



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**THE COMPARISON STUDY OF HANDGRIP PRESSURE ON STEERING
WHEEL NATIONAL CARS (PROTON & PERODUA)**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology

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اونيورسيتي تكنولوجي ملایسيا ملاک
(Product Design) (Hons.)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

by

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TAJUK: **THE COMPARISON STUDY OF HANDGRIP PRESSURE ON STEERING WHEEL NATIONAL CARS (PROTON & PERODUA)**

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I hereby, declared this report entitled “The Comparison Study of Handgrip Pressure on Steering Wheel National Cars (Proton & Perodua)” is the results of my own research except as cited in references.



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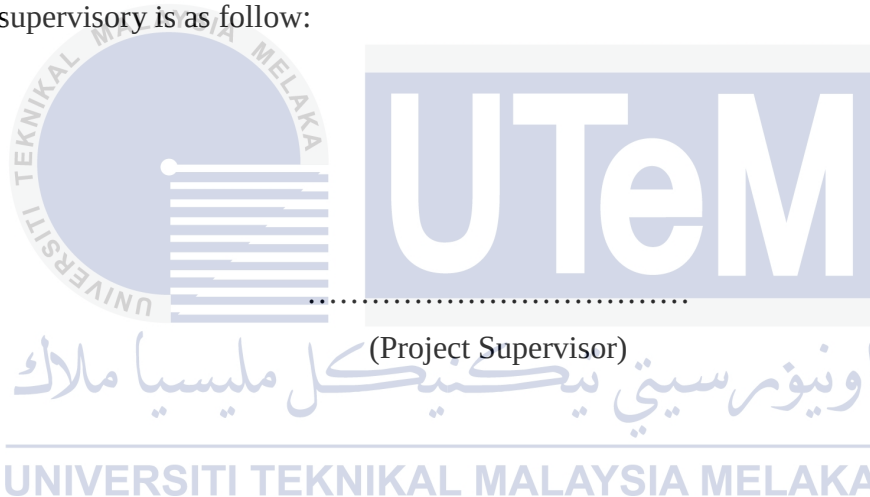
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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor Degree of Engineering Technology Manufacturing (Product Design) (Hons.) The member of the supervisory is as follow:



ABSTRAK

Terdapat perbezaan yang signifikan antara stereng ergonomic dan sebaliknya. Tujuan utama stereng ergonomik direka untuk memberikan keselesaan optimum kepada pemandu terhadap genggam stereng, terutama untuk perjalanan yang jauh. Objektif projek ini untuk menganalisis data mengenai tekanan genggam pada stereng kereta Proton dan Perodua. Projek ini akan dilakukan dengan menggunakan dua jenis kereta iaitu Proton Saga dan Perodua Myvi. Untuk mengumpul data tekanan genggam semasa responden memandu kereta, Sistem Grip Tekscan akan digunakan. Seterusnya, peranti disambungkan ke tangan pemandu dimana peranti itu dilekatkan pada sarung tangan dan ukuran diambil. Pemilihan jalan untuk projek ini adalah bermula dari persimpangan lampu KM 92.1 trafik, memasuki Lebuhraya Utara Selatan dan berakhir di Exit Tol Tangkak. Semasa eksperimen, semua sukarelawan perlu mengekalkan kelajuan dalam julat 80-100km / h tetapi kebanyakan masa mereka perlu memandu di lorong kiri kecuali untuk memotong kenderaan lain. Jarak dari awal hingga akhir adalah kira-kira 68.8km dan akan mengambil tempoh kira-kira 30 minit. Selain itu, pemandu perlu menggunakan kedudukan tangan pukul 9 dan 3 pada stereng kerana ia adalah kedudukan yang paling selamat untuk memegang stereng. Hasil daripada analisis data yang dihasilkan tekanan genggam akan dibandingkan antara kedua-dua jenis kereta dan tekanan cengkaman akan berkaitan dengan kidal dan tangan kanan di kalangan pemandu.

