# DEVELOPMENT OF CUSTOMER FRIENDLY METHOD FOR MEASURING REAL FUEL CONSUMPTION OF SMALL PASSENGER CAR


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**Declaration**

This thesis is a presentation of my original research work. Whenever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature, and acknowledgement of collaborative research and discussions. The research and work was done under the guidance of Mr. Abdul Yamin Saad.

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In my capacity as supervisor of the candidate's thesis, I certify that the above statements are true to the best of my knowledge.

________________________________

Mr. Abdul Yamin Saad

Date:

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First of all, praises and thanks to Allah, the Almighty for His showers of blessing throughout my research work. Next, I would like to thank my supervisor, Mr. Abdul Yamin Saad for his encouragement, guidance and support throughout this research. It was a good experience for me to be able to learn a lot from him. I am thankful to be given a chance to learn from him.

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Mohammad Hafeez Bin Abdul Wahab

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**Abstrak**

Kitaran memandu adalah satu siri titik data kelajuan kenderaan terhadap masa. Kitaran memandu mewakili keadaan memandu dunia sebenar kerana ia dicadangkan untuk dibandingkan antara anggaran penggunaan bahan api kenderaan dengan hasil yang diukur. Tujuan penyelidikan ini adalah untuk mencadangkan kitaran memandu mudah dalam masa tertentu dan juga untuk menunjukkan penggunaan bahan bakar. Tujuan lain adalah untuk mencari hubungan antara pemanduan yang cekap dan pemanduan yang selamat dengan anggaran pengunaan bahan api ketika melakukan eksperimen penyelidikan ini. Pada dasarnya, percubaan kitaran memandu melibatkan hanya beberapa langkah. Langkah pertama ialah memilih pemilihan laluan terdiri daripada kawasan bandar dan bukan bandar. Langkah kedua ialah mengumpulkan data yang diperlukan untuk membuat kitaran memandu. Aplikasi Android digunakan untuk mengambil data yang diperlukan dan akan menghasilkan graf kelajuan masa secara automatik. Selain itu, satu soal selidik akan disebarkan secara media sosial untuk orang ramai mengisi bagi mendapakan korelasi antara pemanduan cekap dan selamat. Data yang akan dikumpulkan digunakan untuk mencari penggunaan bahan api kenderaan. Parameter yang akan dibandingkan adalah kelajuan maksimum kenderaan, kelajuan purata kenderaan dan juga tempoh masa. Data rujukan boleh digunakan dari data New European Drive Cycle (NEDC) data. Soal selidik akan diperiksa dan korelasi boleh dibuat dengan keputusan yang diambil. Kaedah ini sangat mesra pengguna dan boleh digunakan untuk kaedah hidup seharian untuk memandu kenderaan yang selamat. Penggunaan bahan api berada dalam unit (l / 100km). Kitaran memandu mempunyai corak sendiri untuk mewakili kelakuan ujian jalan. Oleh itu, keputusan kitaran memandu akan diselaraskan dengan responden soal selidik untuk kaedah memandu dan pengisian bahan bakar yang selamat.

## Abstract

Drive cycle is a series of data points of vehicle speed against time. It represent the real world driving conditions as it was proposed to be compared between estimated vehicle fuel consumption with the measured results. The purpose of this research is to suggest a simple drive cycle in certain amount of time and also to indicate the fuel consumption used. The other purpose is to find the relationship between efficient driving and safe driving while doing this research's experiment. Basically, the drive cycle experiment involves only a few steps to be done. The first step is to have a route selection consist of urban and non-urban area. The second step is to collect the data needed to make the drive cycle. An Android application is used to take the data needed and a speed time graph automatically be produced. Plus, a questionnaire will be spread online for people to fill up to find the correlation between efficient driving and safe driving with fuel consumption. The data that will be collected is used to find the fuel consumption of the vehicle. The parameter that will be compare is the vehicle maximum speed, vehicle average speed and also the time duration. The reference data can be used from the New European Drive Cycle (NEDC) data. The questionnaire will be examine and a correlation can be made by the results taken. This method is very user friendly and can be used for daily life method for safe vehicle driving. The fuel consumption is in (l/100km) units. The drive cycle has its own pattern to represent the behaviour of road test. Therefore, the drive cycle results will be coordinated with the questionnaire respondent for safe driving and refuelling fuel method.

## Chapter 1: Introduction

### 1.1 Overview

The importance of vehicle has grown unconditionally. It is now plays an important part of our daily life event. Some of distances covered by car during a single ride are shorter especially for student, which unfortunately increases the times of engine cold starts. This will lead to an increase of fuel consumption. Nowadays, the fuel price is quite expensive. The request for low fuel consumptions is getting more important. The main reason is because price of fuel is inconsistent in Malaysia. The extinction of fossil fuel is also part of the reason our fuel price is high. In figure 1.1 show the latest fuel prices in Malaysia in 2017. We can see clearly how the price of fuel fluctuating.

