that are commonly used today. With the development of a human transporter, it can overcome the problem of commuting great distances between places faced by the students inside the university. To use the human transporter as an alternative means of transportation inside the university, the vehicle must be created with the advantages of being lightweight, energy efficient, durable, user-friendly, economical and safe. The project scopes that are involved to achieve these objectives includes researches on current technologies inside existing human transporters, conducting survey form to Universiti Teknologi PETRONAS (UTP) students and doing an extensive research on the source of energy that drives the human transporter. The methods that are being used inside the project are planning the project work for the whole time frame allocated, do the literature review and research at the beginning stage, collect data for available source of clean energy and mechanical mechanism that can enhance the performance of the human transporter, produce technical drawing during the design stage and finally, construct the prototype. The research and design stage is completed during the first semester while the fabricating stage for the prototype is done during the second semester. Through the development of this human transporter, the project delivers a good optional solution for UTP students to overcome the commuting problems they face in the university. A part from that, by promoting the use of clean source energy, this device will be much an environmental friendly product as it produces no pollutant emissions compared to other fuel combustion vehicles nowadays.

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ABBREVIATIONS AND NOMENCLATURES

Abbreviations	Definitions
T	Torque
FYP	Final Year Project
Kg	Kilogram
L	Length
mm	Millimeters
N	Newton
P	Power
RM	Ringgit Malaysia
t	Time
V	Velocity
W	Watt

CHAPTER 1: INTRODUCTION

With the rapid advancement of modern transportation technology, people nowadays are trying to develop convenient ways of travelling that are more energy efficient, user friendly and also economical. Nowadays, with the aid of modern technology the transportations are more concentrated on developing a single person use vehicle that can be used by individuals and suitable for any conditions [1].

There are a several single person vehicle that has been designed and available in the market nowadays. For example, the invention of the Segway Public Transport (PT) that functions as a two-wheeled, self-balancing electric transportation device [2]. The Segway PT is designed to be used on sidewalks, other pedestrian areas, as well as bicycle lanes and city streets. Basically with this human transporter, it has become an alternative solution to replace the conventional human-powered-transport such as walking or cycling.

The creation of a human transporter can also be done by integrating parts of different technologies that are useful. Since the human transporter is mostly motorized, it can be powered by any means of energy sources such as electricity or fuel combustion. Choosing the right parts for the build up is also vital in producing a human transporter. For example in producing an environmental friendly human transport vehicle, it must be constructed by using a technology that does not harm the environment and the materials that are used are recyclable [3].

Aspects of stability, power and durability must be carefully studied since it may affect the overall safety of the user. Failed inventions of human transporters are mostly caused by not taking any considerations of the users comfort and ergonomics aspects which leads to unwanted injury or accidents.

In this project, a human transporter is designed for use within the compound of a university. Hopefully, the device can function as an alternative transportation vehicle for the students to travel inside the university.

1.2 Problem Statement

One of the basic purposes of the human transporter is for commuting great distances between places. With the current travelling situation inside Universiti Teknologi PETRONAS (UTP) area, the trouble of travelling between places is beginning to be a problem for the students. From the observed current situation, the average distance for students to travel from their respective residential villages to the university's academic building is about 300- 400 meters. Since the most common way of students reaching to classes is by walking, it is estimated that the time taken for students to cover this distance is about 10-15 minutes. Thus, students are forced to walk early from their residential college in order to arrive early to class.

With the hot weather that the students face everyday, the travelling process causes the students to become uncomfortable and tired. Despite the optional use of vehicles, there are other problems to be considered, for example far away parking spots and limited parking spaces. This results in the vehicle users preferring to walk rather using their vehicles.

Even when there are other means of transportation such as cars and motorcycles, both of these vehicles have a lot of disadvantages. Given that the internal combustion engine is the main energy source, the carbon emissions from both of these vehicles contribute to poor air quality around the campus area [4].

Hopefully with the invention of a human transporter, this vehicle can overcome the problems faced by the students. It will help the traveling experience to be much easier and comfortable for student use.

1.3 Objectives and Scope of Study

The main objective of this project is to design a human transporter that is lightweight, durable, user friendly, economical and safe. In terms of lightweight, the product must be light enough so that it can be carried or stored easily by the students. To design a lightweight vehicle, consideration is given to materials that are suitable for the fabrication of the project. The material may be in form of any polymer materials that are available in the market and are also inexpensive [5].

This build up of using suitable materials allows light weight and excellent durability for the product**.** It is important that it does not quickly wear out, or more specifically, it resists services or utility over the period time of use.

Through improving the ease-of-use of the product, it can increase the human interaction between the product and the user.This can be done during the designing stage process. The user-friendly quality can be defined by four quality components, which are, taking from a research on

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design.
- Efficiency: How quickly can users perform tasks once they adapt to the function of the design.
- Errors: Number of errors users make, the severity of these errors, how easily can they recover from the errors.
- Satisfaction: How pleasant is it to use the design.

The target users for the product are the students. To meet with their financial status, the product must be designed carefully so that it will be affordable for the students to purchase.

Safety is also an important aspect of design that must be taken into consideration. In view of the fact that the product design is based on a transportation vehicle, the outmost aspect that is focused on is the user's safety while manoeuvring the device.

The study also involves finding alternative methods of powering the human transporter which will include developing a full functioning mechanism that will be installed inside the human transporter. Detailed description of the required tools and equipments to construct the prototype will also be done during the project.

Below is the list of the tasks that are required for implementation of project:

1. Conduct survey among students and workers inside the university to obtain feedback on the potential usage of a human transporter inside the campus and also the acceptance of the product.
2. Establish the requirement and specifications of the designed product.
3. Generation of conceptual design and evaluation of alternative designs before design finalisation.
4. Produce blueprint (engineering drawing from Catia/AutoCad) and prototype of the human transporter
5. Testing the product to determine whether each design requirement is met.

CHAPTER 2: LITERATURE REVIEW

This chapter features all the information and data that are used for the producing the Human Transporter (E-Porter) device. Prior to the work done, some related researches have been made to support this project. List of research that have been completed are:

1. The application of single person human transporter
2. Rechargeable battery as source of energy
3. Design of portable human transportation device
4. Existing products in market

2.1 Human Transporter

The development of single person human transporter is becoming a popular invention replacing current traditional transportation options like cars and sports utility vehicles (SUVs) [3]. Based on a comparison made between this 2 options of transportation, the research evaluates a variety of vehicles that are relative to their impact on the environment, both in emissions created and energy consumed, proving that the human transporter can substantially decrease greenhouse gas emissions and is the most energy-efficient alternative to short-distance, single-occupancy car journeys. Mechanical aspects that are incorporated within other moving vehicle devices can also be built onto the human transporter to improve the performance during functioning on the streets or roads [4] .With escalating fuel prices and the environmental and political forces that have de-stabilized the global petroleum supply, there is an enormous opportunity right now for people to embrace new transportation options that can help shrink their carbon footprint.

2.2 Source of energy

The motion of a human transporter can come from any source of energy. The most popular and current technology used nowadays is the electric transportation (E-Porter) which is fully powered by electricity [5] .Using electricity is very efficient in

providing power to move any mechanical mechanisms (e.g. motor) allocated in a human transporter allowing the motion or movement of the transportation device. The move toward electric transportation, which is typically 40 to 60 percent more efficient than gasoline vehicles, is gaining momentum world-wide and might be among the most preferable transportation device in the future. The benefits of electric human transportation are clear. From various researches and findings, road vehicles and transit systems powered by electricity offer clean, quiet and reliable alternatives to those powered by internal combustion engine.

