

SUPERVISOR COMFIRMATION

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of a Bachelor of Mechanical Engineering (Design & Innovation)."

Signature :
Supervisor : DR SHAMSUL ANUAR BIN SHAMSUDIN
Date :

DESIGN AND ANALYSIS OF SPEED LIMITER DEVICE FOR A VEHICLE

MUHAMAD SAUFI BIN ISMAIL

This thesis is submitted in fulfillment of the requirement for the degree of Bachelor
of Mechanical Engineering (Design and Innovation)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

June 2015

DECLARATION

“I hereby declare that the work in this thesis is my own except for summaries and quotations which have been duly acknowledged.”

Signature :

Author : MUHAMAD SAUFI BIN ISMAIL

Date :

Dedicated to
My Lovely Family

ACKNOWLEDGMENT

Alhamdulillah, I give thanks to the Almighty with His permission for me to complete this Final Year Project with excellent.

Thanks and appreciation goes to my supervisor Dr. Shamsul Anuar Bin Shamsudin who helped in contributing ideas and advice that never stop me in preparing this study Final Year Project. Unforgettable thanks to my family who helped in terms of moral support, financial and encouragement uninterruptedly. As well as appreciation addressed to colleagues who contribute ideas and support. As a token of appreciation that will never expire until the end of time.

ABSTRACT

The aims of the project is to design a speed limiting device for a vehicle. The function of the speed limiter is to limit the speed of a vehicle at a set speed. To complete this project, all three objective needs to achieve. The objectives are study about real time speed of a vehicle, design a product that function as a speed limiter and control the speed of a vehicle based on predetermined speed. There are a lot of speed limiter existing products in order to ensure that the vehicle speed is below a safe speed. Among these are the limiting speed using global position system and also Ford Speed limiter Technology. Existing mechanism and concept are reviewed to help ensure the success of this undergraduate project. In the process of designing, draft final steps of the selection is made. Assisting in the concept selection process are the House Of Quality (HOQ), Morphological Chart and Pugh Concept Selection Method. For the final design, CATIA software is used to generate a three-dimensional modules. Within CATIA, strength analysis was carried out to complete the entire process in this project, a prototype of the final design was applied to simulated vehicle speed and the result were promising.

ABSTRAK

Tujuan projek ini adalah untuk merekabentuk sebuah peranti penghad kelajuan untuk kenderaan. Fungsi peranti penghad kelajuan adalah untuk menghadkan kelajuan kenderaan pada kelajuan yang ditetapkan. Untuk menyiapkan projek ini, ketiga-tiga objektif perlu dicapai. Antara objektif kajian adalah tentang masa kelajuan sebenar sebuah kenderaan, merekabentuk produk yang berfungsi sebagai pengehad kelajuan dan mengawal kelajuan kenderaan berdasarkan kelajuan yang telah ditetapkan. Terdapat banyak produk sedia ada bagi alat penghad kelajuan bagi memastikan setiap kenderaan di bawah kelajuan yang selamat. Antaranya ialah alat penghad kelajuan menggunakan sistem GPS *Global Positioning System* dan juga sistem *Ford Speed limiter Technology*. Mekanisme dan konsep yang sedia ada ini dikaji semula untuk membantu dalam menjayakan projek sarjana muda ini. Dalam proses merekabentuk, beberapa langkah pemilihan untuk mendapat konsep terakhir. Dalam membantu proses pemilihan konsep, beberapa prosedur pemilihan diaplikasi antaranya *House Of Quality* (HOQ), Carta Morfologi dan Kaedah Pemilihan Konsep Pugh. Untuk rekabentuk yang dipilih, perisian CATIA digunakan untuk menghasilkan modul tiga dimensi. Dengan menggunakan perisian CATIA, rekabentuk yang telah dimodulkan boleh menjalani analisis kekuatan bahan. Untuk melengkapkan keseluruhan proses dalam projek ini, rekabentuk akhir ini difabrikasi untuk memastikan alat penghad kelajuan ini berfungsi dengan baik untuk sebuah kenderaan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	SUPERVISOR DECLARATION	i
	DECLARATION	iii
	DEDICATION	iv
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	ABSTRAK	vii
CHAPTER 1	INTRODUCTION	1
	1.0 Introduction	3
	1.2 Problem Statement	3
	1.3 Research objective	3
	1.4 Research scope	3
	1.5 Organization of the thesis	3
CHAPTER 2	LITERATURE REVIEW	4
	2.1 Introduction	4
	2.2 Vehicle speed limiting device	4
	2.3 Speed limiter device working principles	5
	2.4 Existing models of speed limiting device	5
	2.5 Summary	6
CHAPTER 3	METHODOLOGY	7
	3.1 Introduction	7
	3.2 Methodologies process flow chart	7
	3.3 Preliminary research	9
	3.4 The concept of early research	9
	3.5 Design process concept	10