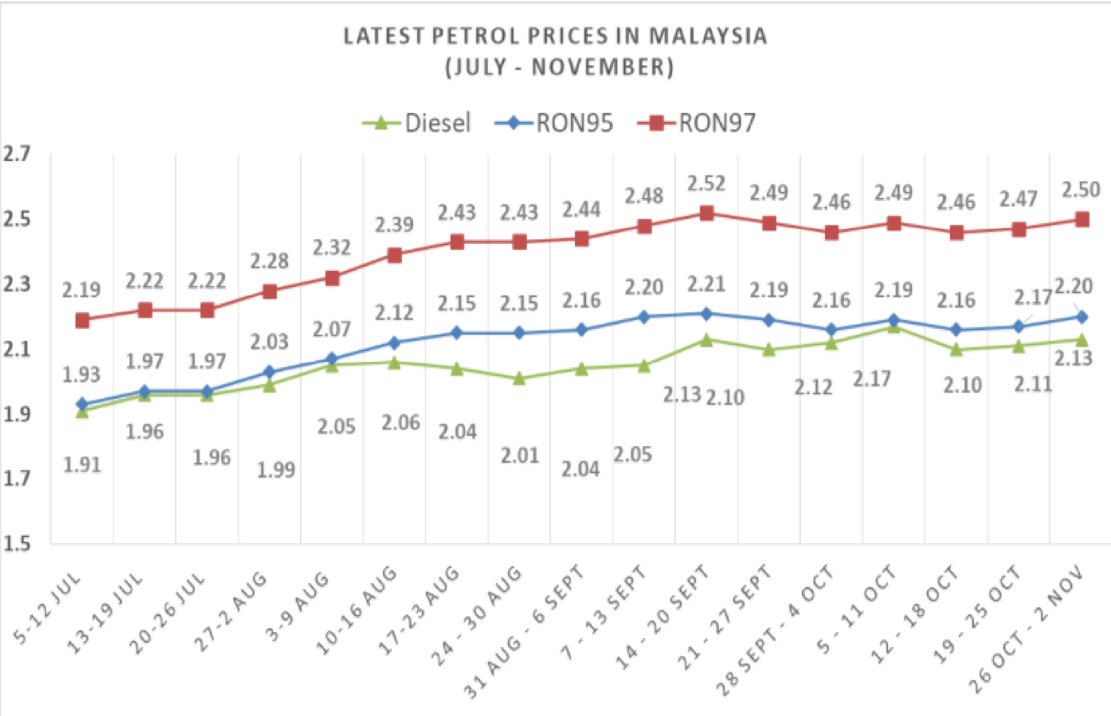


*Figure1.1: Petrol Prices in Malaysia*

This study is targeted to develop a customer friendly method for measuring real fuel consumption of small passenger car. A drive cycle of speed against time will be develop and the amount of fuel consumption will be calculated.

## 1.2 Project Background

One of the most important parameters of exploitation of the vehicles is fuel consumption. Every year resources of fossil fuels are going out, amount of vehicles are increases and charge for one litter of fuel is high. Fuel consumption is actual both for human who wants to provide oneself with the car and both for automobile holders who already are exploiting their vehicle. Particles emissions are the results from the engine combustion process and from the evaporation of fuel. Due to this, the community has taken this problem seriously and research has been conducted to measure the exhaust gas emissions and saves fuel consumption. Drive cycle is representation data of speed against time in a specific loop. It can be used to test vehicle performance or to measure the real fuel consumption that has been used by vehicle in the specific loop. By having a drive cycle , we can compare the most efficient vehicles between cars[1]. Furthermore, new or improve design vehicles can be made to meet the requirement from the test results. Drive cycle can show the typical driving behaviour of users , therefore better behaviour of driving [2]. This study will be done by real driving experiment in urban and non-urban area. The experiment will be done around Nibong Tebal, Parit Buntar, Bandar Bharu and Universiti Sains Malaysia Kampus Kejuruteraan. The criteria that can be measured are maximum speed distribution of acceleration, cruising, deceleration, idling modes, and average of the speed duration taken for one complete cycle, total distance travelled. From this criteria, fuel consumption value can be find and it will be compare to the value stated on board of the car. The current standard driving cycles in a lab controlled condition to test all vehicles has this biggest disadvantage. It assumes all driving activities of driver to be similar, but in real-world traffic condition, the vehicles is driven differently based on the individual. Each individual drive their own car by their own way [3].In Europe , they have this drive cycle called New European Driving Cycle (NEDC) . This drive cycle main purpose is to represent the usage of car in Europe , but it is rejected for giving solution that is quite impossible to be achieve in day life driving reality [4].

## 1.3 Problem Statement

This experiment is mainly to build a customer friendly way to measure fuel consumption of car. By having a new suitable method, it can help the buyers to buy better vehicle by comparing the fuel consumption of different vehicles. By having a drive cycle , it can give the buyers info about the fuel consumption , better way to fuel up tank , and also accumulate a long term data for the specific drive cycle location.

## 1.4 Objectives

1. To access the current practice of refuelling fuel by using questionnaire to determine the real world fuel economy.
2. To suggest simple drive cycle in urban and non-urban area for short and long term duration of time.
3. To estimate fuel consumption of car using suggested data.

## 1.5 Scope of Work

For my project the scope of work includes:

1. Main focus is to develop a drive cycle of my own in urban and non-urban area.
2. Explain about this data collecting methods to three candidates and kindly ask them to help provide their own drive cycle so that each drive cycle can be compare according to driver style.
3. Arrange the data answer from questionnaire to learn driver's habit and provide the suitable and safest method when refuelling the fuel.
4. Compare drive cycle pattern, fuel consumption and fuel economy by calculation.

# Chapter 2: Literature Review

## 2.1 Drive Cycle

There are many ways to provide fuel consumption to drivers from all around the world. Drive cycle is one of it and it is a travel based experiment. A group of data of fuel consumption and exhaust emission can be produced. This method is the simple and efficient method for estimation of emission inventories, traffic engineering purpose, and estimation of fuel consumptions[5] . Drive cycle is a speed-time profile which represent the activities in road test. It consist of data points that represent the speed of vehicle versus time. It also refer as speed-time profile for study area which vehicle can accelerate , decelerate , cruising or even idling [6]. The profile is develop only for certain routes in a specific area.

Drive cycle can be divide into two categories which is legislative and non-legislative. The legislative purpose is for controlling the emission of vehicle while the non-legislative purpose is to find exhaust emission and fuel consumption[7].

## 2.2 Function of Drive Cycle

The speed-time profile drive cycle is used to determine the activity of road test. There is also drive cycle that had been experimented in a lab to test all types of vehicle. This lab test is not quite accurate as it has its own drawback. The first drawback is that the lab test have to assume that all driver's driving style is the same. In the real world driving, every individual has its own style of driving. Every driver's driving habit does not exactly follow the traffic law that had been set by the government. The second drawback is the cruise driving technologies. Almost each and every modern car has this technology. The lab condition driving cycle test does not take this cruise driving technology into account while most of the modern drivers nowadays applied this technology to make their driving less tiring and easier[3].

The US EPA uses five standard test cycles based on dynamometers in laboratory condition to provide point estimates of vehicle fuel economy to consumers. This information is valuable in making vehicle purchase and use decisions. Other than capital costs, energy costs are heavily weighted when consumers make vehicle purchase decisions[8]. The overall framework is illustrated in figure 2.1, where we conceptualize the system. The key proposed strategy deals with generating more precise information about fuel economy for individuals who are interested in purchasing conventional vehicles. To design customized drive cycles, the overall approach uses case-based reasoning. This is done by clustering and joining micro-trips to create drive cycles, and vehicle simulations to estimate the fuel economy for a driver[9].