2.3 Portable human transportation

The occurring problem that might happen when acquiring a simple transportation device is the how the vehicle consumes a large space to be stored or saved. For a simple use of this type of vehicle, reducing the size is an important factor for a buyer to consider the use of a human transporter. This is due to storage purposes where the vehicle can be placed in a close compound area or section. With the aid of portability device, it light be helpful for user to bring or carried around to other places without any problems

2.4 Existing designs in market

Many electric-powered human transporters have been designed and marketed by some organizations. There are a few types of human transportation devices such as the Segway Human Transporter [6] and the Electric Motorized Skateboard [7].These products use the electrical energy as their main source of energy. The electrical energy will be used to activate the mechanical components inside the human transportation device. These two current devices are portable and come in different shapes, own features and specifications.

2.3.1Segway Personal Transporter (PT)

The Segway Personal Transporter (PT) (Figure 1) is a two-wheeled, self-balancing electric vehicle invented by Dean Kamen and unveiled in December 2001. It is produced by Segway Inc. of New Hampshire [8].

Computers and motors in the base of the device keep the Segway up at an upright balance position when powered on. To manoeuvre the device, users lean forward to go forward, lean back to go backward, and turn by using a "Lean Steer" handlebar, leaning it left or right. Segways are driven by electric motors proximately up to 5.6 m/s (12.5 mph/20 km/h). Gyroscopic sensors are used to detect tilting of the device which indicates a departure from perfect balance. Motors driving the wheels are commanded as needed to bring the Segway PT back into balance.

The Segway PT is designed to be used on sidewalks, other pedestrian areas, as well as bicycle lanes and city streets depending on local laws. Its footprint is approximately half a square meter. It is used in some theme parks by both visitors and employees. Some companies are known to organize guided group tours on Segways in the USA, France, Thailand and other countries. Certain organizations have run pilot tests on the application of Segway, among them police departments, post offices, warehouses, and utility companies.

Height	1.5 m
Payload	Total capacity: 118 kg Rider: 45-110 kg
Speed	10 – 20 km/h
Range	24-39 km on a single charge
Power	260 V, 50-60 Hz AC Outlet Lithium Ion Pack Chargers 115-300 W AC motor

Figure 1: Segway Personal Transporter (PT)

2.3.2 Motorized Skateboard

The motorized skateboard (Figure 2) is an integration of two major components which is the board of a skateboard and the electric motor [7]. By adding additional motor to rotate the board wheels, this will allow the motion of the device to move faster than

its normal speed. Electric motors allow higher efficiencies and greater flexibility in design. Through this advantage, the combination between both motor and skateboard can be done fittingly without any complications.

Weight	34-39 kg
Speed	35 km/h
Range	25-30 km on a fully charged battery
Power	90-250 V battery input voltage 800 DC W
Charging time	3-6 hours

Figure 2: Electric Motorized Skateboard

CHAPTER 3: THEORY

This chapter presents the theory used to mathematically or theoretically model the Human Transporter (E-Porter) device. This information was obtained through literature review and referring to other similar type of single human devices. This analysis is important since the project requires certain type of mechanical and electronic devices to ensure the human transporter works properly.

3.1 Torque and Motor Analysis

After some research to determine what type of motor specification is suitable enough to for the human transporter, the student observed that a typical DC motor that runs with a high rpm can be used. Applying this analysis, the student will be able to calculate the mechanical requirement for the motor to run the Human Transporter. By using suggested parameters of speed, the torque and power of motor can be acquired. Below is the suggested milestone in terms of velocity that might be achieved from the motion of the vehicle.

Design parameters of Human Transporter

i. 3 speed selection with constant acceleration:

Low speed	5 km/h
Medium speed	10 km/h
High speed	15 km/h

ii. Weight: 100kg (bodyweight+max passenger)

iii. Wheel diameter: 50mm

iv. Transmission ratio: 1:1

** Parameters of weight and wheel diameter refers human transporter design*

3.2 Circuit Analysis

The purpose of a motor speed controller is to take a signal representing the demanded speed, and to drive a motor at that speed. The speed of a DC motor is directly proportional to the supply voltage, so if we reduce the supply voltage from 12 Volts to 6 Volts, the motor will run at half the speed. The speed controller works by varying the average voltage sent to the motor, this is by switching the motor's supply on and off very quickly.

The block diagram that describes the working mechanism of the whole circuit is as follow:

Figure 3: Circuit block diagram

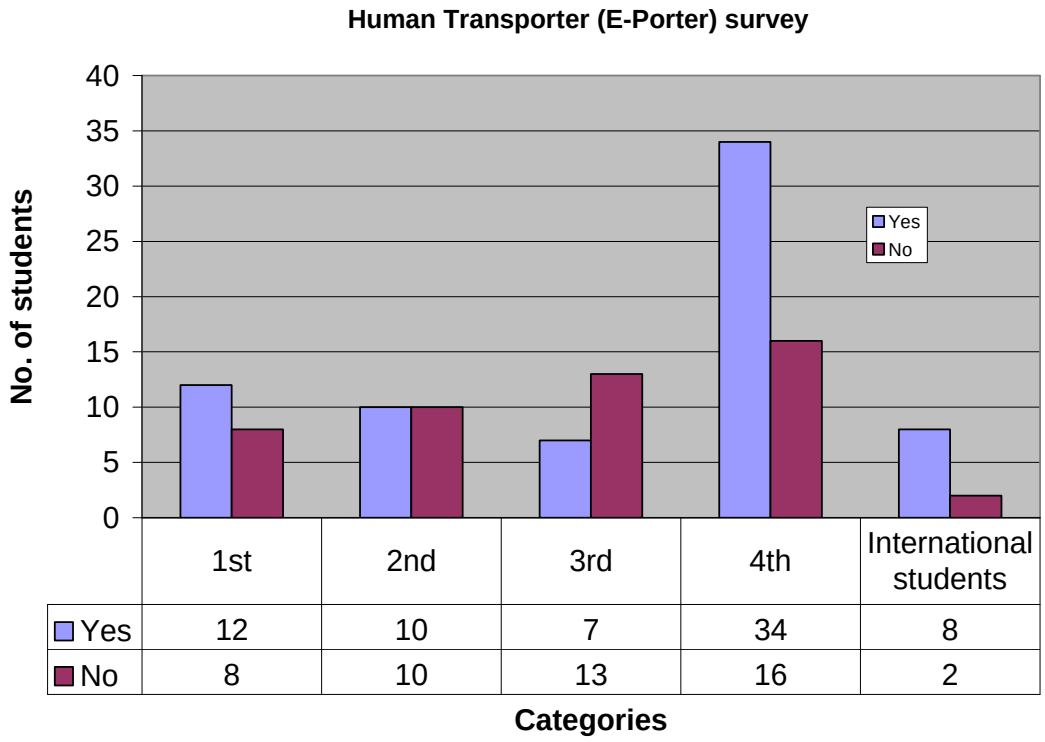
The battery acts as a power supply. When the switch is set to 1 (on), the current will flow to the controller. Here, the output voltage is controlled by varying the value of potentiometer (voltage regulator) in the controller circuit. Then this value of output voltage will be used to drive the motor, at the speed according to that particular value at particular time. The motor will turn the rotating tire that are attached on to the human transporter and moves it.

3.3 Survey Analysis

A survey had been conducted to 120 Universiti Teknologi PETRONAS (UTP) students during the four weeks of the semester. The survey was done verbally among among the students who represent different categories of age and background. The outcome of the result is shown in Figure 4 of the report.

The sets of question given to the students are within scope of the usage of the Human Transporter (E-Porter) inside the campus area. The respondents were only required to

give a straight answer of yes or no to respond the question. During the survey also, the students were given the opportunity to provide some feedback and suggestion regarding to the device.