CHAPTER	TITLE	PAGE
	3.6 Houses of quality (HOQ)	11
	3.7 Morphological chart	13
	3.8 Concept selection	16
	3.9 Design modelling	18
	3.10 Summary	19
CHAPTER 4	DATA AND RESULT	20
	4.1 Introduction	20
	4.2 Data and analysis	20
	4.2.1 Final design	21
	4.2.2 Analysis on threaded shaft	28
	4.2.3 Safety factor	34
	4.2.4 Schematic diagram for speed limiter circuit	36
	4.2.5 Coding on Arduino	37
	4.2.6 Result on prototype	39
	4.3 Summary	43
CHAPTER 5	DISCUSSION AND ANALYSIS	44
	5.1 Introduction	44
	5.2 Problem encounter	44
	5.3 Summary	46
CHAPTER 6	CONCLUSION AND RECOMMENDATION	47
	6.1 Conclusion	47
	6.2 Recommendation	48
	REFERENCE	49
	APPENDIX	50

LIST OF FIGURE

BILL	TITLE	PAGE
Figure 1.1	Statistics on the number of accidents in January-June 2014	2
Figure 3.1	Process flow chart	8
Figure 3.2	Vehicle speed limiting devices	10
Figure 3.3	House Of Quality (HOQ)	12
Figure 3.4	Design concept for speed limiting device	15
Figure 3.5	Design of speed limiting device	18
Figure 4.1	The isometric view of the final design with hidden line	23
Figure 4.2	The exploded view of the final design	24
Figure 4.3	Orthographic views of the final design with dimension	26
Figure 4.4	Bills of material for the final design	27
Figure 4.5	Analysis on threaded shaft for PVC material	29
Figure 4.6	Analysis on threaded shaft for Mild Steel material	30
Figure 4.7	Analysis on threaded shaft for High Density Polyethylene material	31
Figure 4.8	Analysis on threaded shaft for Low Density Polyethylene material	32
Figure 4.9	Analysis on threaded shaft for Polyvinyl Chloride material	33
Figure 4.10	Schematic diagram	36
Figure 4.12	Result of prototype using a 3D printer	40
Figure 4.13	Result of cleaned prototype	41
Figure 4.14	Result of threaded shaft from machining	42

LIST OF TABLE

BILL	TITLE	PAGE
Table 3.1	Morphological chart for speed limiting device	14
Table 3.2	Pugh concept selection chart	17
Table 4.1	Properties of Mild Steel (MS)	30
Table 4.2	Properties of High Density Polyethylene (HDPE)	31
Table 4.3	Properties of Low Density Polyethylene (LDPE)	32
Table 4.4	Properties of Polyvinyl Chloride (PVC)	33
Table 4.5	The values of safety factors for different material	34
Table 4.6	Table of building progress of prototype models	39

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

This undergraduate project entitles Design and Analysis of Equipment Speed limiter for the vehicle. The importance of this study is to intensify their efforts in reducing road accidents in Malaysia. As we know that the rate of road accidents recorded increased year by year and with this study can help the government deal with the issue. Many efforts have been undertaken by various parties, for example, in a tightening of the rules, giving the offense the summons speed limit, and also awareness campaign road. From the study of the speed limiter device, the speed of a vehicle can be controlled and thus it can minimize the number of road accident cause of lost control due to speeding.