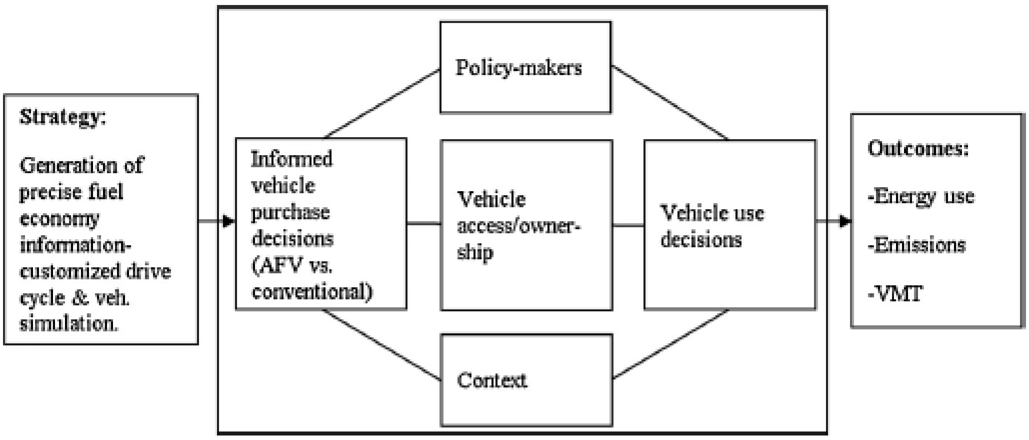


***Figure 2.1: Conceptual framework: strategies, behaviour, and outcomes***

Plus, by doing drive cycle road test, it can also generate pollutants emission. Pollutants will be vary depending on type of vehicle being used when doing this experiment. Small car and big car have different type of exhaust emission depending on the engine capacity. Figure 2.2 shows the factors that influence vehicles exhaust emissions [10].

| | |
|---|---|
| Vehicle/Fuel Characteristics | • Engine type and technology<br>• Exhaust, crankcase, and evaporative emission control systems<br>• Engine mechanical condition and adequacy of maintenance<br>• Air conditioning, trailer towing, and other vehicle appurtenances<br>• Fuel properties and quality<br>• Alternative fuels<br>• Deterioration characteristics of emission control equipment<br>• Deployment and effectiveness of inspection/maintenance (I/M) and anti-tampering (ATP) program |
| Fleet Characteristics | • Vehicle mix (number and type of vehicles in use)<br>• Vehicle utilization (kilometers per vehicle per year) by vehicle type.<br>• Age profile of the vehicle fleet<br>• Traffic mix and choice of mode for passenger/goods movements<br>• Emission standards in effect and incentives/disincentives for purchase of cleaner vehicles<br>• Adequacy and coverage of fleet maintenance programs<br>• Clean fuels program |
| Operating Characteristics | • Altitude, temperature, humidity<br>• Vehicle use patterns—number and length of trips, number of cold starts, speed, loading, aggressiveness of driving behavior<br>• Degree of traffic congestion, capacity and quality of road infrastructure, and traffic control systems<br>• Transport demand management programs |

***Figure 2.2: Factors effecting vehicle pollutant emissions***

## 2.3 New European Drive Cycle (NEDC)

Reducing energy consumption is a national goal for many reasons, from economic and national security to improving air quality and reducing greenhouse gas emissions. Declining energy resources and the climate effects from the use of fossil fuels have resulted in energy saving objectives in all industry sectors. The situation is similar for the official measurement of fuel consumption. The regulations that are valid today across the whole of Europe were adopted by the European Union and the UN Economic Commission for Europe (ECE) as the only binding standard for passenger cars. An important part of the process used for determining fuel consumption is the driving cycle according to which all cars are tested. It shows the behaviour driving of driver in a specific distance, speed that should be driven.

The cycle is different for each car. The experiment can be tested on road or at lab. ”New European Driving Cycle” (NEDC) is a test from small cars to super sports cars that had been measured since 1996. NEDC consists of two parts. The car is left for a few minutes after the cold start. After that, the driving in the specific loop area starts with acceleration, braking, and idling of car. At first, the main purpose of NEDC is to act as a standard for the measurement of exhaust pollutants such as carbon monoxide, nitric oxides and unburned hydrocarbons[4].

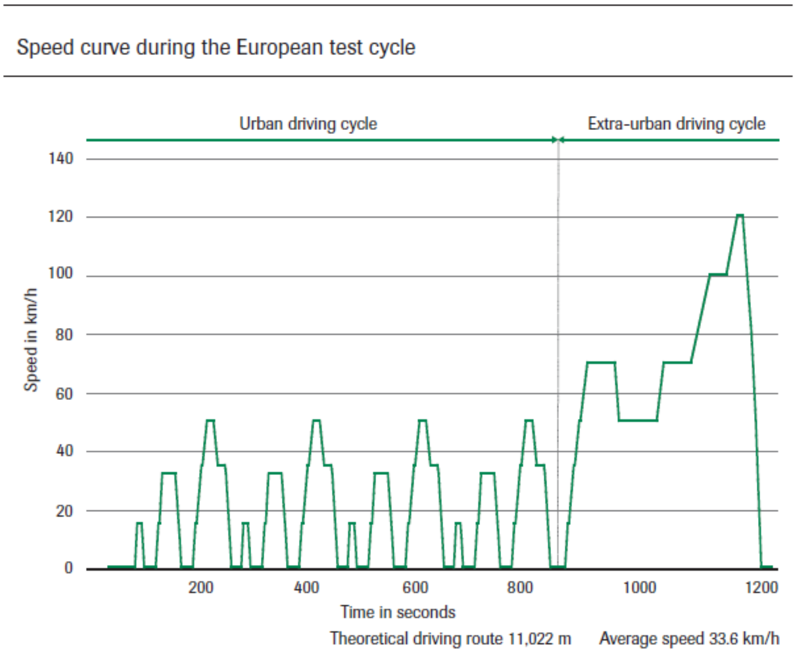


***Figure 2.3: NEDC speed curve***

There are many ways to provide fuel consumption to drivers from all around the world. Drive cycle is a travel based experiment. A group of data of fuel consumption and exhaust emission can be produced. This method is the simple and efficient method to estimation of emission inventories , traffic engineering purpose and estimation of fuel consumption[5]. Watson (1978) predict air pollution. Drive cycle have two categories, legislative and non-legislative. The US.FTP 75 cycles, ECE cycle and Japan 10-15 modes cycles used in the United State of America, Europe and Japan for controlling emissions of vehicle. Sydney driving cycle is an example of non-legislative. Its purpose is to find exhaust emissions and fuel consumption[6]. To estimate on road vehicle emissions by coupling emission rates in United States, the model EMFAC and MOBILE is used. For the mobile emission rates , the Federal Test Procedure (FTP) cycles is used[7]. Two method can be used to get data for drive cycle which is the chase car method and on-board instrument (Global Positioning Method or GPS).