Overall YES response: 71/120 = 59.2%

Overall NO response: 49/120 = 40.8%

Figure 4: Graph of Human Transporter (E-Porter) student survey

Figure 4 shows the response of student's when approached with the idea of applying the use of the human transporter inside the university area. Referring to the graph, it shows that the overall responses from 120 students are considerably willing to use the human transporter as an alternative transportation vehicle. This is shown from the percentage of 59.2% positive response. This result supports the problem statement which is finding a suitable single human transport vehicle that can commute great the distances between places inside the campus.

By comparing result from each category, the positive response of the device is from the first year students, fourth year students and also international students. Equal response was obtained the second year students but low good response from the third year students. The understanding of this response pattern can be assess through the traveling culture adapt by the students. It is understandable that first year students has little option means of traveling with only minority of them posses a motorcycle or a car. This is a similar situation to the international students, the difficulty to own a transportation vehicle in Malaysia seems to restrict them for purchasing any. With additional reason of staying for only a couple years abroad studying, it is not preferably for them to own any heavy vehicle.

Poor response from the second and third year students is reasonable. Both categories of students are most likely to own a personal vehicle to travel around the campus. With the trend of going to class in forms of group, little will consider the use of the human transporter. Far from the condition during the fourth year, the trend of going to classes in groups is slowly fading. Students can be seen traveling individually especially going to lectures. The reason is due to the diverse course subject taken by the students. The type of situation that can be related to this cause is that each of the final year students are busy with their own agenda especially when dealing with their final year projects which is done individually.

CHAPTER 4: METHODOLOGY

This project the 'Human Transporter (E-porter)' will be implemented in duration of two semesters. The distributions of the main tasks are listed as below:

- 1st semester: *Literature Review/Research/Data gathering*
- 2nd semester: *Design Stage /Fabricate prototype/Testing/Analysis*

During this second semester, the project will concentrate on the prototype design, prototype construction and detailed test and analysis. Further analysis on the technical requirements of the project will also be revised. All of the significant researches made will be fully applied during this semester. The complete project work flows are shown in Figure 3.

4.1 Literature Review and Research

Literature review and background study are the important elements in the project and should be done at the beginning of the project. To obtain all of the required information, revision through books, internet, journals and thesis can help develop ideas that can be very useful during the design stage of the project. For the project, the scope of the literature review discusses the background of the human transporter as a single human transport vehicle, the suitable energy source to power the human transporter and also analysis of existing design related to the human transporter.

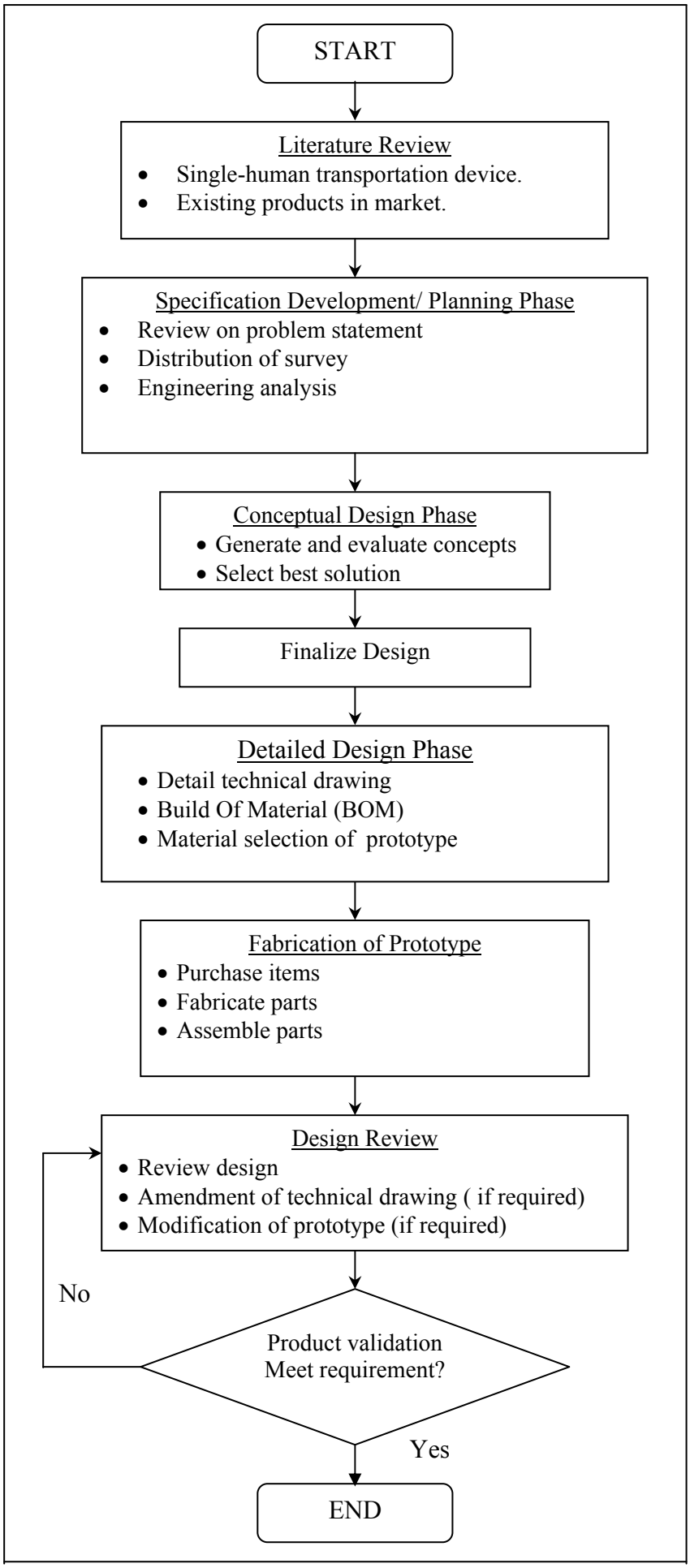


Figure 5: Project Flow Chart

4.2 Specification Development / Planning Phase

The main purpose of specification development service is to develop requirements specifications which enable efficient and effective development of a good product. Specification development is where all the information are collected and to be studied in more details. The phase requires proper planning so that during the development of the project, information gathered through literature research, surveys and other available tools will be integrated successfully into the project.

4.2.1 Distribution of Survey

Surveys were done among 120 UTP students to determine the response on considering the usage of a human transporter inside the campus. The survey is done onto different type of student categories based on their year of study. This stage is also very useful to know if this project is significant and will give benefits to all students.

4.2.2 Engineering analysis

For this stage, a detailed analysis on the mechanism and components of the proposed human transporter is done. In this section, selection of part by part components such as the power source is done thoroughly to enhance the solution of finding an alternative energy source for the device. Mathematical analysis to describe the motion of the device is made based on the finding of its required motor speed and power.

4.3 Conceptual Design Phase

Conceptual design is the explicit construction of the ideas or concepts that a user needs to learn about what a product is, what it can do, and how it is intended to be used. It may also address what a product is capable of. Conceptual design is done from the student's point of view.

The process of conceptual design involves a set of steps for translating requirements into a user interface design. The process begins by getting at the core of an application which involves the use of a single human transporter and proceeds by organizing the functionality from the student's point of view. Along the way, a deeper understanding

of users and their requirements is developed. The result is an outline or model of the user interface that may be further developed during the detailed user interface design phase.

Conceptual design is important for creating a solid, user-centered foundation on which to build a successful user interface. It is the best way in order to determine which of the desired design that will be incorporated inside the project. A simple, well-defined conceptual design that is clearly and accurately represented in the user interface makes it easier for people to learn and use a product.