This study aims to produce and design a control device speed limit and operate properly and also durable. Besides that, further study on real time speed of a vehicle and how to control the speed is taken deeply. This project will be carried out starting from concept selection process, material selection, prototyping, testing and up to the fabrication process. The previous draft was conducted by the Kuala Lumpur City Hall (DBKL) and the study linked to ensure this project is successful.

Figure 1.1 shows the number of accidents in January-June 2014. (Source: Board Highway, 2014).

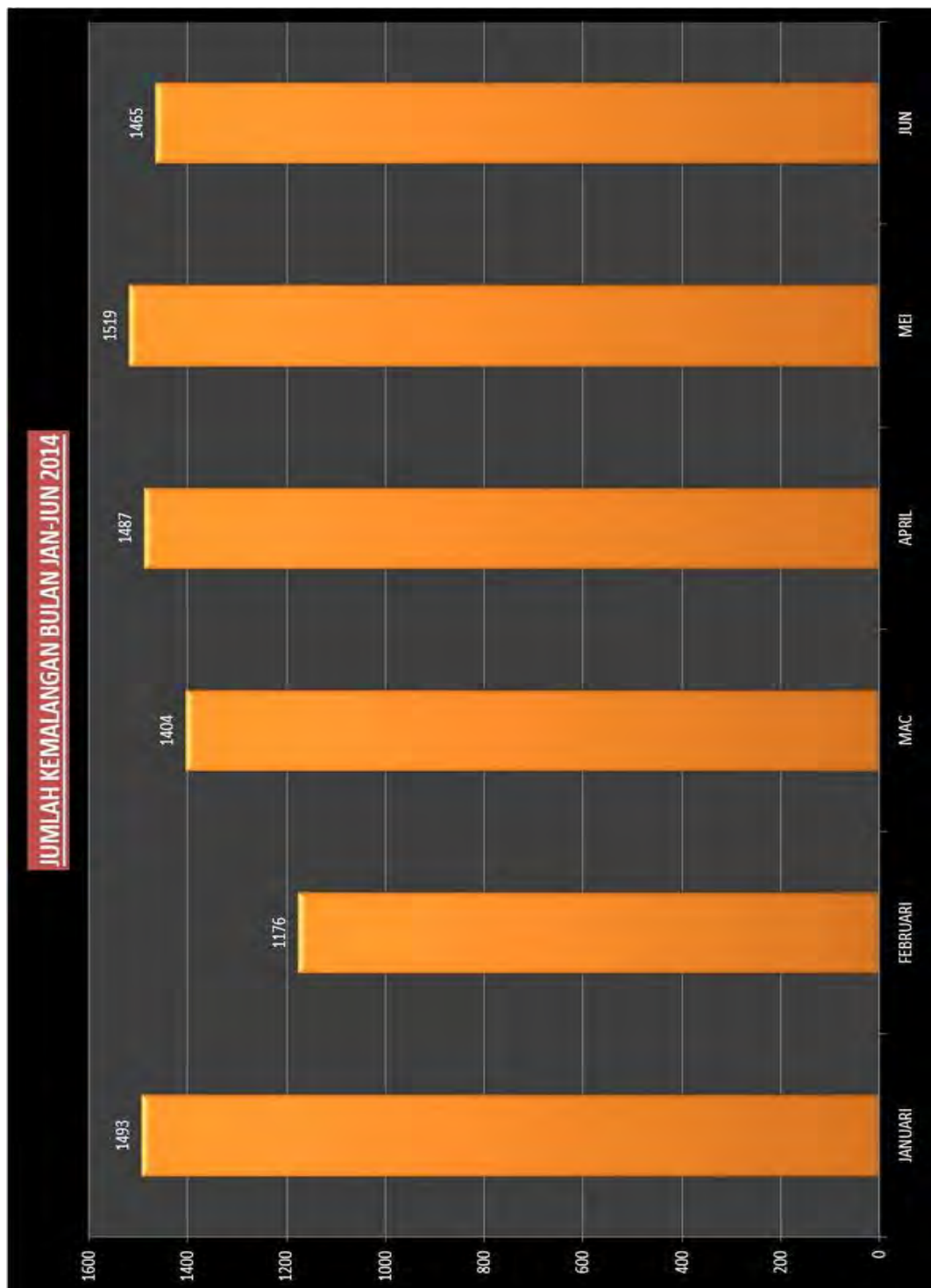


Figure 1.1: Statistics on the number of accidents in January-June 2014 (Source: Board Highway, (2014))

1.2 PROBLEM STATEMENT

A speed limiter is one of the product that exists and technically ours, but not in our country. Mostly the product placed inside the system of a vehicle transmission, such as in a throttle box. The speed of the vehicle exceeds the limit allowed by the government and a number of cases road accident rate is increasing every year and uncontrolled. So by design the speed limiter that applied on the throttle paddle, the problem can be reduced and controlled.

1.3 RESEARCH OBJECTIVES

For Undergraduate Project (PSM), there are several objectives to be implemented, among which are:

1. To study about the existing product of the speed limiter device
2. To design a product that functions as a speed limiter
3. To produce a model of prototypes that can demonstrate the function as well

1.4 RESEARCH SCOPE

Based on the knowledge of automotive and design study that related to fulfill the Dewan Bandaraya Kuala Lumpur (DBKL) requirement. The idea of this project will be translated into rapid prototyping and up to the testing process.

1.5 ORGANIZATION OF THE THESIS

The rest of the thesis is organized as follows. Chapter 2 describes some of the related works on this issue. Next, Chapter 3 lays out the methodology used in this study to realizing the objective of this research. For Chapter 4 will explain in theoretically and practically about the output process for the research. Another two chapter will discuss the problem and the solution for any circumstances that occur.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will describe the scientific studies on matters connected with the vehicle speed limiter as described previously. A thorough review of existing products that help also adopted in this chapter. Therefore revenue for this study was quoted from the website, internet, reports pattern, thesis and journal also for the success of this PSM study. Among the matters to be discussed is the principle means that the speed limiter function, speed-limiting example of one of the existing, and also the weakness of existing tools, materials and lastly mechanism materials used.