The chase car method is not appropriate as the experiment is being done by following any car in a few seconds of interval distance. GPS method is more suitable as it can get the speed by time(seconds) automatically as we move[11]. To investigate the effects of driving cycle fuel consumption, experiments on a test vehicle are carried out on a standard chassis dynamometer. The exhaust emissions including carbon monoxide (CO), carbon dioxide ($CO_2$), total unburned hydrocarbons (HC) and oxides of nitrogen ($NO_x$) were measured according to a constant volume sampling (CVS) method when the vehicle is operated at specified driving cycle with hot start engine[12].

## 2.4 USA Driving Cycle

USA driving cycle is an example of other country driving cycle. It is also known as Federal Test Procedure (FTP-75). It used for testing car and light duty truck emission certification. The FTP-75 cycle obtain from phase 1 and phase 2 as known as FTP 72 or Urban Dynamometer Driving Schedule (UDDS). The third phase starts after the engine is stopped for 10 minutes. The table below shows the main characteristic of FTP-72 and FTP 75[6].

***Table 2.1: Main characteristic of FTP-72 and FTP 75.***

| Cycle name | Total time (s) | Distance (m) | Cruise period (%) | Accelerating period (%) | Average speed (km/h) | PKE m/s2 |
|---|---|---|---|---|---|---|
| FTP-72 | 1369 | 11996.85 | 18.04 | 36.96 | 31.6 | 4.307 |
| FTP-75 | 1874 | 17786.59 | 20.06 | 36.45 | 34.2 | 4.197 |

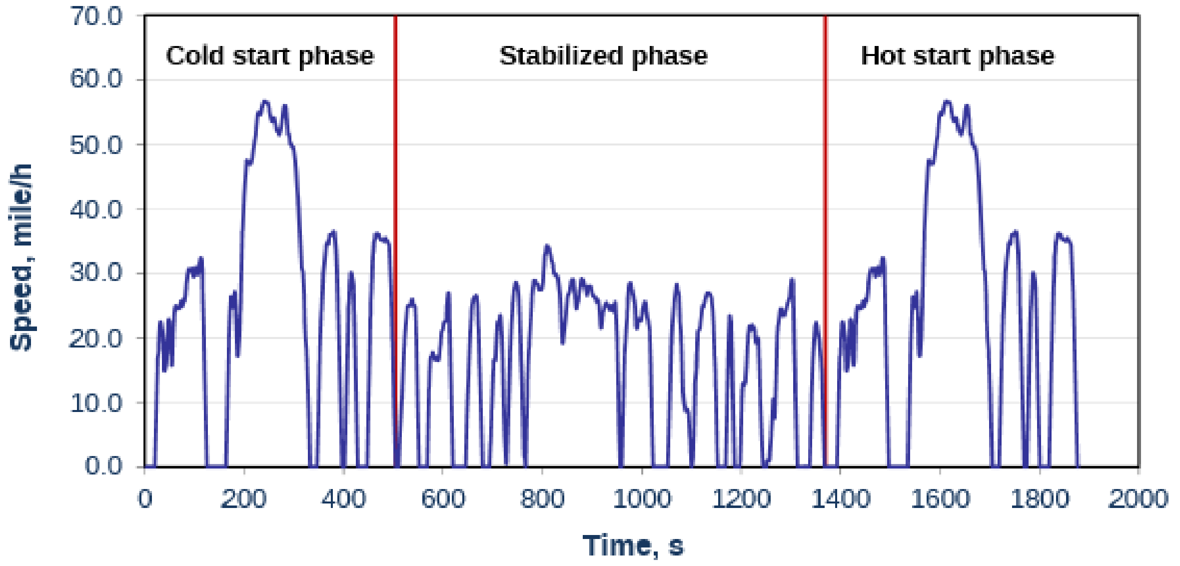


*Figure 2.4: US EPA Urban Dynamometer Driving Schedule (FTP-75)*

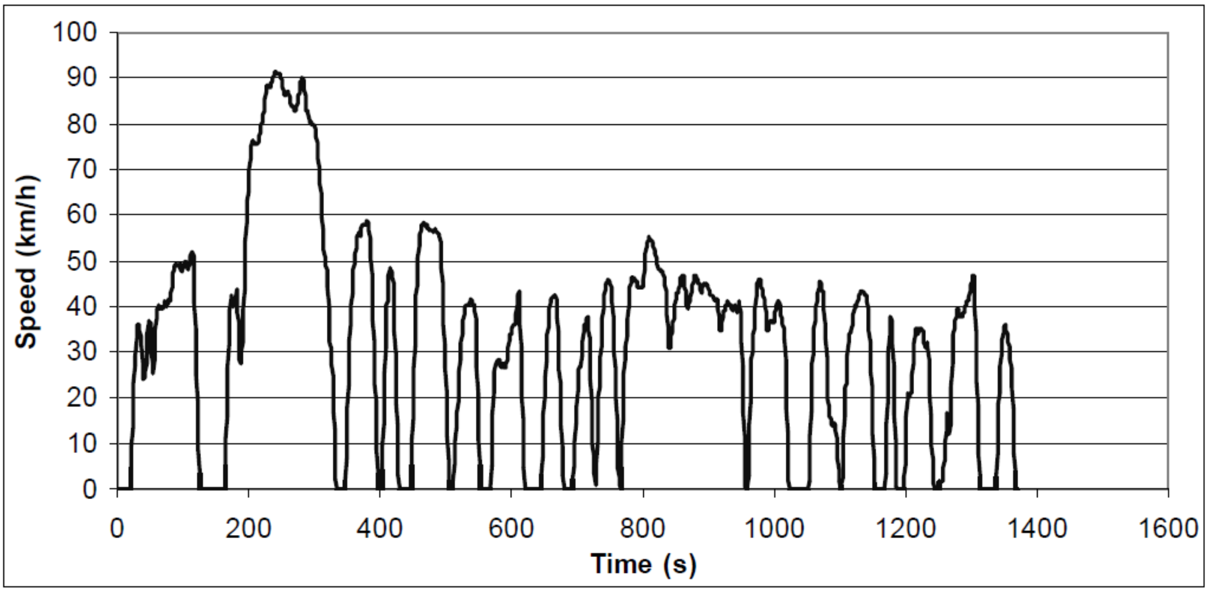


*Figure 2.5: Urban Dynamometer Driving Schedule (FTP-72)*

## 2.5 Worldwide Harmonized Light Vehicles Test Procedure (WLTP)

World Forum for Harmonization of Vehicles Regulations (WP.29) of the United Nations Economic Commission for Europe (UNECE) has established an informal group under its Working Party on Pollution and Energy (GRPE). The purpose of this group is to prepare a road map for the development of a world-harmonized light-duty vehicle test procedure (WLTP). WLTP is a global harmonized standard for determining the level of pollutants, emission, fuel consumption, and electric range for the passenger car. This experiment can be said as an advanced or improved version of NEDC.