4.4 Detailed Design Phase

4.4.1 Detailed Technical Drawing

4.4.2 Build Of Material (BOM)

4.4.3 Material Selection for Prototype

4.4.1 Detailed Technical Drawing

The technical drawing of this project will be created during this phase. Basically the CAD design should be completed during the 1st semester of the project. All measurements and specifications required in designing the Human Transporter (E-porter) are represented in the drawing. The design is very important and is the blueprint for the construction of prototype.

4.4.2 Bills of Material (BOM)

The build of materials (BOM) is, in its simplest form, a list of parts or components required to build a product. It provides the part assembly on the product and the quantity needed of each component. In this project, the BOM will allow the student to monitor the fabrication of the prototype accordingly to the list of the material developed.

4.4.3 Material Selection for Prototype

During this stage, several of materials will be short listed according to the required properties for the Human Transporter. The material selected must fulfil projects objective specifically in producing a lightweight, durable and economical product.

The selection of material mostly will be focused on the criteria of the vehicle's platform and motor which contributes mostly to the weight of the vehicle.

4.5 Fabricate Prototype

This phase requires the student to produce a working prototype of the human transporter. After identifying the materials and specification required for the prototype, the student will carry out the fabrication process and also the part assembly of the vehicle. The process involved in fabrication stages are:

- Fabricate portable transportation by reducing size of vehicle for storage purposes.
- Connect rechargeable battery with motor and speed controller.
- Fabricate casing for speed controller.
- Construct the brackets for mounting of motor and battery onto vehicle,

4.6 Validation of Design

After the prototype had been completed, a test will be run to observe whether the prototype can work or not. If no, the design needs to be reviewed and if the error is major, process need to be started again from the design stage. If the prototype passes the test, it can proceed to the next stage. Below is the suggested work flow of validation process:

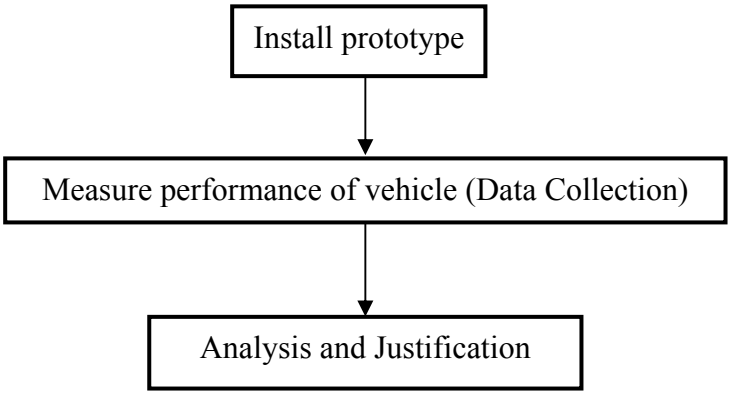


Figure 6: Validation of Design Work Flow

4.7 Design Review

During this stage, the design will be revised to identify the problem that occurs to the prototype. Amendment will be made to the technical drawing if necessary. After that, modification to the prototype will be conducted to fix the error. If the same problem occurs again, this step will be repeated until everything is fixed.

4.8 Analysis and Conclusion

All the results from testing stage will be gathered and analyzed in this stage. This analysis will prove satisfactory information whether the use of the Human Transporter (E-Porter) can be fully used by achieving its entire objective.

CHAPTER 5: RESULTS AND DISCUSSION

This chapter presents all the findings and outcomes of all works to complete the project of Solar Powered Exhaust Fan for Automobiles. All elements in this part are important because its shows the justification of the decision that had been make to design this operated device. The results that need to be discussed are as follows:

This chapter presents all the findings and outcomes of progress work that had after the first semester project has been completed. In this part of the report, it is important to justify the achieved target for producing the device. The result that needed to be reviewed are as follows:

5.1 Engineering Analysis
5.2 Project Design
5.3 Selection of Material and Component
5.4 Mechanism of Human Transporter Motion
5.5 Prototype of Human Transporter
5.6 Project Validation

5.1 Engineering Analysis

Design parameters of Human Transporter

v. 3 speed selection with constant acceleration:

Low speed	5 km/h
Medium speed	10 km/h
High speed	15 km/h

vi. Weight: 100kg (bodyweight+max passenger)
vii. Wheel diameter: 50mm
viii. Transmission ratio: 1:1

** Parameters of weight and wheel diameter refers human transporter design*

Speed requirement

At maximum speed of 15 km/h = 4.17 m/s in 20s

Mechanical torque, $T = F \times r$

r = radius of wheel = (0.05/2) m = 0.025m

F=ma
a = acceleration = v/t = 4.17/20 = 0.2085 m/s^2

F=ma=100 x 0.2085= 20.85 N

T= 20.85 x 0.025
T= 0.521 Nm

Angular speed at wheel, $\theta = v/r = 4.17/0.025 = 166.8$ rad/s

At medium speed, of 10 km/h,

Angular speed at wheel, $\theta = 111.11$ rad/s

At low speed, of 5 km/h,

Angular speed at wheel, $\theta = 55.56$ rad/s

Torque analysis

From maximum speed,

Angular speed at wheel, $\theta = v/r = 6.94/0.025 = 166.8$ rad/s

From calculation,

Pwheel = P motor

$T_L \theta_L = T_M \theta_M$

$T_L \theta_L = 0.521 \times 166.8 = 86.9$ watt

$\frac{\theta_M}{\theta_L} = \frac{1}{1}$

$\theta_M = \theta_L = 166.8 = 166.8$rad/s

Thus, $T_M = \frac{166.8}{86.9} = 1.92$ N m

Mechanical requirement

Selecting motor

RPM = (v / 2π r) x 60

From maximum speed,
RPM = (4.17 / 2π x 0.1) x 60

RPM = 398.82

With $T_M = 1.92$ N m

Power = 80.1 HP

From determining the torque and speed of each levels of required speed, selecting the suitable motor to incorporate onto the vehicle can be achieved. Reviewing back the calculation, the desired power of the motor should be at the value over than 80 hp.

5.2 Project Design

5.2.1 Comparison of Project with Existing Products

Due to the diverse types of single human transport vehicle available in the market, it is good to do a comparison to determine which vehicle has the advantages in terms of the mobility solutions. The mobility solutions can be represented in different performance characteristics such as the maneuverability, portability and other related aspects. Inside the report, the comparison is done using the decision matrix method (Table 1). Each attribute of mobility solutions are compared with the student's own personal design.

Table 1: Weightage table of different typologies of single human transportation vehicle and their performance characteristics.