2.2 VEHICLE SPEED LIMITING DEVICES

The speed limiter device has been created to enhance security by controlling the speed of a car on the oil throttle, so it can reduce the rate of road accidents. The basic function of this system is to limit the maximum speed of the vehicle to a pre-set level while the throttle (acceleration) cannot be suppressed completely if it has reached a specified speed limit.

2.3 SPEED LIMITER DEVICES WORKING PRINCIPLE

Basic principles of vehicle speed limiter device is to maintain the speed of the car under a specified speed. This device is mounted on the throttle and the engine control system of the vehicle. If the vehicle exceeds a set speed, the engine control system will send a signal to the engine to filter the rates of oil entering the engine. With this, the vehicle speed is cut off and a safe speed can be kept.

2.4 EXISTING MODELS OF SPEED LIMITING DEVICE.

Nowadays, there are a variety of speed-limiting devices in the market. Among these are, intelligent speed limiter with GPS. Global position system (GPS) be used to determine the global position and speed limit of a vehicle. GPS detects the position of the vehicle and sends a signal to the control system of the vehicle if the vehicle is exceeding the speed limit. The use of GPS and car control system is a key component in this system. Among other examples of the speed limiter device is Ford Speed limiter. For this tool does not require any contact with the satellite data such as GPS. This device consists of several components, such as speed sensors on the front tires, the vehicle control system and engine control division. The concept is when the vehicle speed sensor mounted on the front tire track car speed exceeds a specified speed, a signal is sent to the control system of the car. So the rate of fuel injected into the engine will be reduced. According to Ford engineers, Alex Kaps stated that this tool serves same as normal existing speed limiting device. The maximum speed of vehicle is between 20 to 110 km / h. A speed control device function is to keep a constant speed, while the speed limiter device is to not let the vehicle passes a set velocity.