Development of WLTP consists of two main elements which is development of a harmonized driving cycle representative of world average driving conditions (internally referred to as the DHC) and Development of a harmonized test procedure that sets the conditions, requirements and tolerances for the emissions test (internally referred to as the DTP)[13].

Three different vehicle classes varying in its vehicle’s power-to-mass ratio and its maximum speed is used to get three different driving cycle. The figure below will show the pattern for the highest power and class of vehicle. Basically, this cycle is fixed at 1800 seconds. For NEDC and FTP cycle, it only takes about 1180 seconds and 1372 seconds[14]. However, this WLTC cycle are still unrealistic for the Western Europe region area. The maximum speed for this cycle was 131.3km/h and its average speed was about 53.5km/h. [15]

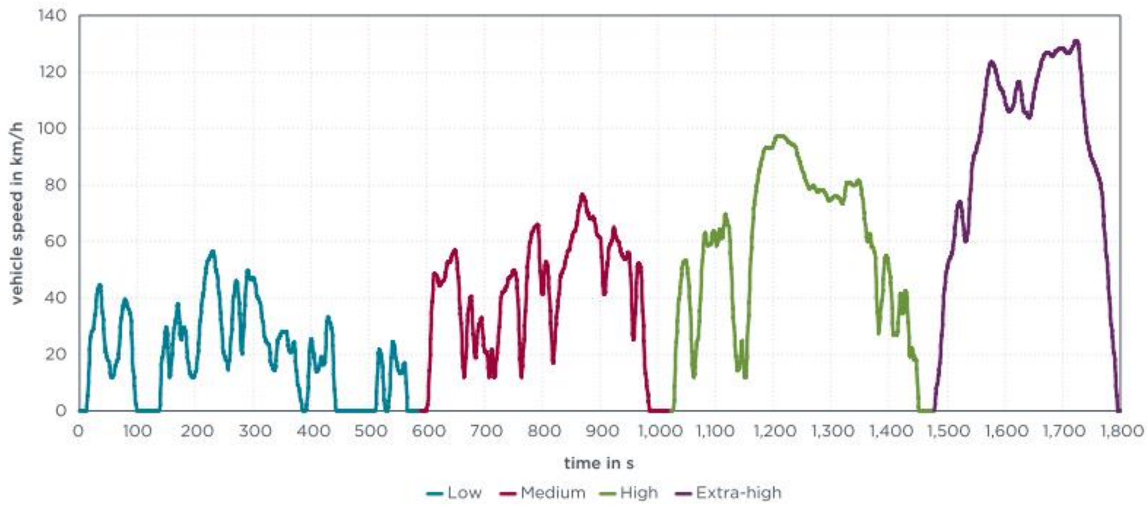


***Figure 2.6: WLTC for Class 3 Passenger***

## 2.6 Dublin City Drive Cycle

The test for drive cycle was carried out on a passenger car with the following specification

Car maker : Fiat Marea

Model : 2001

Legislative standard : Euro 3.

Figure 2.7 below show the flowchart of development of driving cycle.

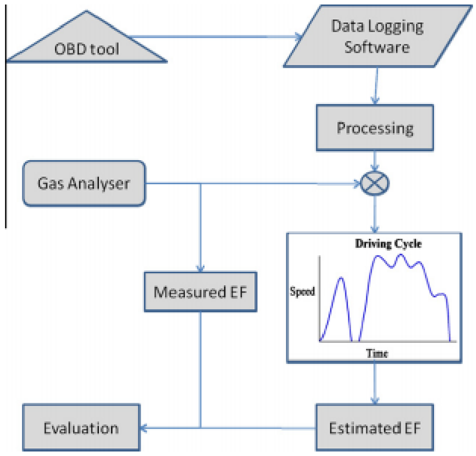


***Figure 2.7: Development of driving cycle***

The test were conducted on three different time which is at the time people go to work from home , people go home from work and at night where traffic is less[16].