	Segway human transporter	Electric bike	Motorized Scooter/Skateboard	E-Porter
				**NA**
Weight	Heavy vehicle ,weight ranges up to 118kg	Heavy vehicle, weight ranges up to 130kg	Light vehicle weight ranges from 20-30kg	Light vehicle weight ranges from 10-15kg
Points	1	1	3	4
Speed	Vary in speed from 10-20km/h, low affects on speed due to weight	Vary in speed from 40-60km/h, low affects on speed due to weight	Vary in speed from 10-20km/h,highly affects speed due to weight, rough terrain	Vary in speed from 15-25km/h,highly affects speed due to weight, rough terrain
Points	1	4	2	2
Portability	Heavy, unable to dismantle	Heavy, unable to dismantle, difficult storage purposes	Easier to transport, able to be stored easily	Easier to transport, able to be stored easily, can be carried around with available folding dimensions
Points	4	3	1	2
Maneuverability	Ease of handling depends on the fluency of control	Ease of handling depends on the fluency of control, physical user ability	Excellent maneuverability depending on user physical ability to balance	Excellent maneuverability depending on user physical ability to balance
Points	4	3	2	2
Cost	Expensive for target user, unavailable in the market, high cost maintenance	Expensive for target user, high cost maintenance	Affordable, low availability in the market	Affordable for target user , low maintenance required
Points	1	2	2	3
Manufacturing/ fabricating	Complex fabrication process. accuracy and tolerance difficult to compensate	Complex fabrication process. accuracy and tolerance difficult to compensate	Wide variety of Man. Process and fabrication	Wide variety of Man. Process and fabrication
Points	1	1	4	4
Design Simplicity	Detailed design and high complexity part assembly	Detailed design and high complexity part assembly	Simple design and assembly	Simple design and part assembly
Points	1	2	3	4
Total	18	17	20	25

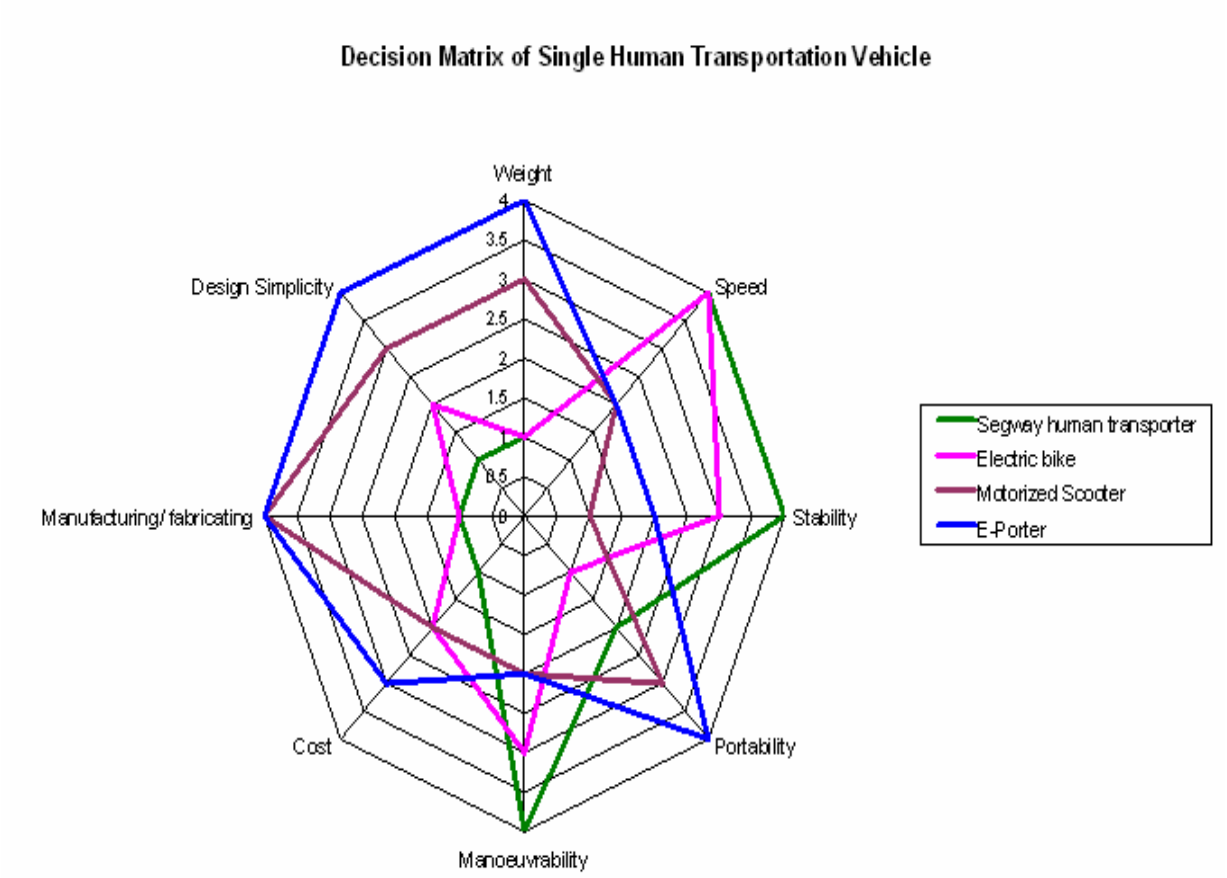


Figure 7: Radar chart for decision matrix of single human transportation vehicle

5.2.2 Detailed Technical Drawing

Technical drawing is the art and practice of creating accurate representations of objects for technical, architectural and engineering needs. Technical drawing includes the various fields and technologies underpinning electronics, which has in turn revolutionized the art with new tools in the form of Computer Aided Design. Throughout the process of producing the technical drawing for the project, the student has acquired the use of computer aided design software known as Catia.

The drawing software allows the student to create a three-dimensional view of the human transporter which traditional projected views at right angles. The drawing will include the actual measurements of the device before the fabrication process is done.

In this report, the drawings that will be projected are the side, isometric, top and bottom view of the device as shown from figure 8.

The technical drawing is the follow-up task to the chosen conceptual design that is previously draft out during the first period of the semester.