In addition, there is a system introduced by VDO. VDO road speed control is designed to maximize the efficiency engine of a vehicle. This device can control the top speed by detecting the vehicle road speed and comparing it to a set speed. The system works using the actuator which served as a tool to limit the enrollment rate by changing the fuel control lever on the injector pump. (Source: VDO (2008))

For this undergraduate project, which investigated the speed limiter device must be able to function properly when connected to any vehicle components and also be able to limit the speed of a vehicle if a certain speed limit set.

2.5 SUMMARY

In this chapter, the various types of speed limiting devices are introduced and existing product should be assessed on the conceptual work. Apart from that, the mechanism of the existing speed limiter device is examined and expressed its advantages and disadvantages.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter describes the methodology of the study will be conducted to obtain the vehicle speed limiting device specifications. The study includes a detailed knowledge of the design process and selection method. Many aspects need to be considered such as elegance, robustness, aesthetics, cost, resources, time, skill required and lastly safety. Good designers consider these universal design criteria when choosing which possible solution to implement.

3.2 METHODOLOGIES PROCESS FLOW CHART

The flow chart is a diagram of a particular order of movements or actions of product or project involved in a complex system or activity. Matter that described in this flow chart is how the design process running, with this chart, it can help and resolve problems that arise in each phase.

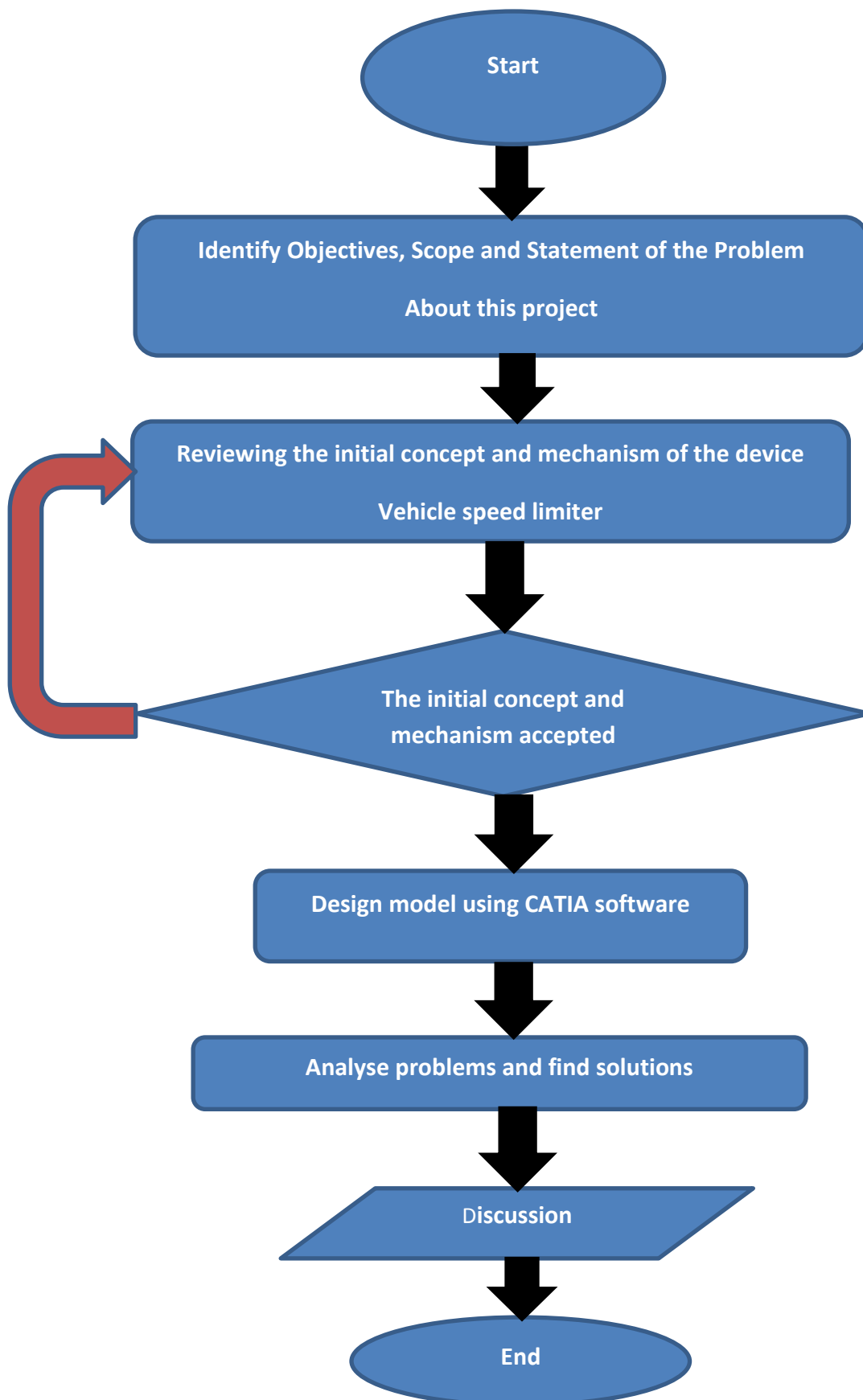


Figure 3.1: Process flow chart

3.3 PRELIMINARY RESEARCHES

In this initial study describes how the concept of the origin of this is performed by way of review of the movement and the speed limiting device mechanism. One reason why this concept under review is because in order to ensure the function of the limiting speed, and ensure that the target of the study is achieved. A more detailed study is made of the mechanism the tool to obtain accurate information and also reduce the problem at the next phase. This mechanism of the limiting devices is studied to help speed and simplify the process of designing.

3.4 THE CONCEPT OF EARLY RESEARCH