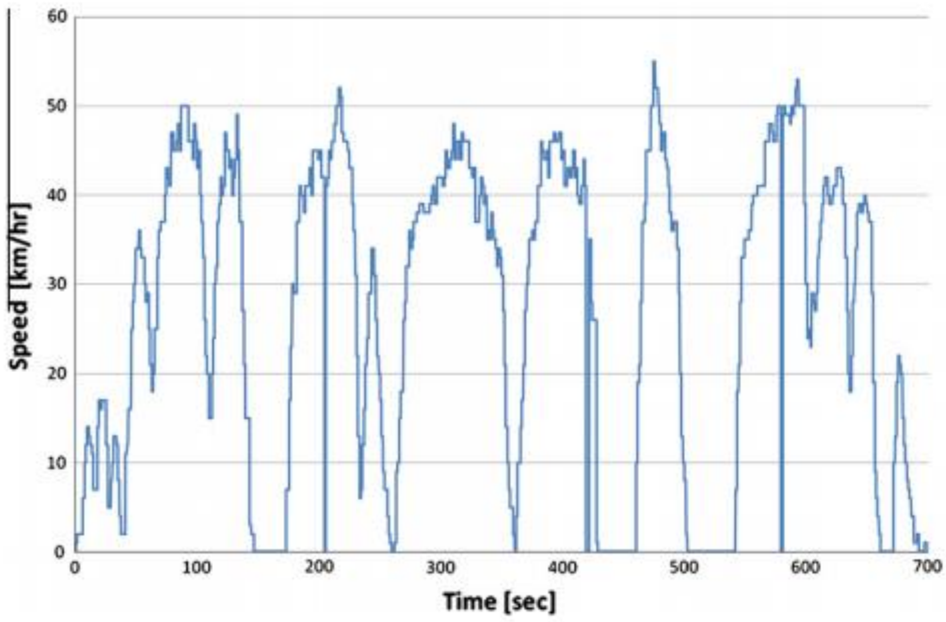


***Figure 2.8: Dublin Drive Cycle***

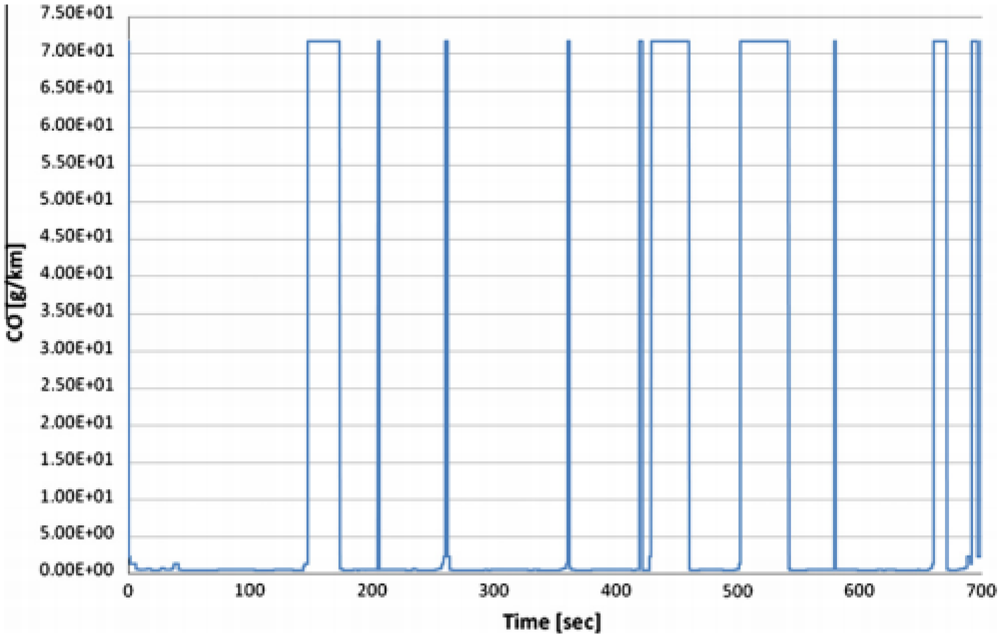


***Figure 2.9:Carbon dioxide emission***[17]

**2.7 ECE 15 Cycle**

ECE 15 cycle is performed on chassis dynamometer. It is used for emission certification of light duty vehicle in Europe. In this cycle , there is an extra urban driving cycle (EUDC) added after the fourth mode of ECE 15 cycle to get more data on high speed driving modes[18]. EUDC maximum speed of vehicle is 120km/h[19]. It is also known as the MVEG-A cycle.

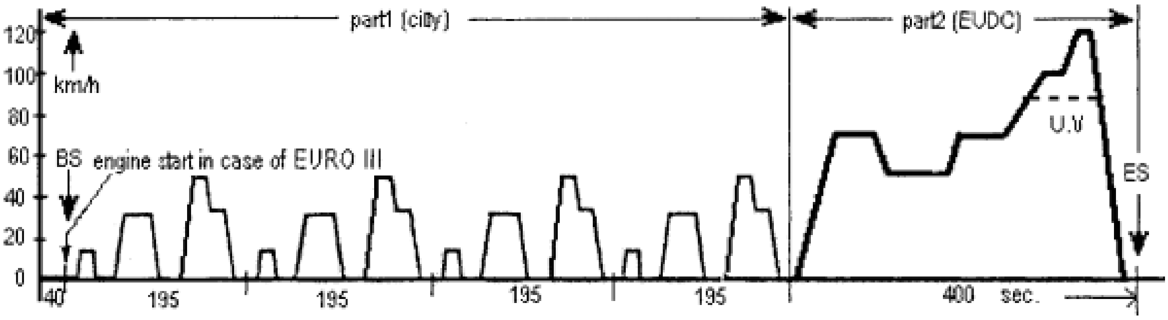


***Figure 2.10:ECE Test Drive Cycle***[20]

**2.8 Japan 10-15 Mode**

In Japan the 10-15 mode cycle is currently used for emission certification and fuel economy for light duty vehicles. The entire cycle includes a sequence of a 15 minute warm-up at 60 km/h, idle test, 5 minute warm-up at 60 km/h, and one 15-mode segment, followed by three repetitions of 10-mode segments and one 15-mode segment. Emissions are measured over the last four segments[22].

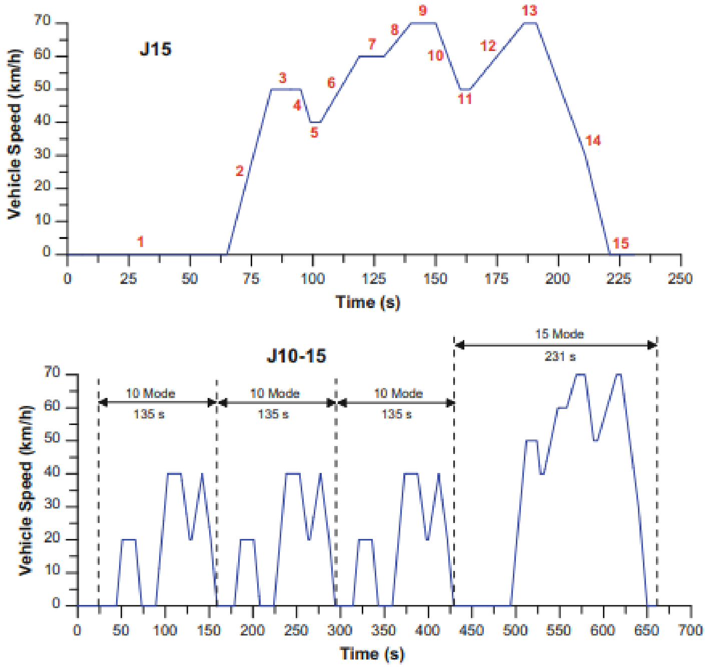


***Figure 2.11:Speed Profile of the Japanese 15 Mode (J15) and 10-15 Mode (J10-15) Driving Cycles***[20][21]

## 2.9 Singapore Driving Cycle (SDC)

In Singapore, they used NEDC for laboratory setting. However, NEDC is not well suited for the highly urban area like Singapore. This driving cycle chose a combining method data collection which can be arranged in three types. The first one is the chase-car method (instrumented car to collect data as it follows randomly selected vehicles). As for the second method is on-board measurement methods (instruments installed in subject vehicles to collect their trip activities) and for the third method is combined method of chase-car, on-board measurement and circulation driving (instrumented car driven during the lull and peak periods on pre-selected routes). Figure below shows the route that has been chosen for the SDC.