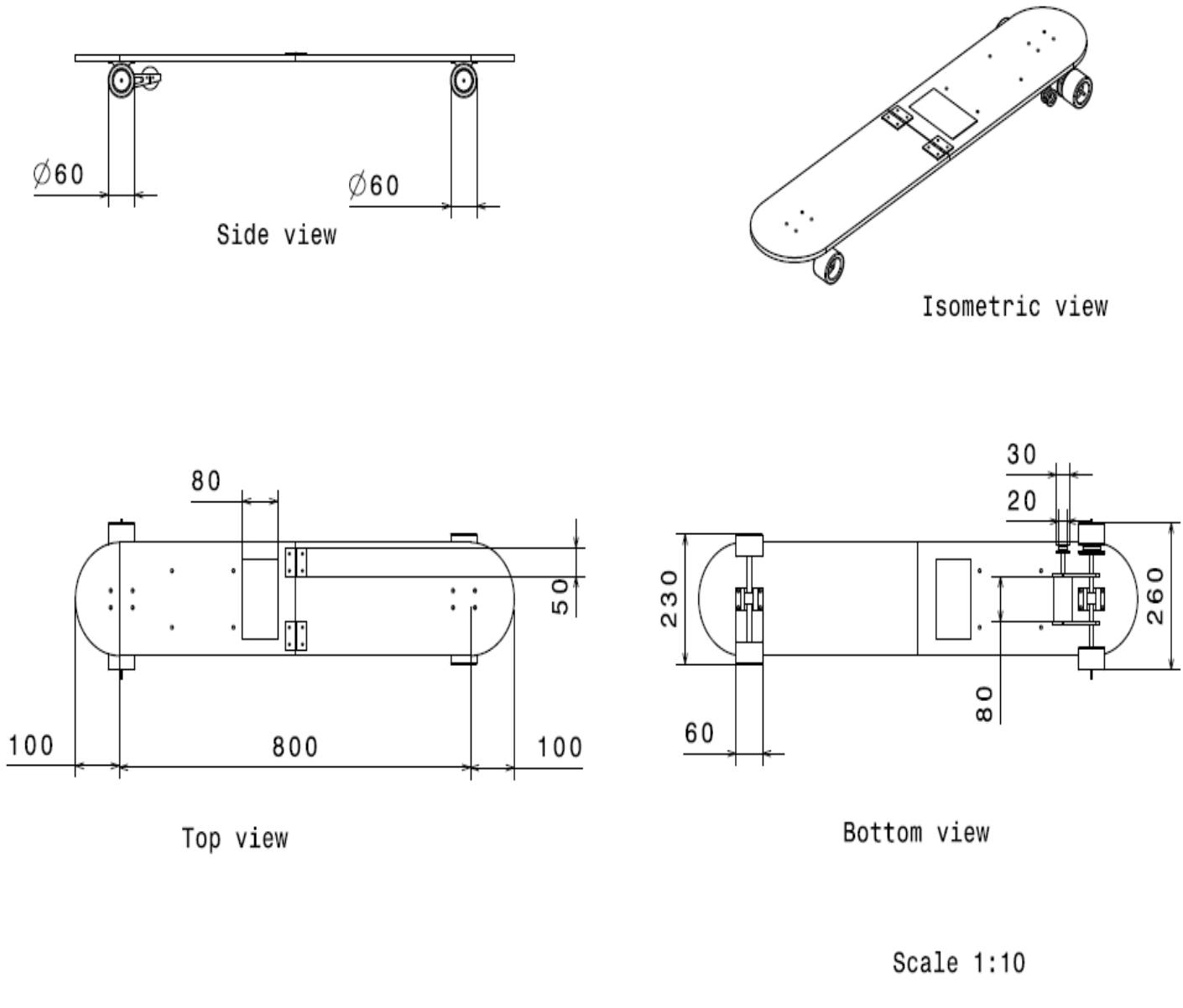


Figure 8: Human transporter (E-porter) design dimensions

From the previous conceptual design, it is suggested that the device will be incorporated with a folding mechanism to enhance its portability for the user. Below is the drawing of the device in from the normal position into the folding position.

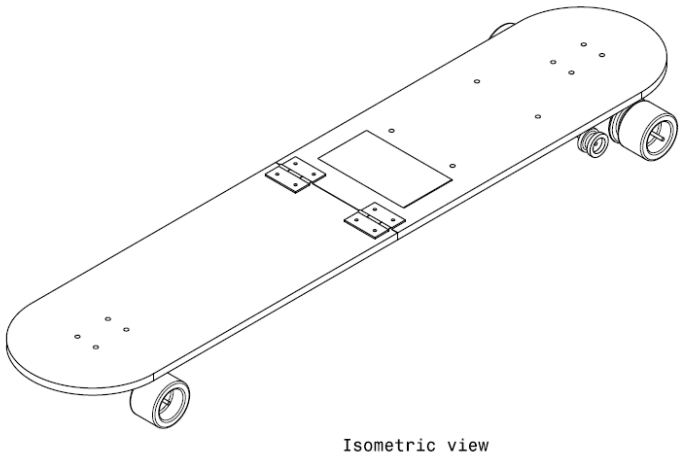


Figure 9: Human transporter (E-porter) in normal position

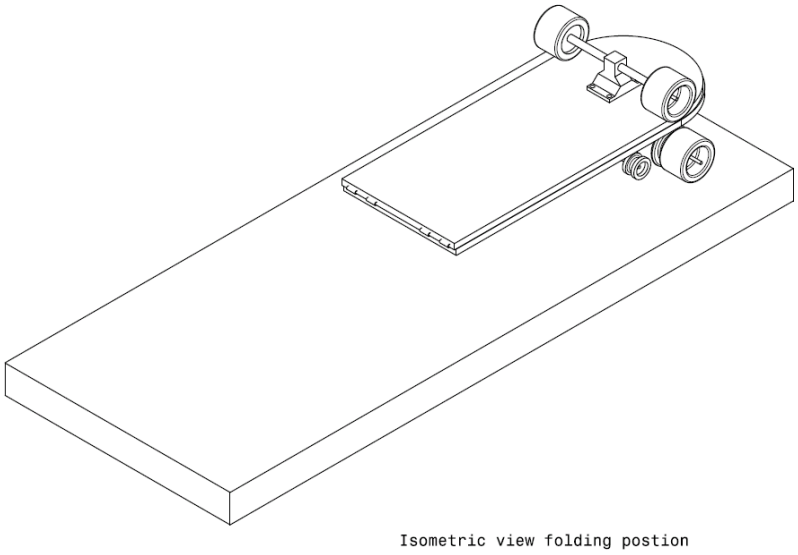


Figure 10: Human transporter (E-porter) in folding position

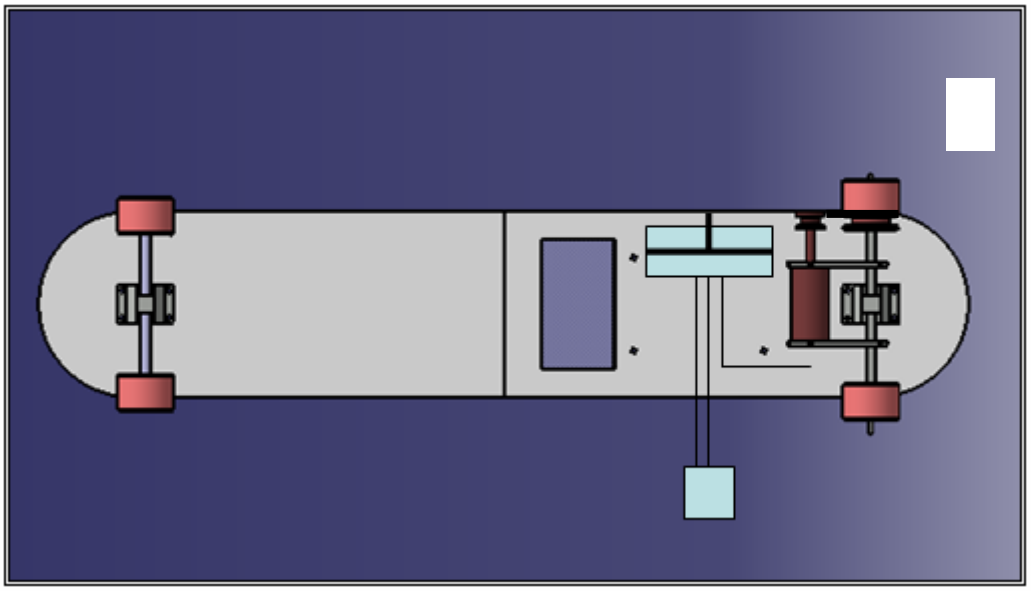


Figure 11: Human transporter (E-porter) in equipped with speed controller position

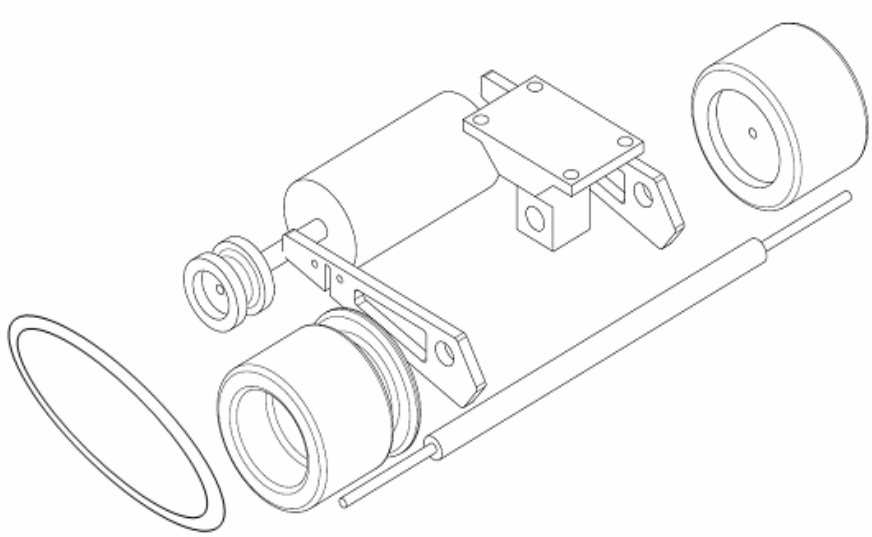


Figure 12: Human transporter (E-porter) rear motor assembly

5.3 Selection of Material and Components

This part illustrates the evaluation of alternatives of main component of building up the Human Transporter ehicle. There are several man components that need to be selected which are:

5.3.1 Alternatives of Motor selection

At the early stages of selecting the right component, the student has to acquire a suitable motor to allow the motion of the vehicle to work. There are 2 alternatives of motor made available for this project; table 2 shows the alternatives of the motor:

Table 2: Alternatives of motor selection

Motor	**Power Window**	**Windshield**
Advantages	- High resistant - Small motor size - Compact and durable - Lightweight	- High in power (50- 100 W) - High resistant - Easy instalment - Compact
Disadvantages	- Low RPM - Complex instalment	- Heavy

The windshield motor will be selected to as the motor to start the motion of the human transporter vehicle. Even though the weight of the motor is slightly heavy then the power window motor, it still fulfilled the motor requirement because the system has enough power to achieve the target speed of 10 – 15 km/h. Other reason for the selection windshield motor is that the component is compact which allows easy instalment onto the body of the vehicle.

5.3.2 Alternatives of Power Supply

Table 3: Power Source Table

Power Source	Fuel Cell	Solar	Battery	Biofuel
Cost	1	2	3	4
Point Source Pollutants	3	4	4	1
Power	2	1	3	4
Weight	1	2	3	4
Running Time	3	1	2	4
Maintenance Accessibility	3	2	4	1
Total	13	12	19	18

1. Cost – Price of source energy product in market
2. Point source pollutants – How well the power source contributes to environmental pollution.
3. Power – Rate of power produced in terms of watt
4. Weight – Advantages of flexibility in terms of weight
5. Running time – How long does the power source can run continuously in a given time.
6. Maintenance accessibility

Table 3 conclude that the rechargeable lead battery is suitable enough to incorporated onto the vehicle result from the total point accumulated based on the given characteristics . Even though the additional component of electronic parts in the system will initially increase the overall cost of product, but towards the end, the overall cost will reduce due to.

5.4 Mechanism of Human Transporter (E-Porter) motion

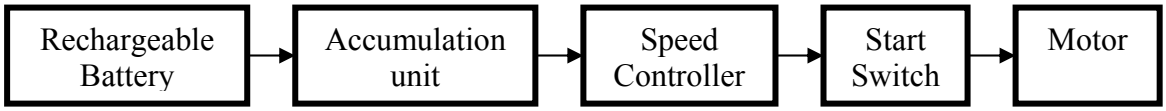


Figure 13: Process flow of Human Transporter control mechanism

Figure 13 shows the control mechanism of Human Transporter vehicle. The rechargeable battery will provide electrical energy to operate the motor. The energy will run through the accumulation unit and functions the speed controller. The start switch consists of the rheostat will control the speed of the motor. With different ranges of speed parameters of the motor, constant acceleration can be achieved.

5.5 Prototype of Human Transporter (E-Porter)

This is the crucial stage in this project which is to fabricate the human tranporter. The first step in the fabrication process is to purchase required material, equipments and parts for the prototype. The next step is to fabricate part by part before assemble them together in one piece as shown in Figure 14.

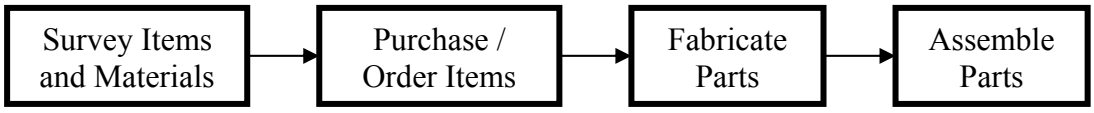


Figure 14: Process flow of Human Transporter prototype

5.5.1 Engineering Design Specification (EDS)

The specifications of the devices are based on standardized component that can be obtained at the mechanical or electrical shops. For example, acquiring a windshield motor from a car that allows obtaining the power needed to motion the Human Transporter. This is similar to the purchase of the rechargeable battery obtain from an electronic shop. Full assembly of the prototype can be referred as shown:

Table 4: Technical Specifications of Human Transporter (E-Porter)

Technical Specifications	
Component	**Remarks**
Body Structure	-Wooden board -Withstand 100kg of weight -Equipped with 4 rotating tires attached to 2 trucks gaining stabilility and rotation purposes
Wheels	- 4 rotating wheels (size diameter 50 mm) -Polyurethane material -Withstand friction of road surfaces
Motor	-100 watt motor -3 levels of speed range -Attached to pulley and rear tire for motion Electrically controlled
Speed Controller	-Rated voltage 6 - 12 volts -Size of casing controller 55 x 4 x 50 mm
Power source	-Rechargeable lead battery, 12 Volts -Size of battery bracket 100mm x 40 x 50 mm
Folding Mechanism	-Foldable -Acquires 2 central hinge to hold front and end part of body