At the initial stage of research, between the first processes is to understand the concepts, functions and mechanisms of the speed limiting device. As a guide in the study of the concept, the beginning concept design by Dewan Bandaraya Kuala Lumpur (DBKL) take as a basic resource in the design process. Fig. 3.2 shows the concept of the DBKL and components used is the connecting pieces of metal that are bound using the typical screw. There is also a motor attached to a shaft that has a screw on its surface that allows the shaft to spin. Therefore, at the time the vehicle speed exceeds a predetermined limit. The speed limiter device will function where it will turn the motor and move the tool holder that is available on the speed limiter device close to the floor of the vehicle. With this, the acceleration pedal on the following vehicles will reach a stage where the pedal was not able to keep suppressed. The same concept is used to design the speed limiting device, but some changes on the design need to be done. The design of the speed limiter device from debacle need to be changed because to make it more suitable and practical when apply to the vehicle. In the material selection, chosen material must fulfill the function of the speed limiter device. In example, the material can assist in moving mechanism on the speed limiter device and also can withstand the exert load from the driver. In addition the material used can survive and be able to be used in a long time.



Figure 3.2: Vehicle speed limiting device

3.5 DESIGN PROCESS CONCEPT

To design a product many aspect that needs to be emphasized, for example the size of the product, product design, safety and customer requirements. These aspects are taken into account to obtain a product that meets the desired criteria. The design process is the most important phase in the overall project flow. This is because if a mistake is made, it can lead to big problems in the manufacturing process. Therefore, some way or procedure taken as a step in the selection of design concepts, such as House of Quality (HOQ), weighted decision matrix (WDM), morphological chart and product design specifications. From the design of the City Hall before, we can list several components that must exist in this speed-limiting device. Among its components are, motor, threaded shaft, base metal plate and screws. The mechanism for this device speed limiter function when the vehicle reaches a speed limit set, the signal will be sent to the motor to drive the threaded shaft close to the wall of the vehicle. With this, the acceleration pedal is prevented from directly pressed.