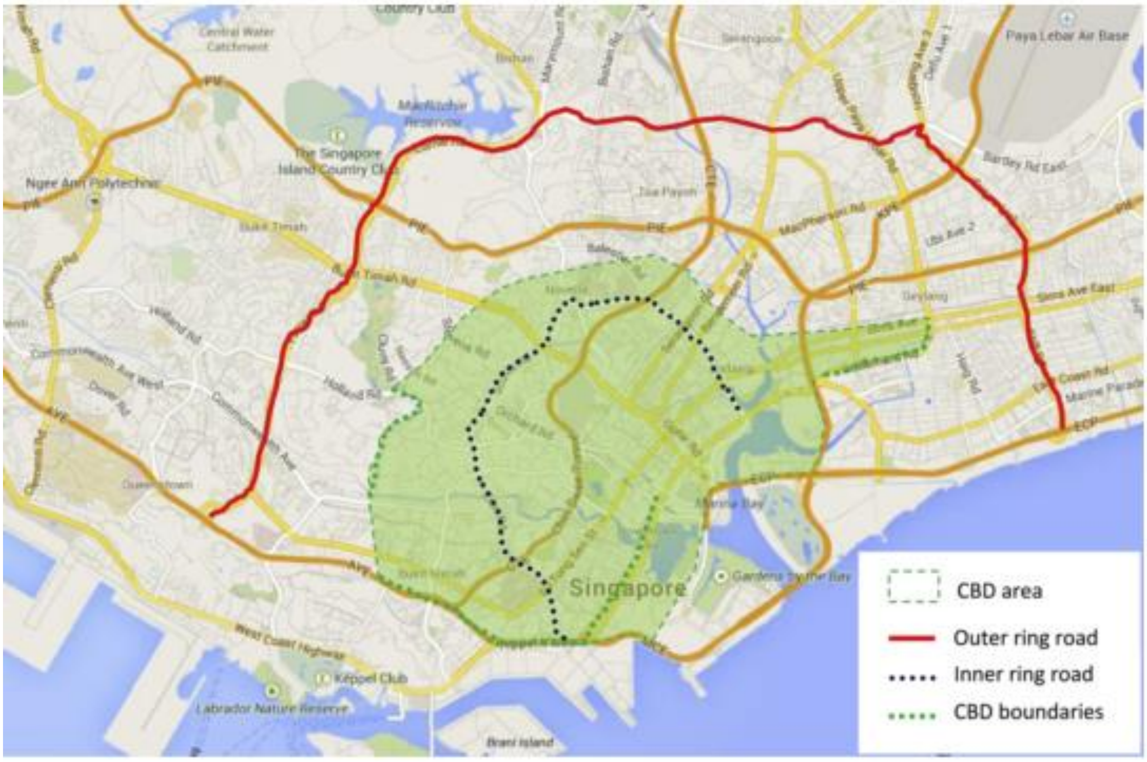


*Figure 2.12: Inner Ring and Outer Ring Road System*

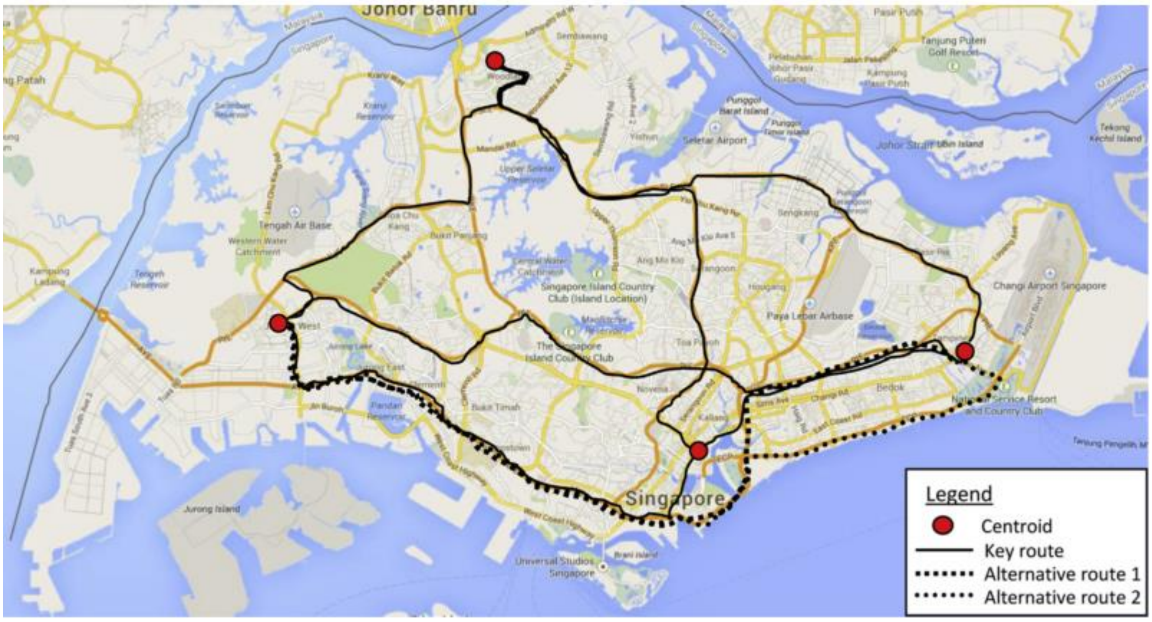


***Figure 2.13: Chosen Routes for Chase-car Method***

Both average speeds of SDC and NEDC are quite the same. Only the characteristics such as maximum speeds, idling periods and speed changes are quite different. SDC give more of a good results of a real world driving conditions. The maximum speed of both cycle being compared is different. Singapore has more urban area which resulting in low maximum speed of vehicles[23].

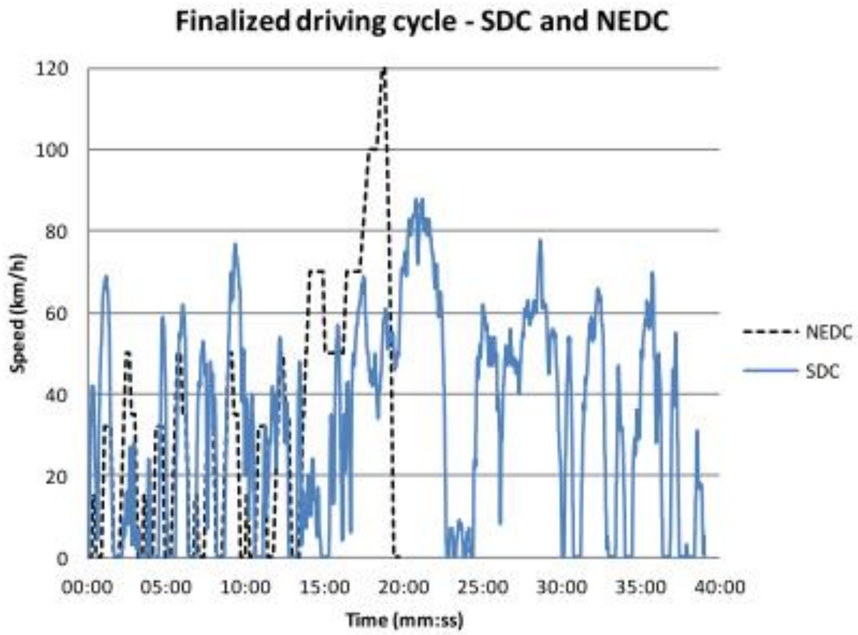


***Figure 2.14: Finalized Driving Cycle Singapore Driving Cycle (SDC) and New European Driving Cycle (NEDC)***

### 2.10 Driving Behaviours

Road traffic crashes continue to present a serious public health challenge. According to the World Health Organization there were approximately 1.24 million deaths on the road in 2010 across the world, equating to almost 3400 a day, with estimates of injuries arising from road traffic crashes rising from the eleventh to the eighth leading cause of mortality from 2002 to 2010[24]. Safe driving is defined as driving which protected from danger or risk; not injured or be harmed; with no harm done. Efficient driving is defined as achieving maximum results with minimum wasted effort or expense.