Figure 15: Human Transporter (E-Porter) Prototype

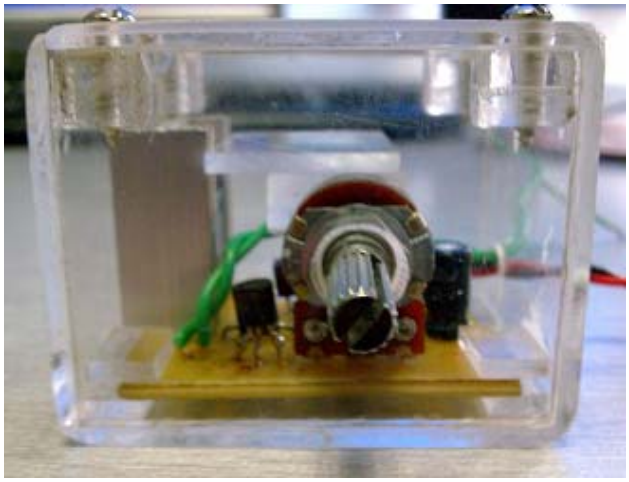


Figure 16: Human Transporter (E-Porter) Speed Controller

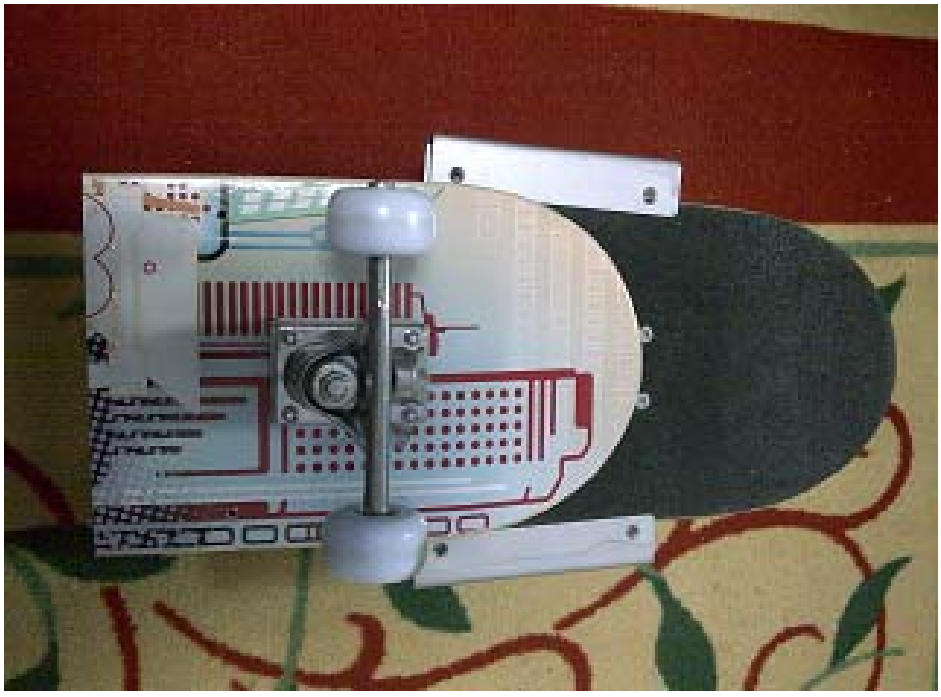


Figure 17: Human Transporter (E-Porter) in Folding Position

Figure 18: Human Transporter (E-Porter) Motor Bracket Assembly

Figure 19: Human Transporter (E-Porter) Battery Bracket Assembly

Table 5: Technical Specifications (weight) Human Transporter

Main parts	Description	Qty	Units	Dimension	Weight
1	Human transporter platform (wood) Tyres (Polyutherene) Trucks (Tyre holder)	1 4 2	pcs	Length 800mm Height 100mm Dia tyre 50mm Base (50x30x80mm) Shaft (L=85mm)	2.5 kg
2	Speed controller (casing)	1	pcs	55 x 45 x 55 mm	0.25g
3	Motor -with bracket	1	pcs	Base (135x100mm) Cover (75mm x 160mm)	4.5 kg
4	Battery -with bracket	1	pcs	100 x 50 mm	3 kg
				Total	10.25kg

5.5.2 Bills of Material (BOM)

Bill of materials (BOM) is used to describe the parts, components, and raw materials needed to produce a saleable end-item. Generally it is a list of components that make up a system. In this report, a bill of materials for the Human Transporter would include the platform, tyres, motor and so on. The report also includes a bill of materials of each assembles or subassembly into its component parts.

Table 6: Bills of Material (BOM) for main parts of Human Transporter

		Qty	**Units**	**Material**	**Dimension**	**Cost (RM)**	**Other**
Main	**Platform**	**1**	**pcs**	**wood**	**Length 800mm Height 100mm**	**30.00**	
1-1	Trucks	1	pcs	Steel	Base (50x30x80 mm) Shaft (L=85mm)		
1-3	Tyres	4	pcs	Polyurethane	Dia tyre 50mm		
1-3	Screw and Bolt	42	pcs	Steel	Head dia (3mm) Head bolt (5mm)		

Table 7: Bills of Material (BOM) for sub parts of Human Transporter

		Qty	Units	Material	Dimension	Cost (RM)	Other
Sub 1	**Motor**	**1**	**pcs**	**-**	**-**	**50.00**	**100 w**
1-1	Bracket	1	pcs	Steel	Base (135x100mm) Cover (75mm x 160mm)		
1-2	Screw	13	pcs	Steel	Dia (3mm)		
1-3	Pulley	1	pcs	Steel	Dia 80mm		
1-4	Belt	1	pcs	Rubber	L = 380mm		
Sub 2	**Battery**	**1**	**pcs**	**-**	**-**	**75.00**	**12V**
2-1	Bracket	1	pcs	Steel	100 x 50 mm		
2-2	Screws	3	pcs	Steel	Dia (3mm)		
Sub 3	**Folding**					**15.00**	
3-1	Hinges	2	pcs	Steel	65 x 40 mm		
3-2	Bracket	2	pcs	Steel	80 x 155mm		
3-3	Screw hinge	12	pcs	Steel	Dia (3mm)		
3-4	Screw bracket	4	pcs	Steel	Dia (5mm)		
Sub 4	**Controller**	1	pcs	-	-	**30.00**	**12V**
4-1	Rheostat	1	pcs				
4-2	Transistor	3	pcs				
4-3	Capacitor	2	pcs				
4-4	Voltage regulator	1	pcs				
4-5	Casing	1	pcs	perspex	55x45x55 mm		
					Total	**RM 200.00**	

5.6 Product Validation

The main objective of this project is to design a Human Transporter that is lightweight, durable, user friendly, economical and safe. Thus, the product validation helps to validate the objective of this project by undergoing a series of testing at actual conditions. The test was conducted on a flat road surface to determine the transportation vehicle motions in a normal condition. This is to show the durability of the prototype when handled on a smooth terrain that is similar inside the campus.

After some test runs taken, the vehicle move smoothly on smooth surfaces of the road and also pedestrian walk inside the academic building area. The maximum velocity that can be achieved is at 8.5 km/h or 2.36 m/s.

An observation also includes student's reaction to the usefulness of the prototype and how it interacts with the user itself. This includes the aspect of user-friendly, the heaviness of the prototype and the safety itself.

From table 6, the remarks made by the students mostly are quite happy with the vehicles performance. Despite not achieving the acquired maximum speed for the vehicle, the prototype still can fully motion. The portability of the vehicle which has the aspect of compact vehicle (folding mechanism) received good remarks from the user as it gives the advantage for the vehicle to be stored at limited spaces including in their room or closets. The economical price that is within the affordable range allows the student to consider applying the use of the human transporter as an alternative moving transport inside the campus.

Table 8: Students review

Aspect	Remarks
Lightweight	• Consider able to lift the prototype without any harm. • The total weight of vehicle is in the rang of 10kg which is a acceptable weight to be lifted by a normal person.
User-friendly	• With the folding mechanism incorporated, storage purposes for the prototype can be done easily. • Early stages of handling the prototype quite hard but gain experience after several test run given. • Difficulty in steering the vehicle at curves or critical angle due to the limitation of wheel angle
Safeties	• Safety of user is achieved due to ability of controller device to adjust the speed.
Economical	• With the price range around RM200.00, the students are still willingly to purchase or use the vehicle as an alternative vehicle inside the campus. • The cost of prototype is still in the range of the economical budget of students.

CHAPTER 6: CONCLUSION

The Human Transporter (E-porter) device is basically an alternative means of transportation for single person use. This device will be very useful as it is capable to transport people from one place to another in a short period of time.

The construction of the Human Transporter (E-porter) is be based on several requirements in order to achieve the objectives of the project. As stated before, the aim is to designed in a manner that it is lightweight, durable, user friendly, economical and safe. Apart from that, the product should take consideration in the use of the product which is for students inside the university.

The project has included the study on the response of students to the use of the product whether it can be implemented inside the university, research and analysis on strengths and weaknesses of existing products in the market and lastly, design and produce a device which is able to operate based on research completed. From the study showed in the repot, most students replied their interest to try new types of transportation vehicle and discover their advantages which includes the Human Transporter itself.

Further through some validation process and analysis on the prototype, it shows that the prototype satisfy the requirements and the objectives of the project which are to design a single-human transportation device that is lightweight, user friendly, durable, economical and safe.

CHAPTER 7
RECOMMENDATION

Based on findings of this project and challenges faced, some recommendations can be made for further works to be carried out to improve the performance and applicability of the Human Transporter (E-Porter) device. The recommendations made are:

7.1 Manoeuvrability of device

Suggestion of applying a steering device on the body structure that allows a more easier riding experience especially when dealing with cornering motions on the road.

7.2 Braking System

The safety of the user will be much more guaranteed if the device has a automated or manual braking device which allows the user to apply when experiencing unwanted conditions such as riding on wet surfaces or riding to fast.

7.3 Automated Folding Mechanism

The folding system of the Human Transporter will be easier if it is powered by electric. The users just need to push one button to fold the device without any bother to do it manually.

7.4 Materials

The Human Transporter will be lighter if most assembly parts such as brackets is built from lighter materials other than steel. Aluminium or plastic are some of the example of materials that can provide lightness to the vehicle design thus, improved the portability of the Human Transporter.

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