3.6 HOUSE OF QUALITY (HOQ)

The House of Quality is a central tool of QFD, it translates customer requirements, market research and benchmarking data into prioritized engineering targets to be met by a new product design. Using house of quality (HOQ), it can help the process of selecting a concept once can produce a product that meets customer demand. Among the components contained in the house of this quality are the characteristics of engineering, benchmarking, position and direction of improvement, and customer needs. The conclusion of the house of quality methods used, the value of targets to be achieved to obtain design specifications can be obtained.

Figure 3.3 shows the methods used HOQ, where some aspect taken into account as an evaluation. Among the specification are taken into account at the component needs of customers is the method of installation, long life, safety, cost, and also stability. The other component is a weight factor for customer needs. The weight factor is to differentiate between the needs of customers that are important to customers. Measuring with a score of 1 to 5 were used as the evaluation scale. For component engineering characteristics contain the force applied, the weight of the product, product materials, product size and product design. For the specification of the characteristics of engineering, it is evaluated using a score of 1, 3 and 9 and there is a purpose for each score. For a score of 1 means that the specification was a much smaller role, followed by a score of 3 and also score 9. After that, the customer needs intersect with the engineering characteristics. Score in the specification engineering characteristics higher than the requirements of the customer. To get its customers' needs with the highest score is obtained by multiplying the weight factor and summing the total. Symbol of arrows in the HOQ is to show the engineering characteristics which need to be corrected or mitigated.

In Figure 3.3 there are six five customers' needs and specifications, engineering characteristics that have been identified for consideration in the design concept. This argues that the design is one of the most significant characteristics that should be given priority among engineering characteristics. Priority structure is composed of a force is applied, the material, design, size and weight of the product.

		Engineering characteristic				
Improvement directions			n/a	n/a	↓	↓
Units		N	n/a	n/a	cm	gm
Customer requirements	Importance weight factor					
	Force applied					
	Material					
	Product design					
	Product size					
	Product weight					
	Assembly method	5	9			
	Material cost	5		9	3	9
Product lifetime	5		9	3		
Stability	4	9	9	3	9	
Safety factor	4	3		3	3	3
Method of use	5	9		3	1	1
Raw score		138	126	69	98	22
Relative weight		30.5	27.8	15.2	21.6	4.9
Rank order		1	2	4	3	5

Figure 3.3: House Of Quality (HOQ)

3.7 MORPHOLOGICAL CHARTS

A morphological chart is a table based on the functional analysis. Along the remaining side of the chart the functions are listed, while on the right side, different mechanisms which can be employed to execute the functions listed are made. It is a visual aid or writing help used to come up with different thoughts. The idea generation is achieved by creating single systems from different mechanisms illustrated in the morphological chart. It is proposed to generate several feasible designs using different mechanisms for each office for each concept.

Table 3.1 demonstrates the morphological chart for speed limiting device. In this figure, it has a few capacities for outline thoughts for a speed limiting device for vehicles. In the introductory mechanism movement, instrument for vehicle speed limiter gadget is the same. Both ideas have diverse design. In view of distinctive design, a determination is made by joining the outline with usefulness somewhere else. The distinction between the two outline ideas indicated is the method of installation. Installation method for Concept A is, will be introduced on the vehicle floor to hold the gas pedal in place not to be pressed after the vehicle achieves a pace of settled rate, while for Concept B will be introduced on the gas pedal shaft that will serve to hold the wall of the vehicle and cannot result in the pedal pressed again when the vehicle achieves a predetermined speed. Installation method for Concept B can be depicted as demonstrated in Figure 3.6. Figure 3.5 demonstrates a conceptual design for a speed limiting device for vehicle as three-dimensional painting.