ABSTRACT

There are significant differences between the steering wheel ergonomics and vice versa. The main purpose of the steering wheel is ergonomically designed to provide optimum comfort to the driver while grip the steering wheel, especially for the long journey. The objective of this project to analyze data about handgrip pressure on Proton and Perodua steering wheel. This project will be done by using two type of cars which are Proton Saga and Perodua Myvi. To collect the data of handgrip pressure while respondent drive the car, Tekscan Grip System will be used. Next, the device is connected to the driver's hand which is the device is affixed to the glove and the measurement is taken. The road selection for this project will be started from KM 92.1 traffic light junction, entering North South Highway and will ended at the Exit of Toll Tangkak. During the experiment, all the volunteers need to maintain the speed in range 80-100km/h, but most of the time they have to drive in left lane unless to overtaking other vehicles. Distance from the beginning until the end is about 68.8km and the time taken will about 30 minutes. Besides, the drivers need to use 9 and 3 o'clock hand position on steering wheel since it is the safest position to hold the steering. Result from data analysis of handgrip pressure will be compared between these two types of car and the grip pressure will be related to left handed and right handed among the drivers.

DEDICATION

To my beloved parents; my late father Hj Abd Sukor Bin Mahat and Hj Noraini Binti Kasdi thank you so much for the prayer from the beginning until end of this project. Not to forget my siblings and Saddam Qhazami Bin Ibrahim. Big thanks to my family, for always being by my side through up and down. Thank you, for always encourage me when I wanted to give up. Dad, I want you to see me from the heaven, even if there are mistakes and flaws, yet I'm getting closer to success as you wish. To my classmates and my friends thank you for the support that has been given to me. Lastly, special thanks to En Mohd Hidayat Bin Ab Rahman, my supervisor for the guidance and patience during this semester to contribute the ideas for this project.



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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

System of steering wheel is a major part and it is the most important components of vehicle. Steering wheel is parts that have linkages that will allow any type of vehicles to follow the driver's desired course to move and may actually affect the driving. However, until now there are still steering wheel which has been designed does not really apply ergonomic feature.

There are significant differences between the steering wheel ergonomics and vice versa. The main purpose of the steering wheel is ergonomically designed to provide optimum comfort to the driver while grip the steering wheel, especially for the long journey. Conversely, if the ergonomic features are incorporated on the steering wheel, the problems that will arise as Musculoskeletal Disorders (MSDs) and Neuromusculoskeletal Disorders which can lead to fatigue in the muscles around the hands. In addition, drivers are also at risk of suffering Hand-Arm Vibration Syndrome (HAVS) which is caused by excessive vibration while grip the steering wheel. Both of these problems will ultimately lead to health problems.

In this project, the two different types of national cars, Proton and Perodua models is used to study about the relationship between the ergonomic steering wheel and hand grip pressure. In this project, by using Tekscan Hand Grip sensor the results was analyzed and the camera system that was installed is provided videos recording to support the results why it is produced.

1.2 PROBLEM STATEMENT

Most of the times, for those who drive for the long distances have risk of getting muscle fatigue. In addition, the situation become worse if the steering wheel used does not have ergonomic features. The driver can suffer from Musculoskeletal Disorders (MSDs), Neuromusculoskeletal Disorders and Hand-Arm Vibration Syndrome (HAVS) which can cause muscle injury, tendon injury and nerve injury. This disorders and syndrome regarding to this project, are related to repeated patterns or movement of the continuous work (turning the steering wheel), the wrong posture of both hand on steering wheel and the force concentrated on small parts of body, such as hand or wrist. Based on the review have been made , there is no specific data of the driver 's between left handed and right handed towards the hand grip force on steering wheel among Malaysian.

1.3 OBJECTIVES

The purposes of this project are:

1. To find ergonomics risk factor during driving.
2. To find out measurement data of gripping force during handling the steering wheel by using Tekscan Hand Grip System.
3. To find the correlation between roads condition while driving the car with hand grip pressure between left handed and right handed drivers.

1.4 SCOPE

Firstly, the work scope of this project is focused on the students. All the respondents are students from Faculty of Engineering Technology (FTK) UTeM aged from 21 years old until 25 years old, 6 males and 6 females. Each of these genders consist of 3 people right-handed and 3 more using the left handed by neglecting other parameter such as height, weighted. Only focus on average handgrip pressure in Pascal. In addition, for this project, the uses of national cars which are Proton Saga and Perodua Myvi which both of them using standard steering wheel design and automatic transmission types was produced and shown the comparison results of analysis. Besides, to obtain the analysis results, Tekscan Hand Grip System's software and camera system such as Handycam Comcoder is used to record the results of experiments during the test drive. Lastly, the road is used for this experiment, was started from KM 92.1 traffic light junction, entering North South Highway, until Exit Toll Tangkak and use the same path return back to the FTK.