In India, road traffic accidents are a major public health problem resulting serious injuries and facilities damage. Every week nearly nine thousand people get injured due to traffic accidents. The distribution of road accidental deaths and injuries varies according to age, gender, month and time. There are also certain exact time where the road accidents are relatively higher due to bad weather influences[25]. Distractions while driving can stem from a competition for visual processing, manual interference, or cognitive sources of distraction, such as speaking with a passenger, conversing on the phone, or in the context of voice control. However, especially during long drives, it can also reduce the risk of driving errors caused by fatigue. Driving anger is a particularly interesting special case of cognitive distraction. Anger is among the most important factors involved in unsafe driving. It is highly relevant to examine the effects of driving anger on driving behaviour, as the behaviours of road users explain much more variance of traffic accidents than do vehicle, roadway, or environment factors[26].

In Arab, young men love to treat driving as a sport or hobby. It is very common to see teenage boys participating in drifting events. Attitudes and driving behaviours in general are founded very early in life and are important to safe driving[27]. Also, some driver are not aware of their driving surrounding when doing this few secondary task engagement actions:

1. Mobile phone use: a mobile phone is held close to their ear.
2. Smoking: Holding a cigarette and smoking it whilst driving a vehicle. This includes smoking, lighting and extinguishing a cigarette or cigar
3. Eating/drinking: Holding or drinking a beverage or holding or eating food while driving.
4. Talking to passengers: Having a conversation or interacting with other people in the car. Evidence of this may be that the driver is turning their head towards the passenger to either listen or talk or appears to be talking and gesturing.
5. Adjusting controls: Leaning forward to manipulate controls on the dashboard of the car (e.g. stereo, heating).

6. Manipulating a phone: Holding a mobile phone in their hand while driving. Includes visibly touching the screen/buttons in a manner to send a text message or dial a number.

7. Reaching for an object: The driver is seen reaching for an object on the floor, beside them or behind them (excluding the dash-board).

8. Other: This included such things as: reading, blowing their nose, grooming, using a satellite navigation device, counting money, picking their nose, finger in mouth, head out the car window, fastening buttons, cleaning car dashboard with a tissue, adjusting car mirrors, cleaning nails, using a hands-free mobile phone, and moving a baby[28].

# CHAPTER 3: METHODOLOGY

***Figure 3.1: Perodua Myvi 1.5 SE Experiment Car***

The drive cycle will be done in Universiti Sains Malaysia (USM) Engineering Campus area. The route that has been chosen for the road test is about 50 kilometre routing around Parit Buntar, Bandar Bharu, and Nibong Tebal as shown in figure 3.2. A Perodua Myvi 1.5 SE is used to make the road test. The data will be recorded by an application in the Android smartphones called Geo Tracker.

The routes consist of urban and extra urban area. The data collected will consist of urban driving and extra urban driving data. The drive cycle will be run for at least five times so that better results can be compare. There will be exactly four checkpoints for this whole 50 kilometre experiment route. All the data between checkpoints are collected separately as the route chosen consists of urban and extra-urban area.

Before starting the experiment, the car will be fill up with RON95 fuel. The tank will be filled up until it is full. The petrol is fill up by using two click method at medium flow rate of fuel. Before the tank is filled, the fuel cap will be leave open for a few seconds so that the pressure on the inside of tank is same as the outside pressure. This is to ensure that the petrol is not stirred up. When the petrol reach at the top of the tank, the nozzle will automatically make a click sound and stop fuelling. Then, the nozzle will be pump and lock again until the second click of sound is heard. This is to ensure that the car is really fill up until petrol reach maximum height. Medium flow rate refuelling of fuel method is used to avoid pressure in the tank.

The experiment will be done by driving the car at the selected route. The car will be stop at very checkpoint that had been set. The checkpoints are selected based on urban and extra urban area. When running this experiment, one person is needed to be our co-pilot to help noted the idle time taking for the whole trip. As the load of car will affect the fuel consumption, the passengers in the car will be the same. Air conditioner also will affect the fuel consumption, but almost everyone will have their air conditioner on while driving. Therefore this experiment will be done following our natural behaviour when driving a car.

Our driving must be natural, like we usually drive daily. All the speed limit and traffic law must be followed. Efficient driving may lead to a safe driving. The safety of people on the road is also a priority. After the car reach each checkpoint, don’t turn off the engine. The handbrake is pulled, and the gear is on neutral. The application will be stop and save for the first checkpoint. Next, the experiment will continue to another checkpoint. The application will be start new again, and the next data will be recorded.

As for safety factor, all the checkpoints are at strategic place so it will not be a problem for us to stop sideway at the road side. At the highway checkpoint, try to maintain car speed at 120km/h for 1 kilometre. It is because it will be easier later for the data to be compare with New European Drive Cycle (NEDC) data.

After completing all the checkpoints, go to the petrol station to fuel up the car until it is full again. The amount of fuel fill, is the amount of fuel that we consumed when doing the experiment. For a better results, go to the same petrol station, exact same spot and side when refuelling the petrol tank. The application will auto generate a speed versus time profile.

After the experiment done for a few times until the suitable results is obtained, the same experiment will be repeated with a few other different cars for one road test. The car will have the difference is the manufacturing year, the engine capacity, and type of car. The driver for each of the car will also have one passenger helping to note down the idle time. The route taken will also be the same but now we will have three types of different data as each driver's driving behaviour is different. All the steps taken when doing this experiment will be the same as before.

Next, the experiment will be run again for another three times using the same car but this time there will be few additional things needed to be done. Before starting the experiment, we will fuel up the car petrol. Then before starting the car engine, the ODO meter and fuel economy meter on the car board will be reset to zero. All the other actions are still as before when doing the experiment. This ODO meter and fuel