1.5 EXPECTED RESULT

At the end of this project, the expected results:

1. Ergonomics risk factor during driving is identified.
2. The pattern of gripping force data when handling a steering wheel by using Tekscan Hand Grip System has been studied.
3. The relationship between roads condition during driving with hand grip pressure between left handed and right handed drivers has been state

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

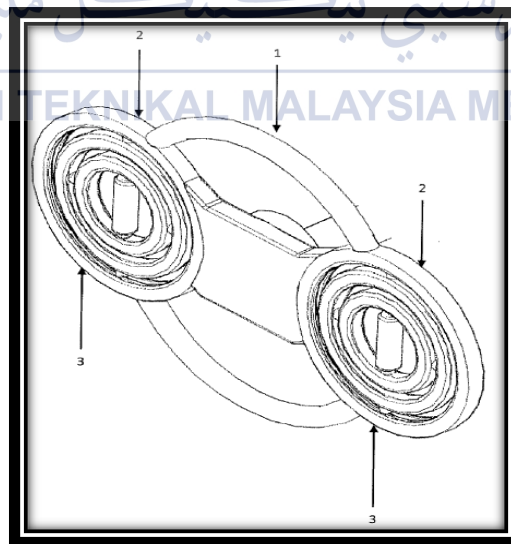
This research studies are about Tekscan Hand Grip System, steering wheel, ergonomics, Neuromusculoskeletal disorders, Musculoskeletal Disorders System (MSDs), Hands Arm Vibration Syndrome (HAVS), road conditions and hand grips. All the literature review based on sources from articles, books, journals, and also from the websites. The purpose of this chapter to obtain more details related to the case study.

2.2 STEERING WHEEL DESIGN (ERGONOMICS)

Usually, ergonomics steering wheel will consider the driver feel of handling, which is easier when arm muscle activity is low during steering wheel operation besides arm positioning and body pressure distribution have a very significant effect on arm muscle loads [1]. A part from that, ergonomic steering wheel design should allow the hands in relaxed position for better comfort. It promotes a neutral position of the forearm and reduces stress by discouraging fixed wrist positions flexion and ulnar deviation [2]. When driving fatigue, the driver is into the sleepy state with brain hypoxia [3]. With Anti-Fatigue Driving for Vehicles Based on Pattern Recognition, design of the steering wheel use technology which set transformer angular displacement sensor; embedded system and GPS module in it. Transformer angular displacement sensor is used when to collect the corner voltage changes of steering wheel. Next, to determine the driver fatigue, implementation pattern recognition by embedded system to waveform which consists of continuously varying voltage.

Besides that, for control algorithm periods of continuous driving time or stop the system also use changes of GPS data in order to determine state in vehicle such as action. Lastly, for the fatigue during driving system will provide early warning by combine these two parameters.

Another ergonomics features of steering wheel which is device for steering wheels of vehicles that also have a handle can be grasped by the user's hand for the steering wheel turns the the vehicle and where three predefined axes such as "X", "Y" and "Z" enable the ergonomic handle to be moved around. For this invention design, characteristics of ergonomics steering wheel such as, fixed ring has a polygonal shaped cross-section, fixed ring channel has a semicircular shaped, the first and second slidable connecting members of the first movable ring have the shape of a sphere and are slidably attached to the fixed ring channel which have a semi circular shaped cross-section, the first and second rotary connection means of the second movable ring comprise a bushing, material surrounding the elongated rod and lastly including striations having a shape that conforms to the fingers of the user's hand when grasping the elongated rod surrounded by said cover[4].



**Figure 2.1: Invention Ergonomics Steering Wheel
(Source: Google Patent US 7895918 B2)**

2.3 DRIVER FATIGUE/MUSCLE FATIGUE

One of the major causes of road traffic accidents is driver fatigue. Driving a common everyday tasks and the function of the shoulder in driving is to provide actuation to steering and thus injuries to this structure can not only inhibit function, but these injuries might also be exacerbated by the steering function. [5]. For most of the time spent driving, the driver is required to maneuver the steering wheel with kinematically constrained arm movements and repetition of such arm motions leads will to muscle fatigue or even to neuromuscular injuries [6]. The steering wheel design takes comfortable range motion of the wrist joint and allows natural twisting motion by added an extra degree of freedom to driver's steering motion in order to reduce driver's arm fatigue and discomfort.

2.4 MUSCULOSKELETAL DISORDERS

Musculoskeletal Disorders MSDs are formed gradually in people who have inappropriate position when working and These type disorders may cause muscular pains and skeleton damages in different parts of body such as waist, shoulders, arms and hands [7]. In addition, Musculoskeletal disorders (MSDs) are about safety and health issues for challenges and to avoid and treat this complicated disorders, understanding the objective causes and effects, economic impacts, and effective strategies is a must. Besides that, Musculoskeletal disorders (MSDs) also on matters such as injuries or disorders of the muscles, nerves, tendons, joints, cartilage, a disorders of the nerves, tendons, muscles and supporting structures of the upper and lower limbs, neck, and lower back [8]. All of these injuries are caused by sudden exertion to physical factors such as repetition, force, vibration or awkward posture. Musculoskeletal disorders (MSDs) injuries may be by the high magnitude of vibration and shock to which the driver are exposed [9]. In additional, the most frequently affected areas of the body are the arms. Driving as a profession involves routine muscular effort for example steering, awkward sitting postures, and exposure to whole-body vibration [10]. Symptoms of Musculoskeletal disorders (MSDs) often appear gradually as muscle fatigue or pain at work and disappears during rest an

examples of Musculoskeletal disorders (MSDs) symptoms including numbness, burning, pain, tingling and Cramping[11].

2.5 NEUROMUSCULOSKELETAL DISORDERS

The Neuromusculoskeletal Disorder is one which affects the system where the nervous, muscular and skeletal systems interlink with each other [12]. Peripheral nervous system is also including nerve-muscle (neuromuscular) junction, muscles, peripheral nerves in the limbs, and in the spinal cord; motor-nerve. Person with neuromuscular diseases can have weakness, loss of muscle bulk, muscle twitching, cramping, numbness, tingling, and a host of other symptoms [13]. This turns to impaired sensibility and limited dexterity. High level of disability and work impairment is due to fully developed neurological vibration damage, irreversible. Lastly, hand function is severely reduced at this stage.

2.6 HANDS ARM VIBRATION SYNDROME

Hand-Arm Vibration (HAV) is a condition caused by regular exposure to vibrating and percussive tools, or working with material in contact with grinding [14]. Between professional drivers of terrain vehicles and a referent group, 769 male professional drivers of forest machines, snowmobiles, snow groomers and reindeer herders and 296 randomly selected male referents completed a questionnaire about symptoms of Hand-Arm Vibration (HAVS) and musculoskeletal symptoms in the neck and the upper limbs [15]. The health effects of hand-arm vibration in the beginning it starts as a pain. The continuous of vibration exposure, may develop pain into an injury or disease [16]. Hand-Arm Vibration Syndrome (HAVS) usually report such as attacks of whitening which is blanching where of one or more fingers exposed to the cold, loss of sensation in the fingers and tingling, loss of light touch, cold sensations between periodic white finger attacks and pain, bone cysts in fingers, wrists and loss grip of strength.

2.7 RECENT HANDGRIP STUDIES ON STEERING WHEEL

Recently, several published studies have compared factors in hand grip force on car steering wheel [17]-[23]. These comparisons might be useful for those who are work related to the car's designer especially in designing steering wheel system to get an ergonomic design. This approach intends to help in shows the effect of non-ergonomics steering wheel during short or long term journey and way to overcome the issues. In addition, the studies are based on factors such as hand position, speed, road condition and handgrip pattern. In this method, there are few different ways to do the research. Some of them using equipment related to pressure and observations.

2.7.1 HANDGRIP POSITION

The main purpose of this study is about factors towards hand grip on steering wheel; driver hand position. Detailed study by Walton in 2007, he does the examines by observed the hand positions on steering wheel and the reported the hand positions on steering wheel of Sports Utility Vehicle (SUV) and car drivers. These original studies were based on field observations which is variation in hand position is found to be an effective, indirect measure of drivers' awareness towards risk. As awareness towards risk increases, he expected the drivers will be more likely to adopt a 10 o'clock and 2 o'clock hand positions to increase their control over the vehicle. Examining drivers' hand positions of driver's looks like the two hands on top half of the steering wheel will give most control over the vehicle. It has been confirmed by the distributed questionnaire. Meanwhile, in the recent study by Dick De Waard in 2010 showed that during the performance of a demanding task which is merging into motorway traffic, hand positions have been observed in the driving simulator. From his study, the whole steering wheel can be observed and there are 3 classified categories for hand positions on steering wheel which are high control, medium control, and low control. The changes in hand positions looks like to be associated with changes in workload demand but

differences in hand position between different traffic conditions were limited besides the hand position did not related with self-reported risk or self-reported mental effort. Therefore, from this study the finding shows information about mental workload also can be obtained from hand position.

Next, another research has been done by Bertil Jonssona in 2011 focusing specifically on hand position on steering wheel when driving and the differences towards hand positions between the genders. In his study, drivers on public road, their photos were taken at the same time registered the genders. The results of this study were during low-risk driving conditions, for males and females 55 percent and 64 percent respectively hand positions on the steering wheel with one or both hands by using 10 o'clock - 2 o'clock hand positions are common and symmetrically (left and right) hand positions at 9 o'clock - 3 o'clock. In addition, 6 percent and 12 percent for male and females describe the rare hand positions; 11 o'clock - 1 o'clock. From this research, it can be concluded that the results need further studies of hand positions on the steering wheel while naturalistic driving in traffic areas where rear-end impacts are frequent. It is due to the upper hand position might affect spinal posture and that influences neck injury risk in rear-end impacts will increased backset which is the distance between back of the head and the head restraint.

2.7.1 SPEED

Regarding for the next factors; speed, research by Schiro in 2013 highlights about low speed and hand positioning which there are significant differences as drivers attempt to steer through sharp turns. In addition, he also proposed a graphical method and lateral indicator to find out driver steering profiles by using different steering methods which being defined by tracking hand position. Besides that, tracking of hand positions on steering wheel from 23 volunteers and this steering exercise occurred in a simulator with no upper arm disabilities was undertaken with a motion capture system. Based on the results obtained, tracking of hand positions on steering shows that there are three distinct driver profiles with 52 percent hand-crossing, 30 percent non-

hand-crossing and lastly 17 percent for the asymmetric-hand-crossing. The findings of this research state that most of the volunteers frequently turns the steering wheel with one hand and crossed hands.

Case study by Schiro is also supported by author studies which reveal the same factor by Seri Rahayu in 2015. She provided 10 subjects consists of male and female drivers which need to grasp the steering using their hands and driving a vehicle on different road conditions such as straight road, hill road, winding road, rough and smooth road at constant speeds which is 80 km/h. The force measurement was taken and evaluated by using tactile grip and also pressure measurement known as Grip System. This system has grip sensor which enables the researcher to analyzed pressure and force felt by each finger, palm and thumb. For the overall results from these studies, it is shown that the left hand has a greater hand grip force compare to the right hand for both male and female drivers. Besides, the most hand grip pressure was produced indicated to the palm part of the hand instead of the other parts. The results obtained from this review shown below in table 1 and 2.

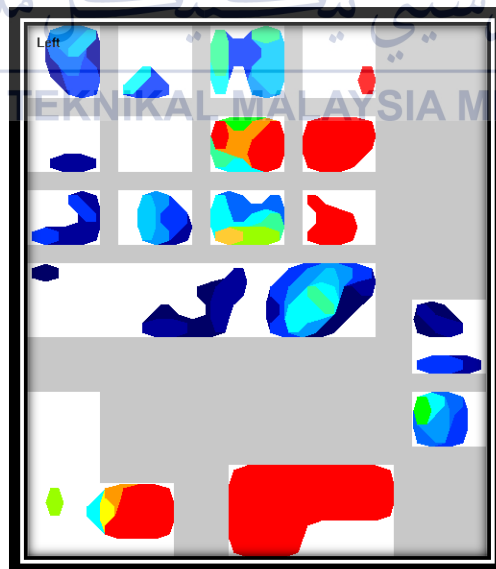


Figure 2.2: Three main parts of the hand; palm, thumb and fingers
(Source: www.tekscan.com)

Table 2.3: Hand grip force for both points

Part Time(sec)	Palm	Thumb	Fingers
14.78	5102.81 N	248.22 N	248.22 N
31.56	5813..63 N	167.51 N	193.53 N

Table 2.4: The summarization of the hand grip forces for the both points

Part Time(sec)	Palm	Thumb	Fingers
172.14	4532.89 N	197.59 N	197.52 N
177.28	4319.09 N	175.50 N	250.94 N

2.7.3 HANDGRIP PATTERN

In contrast to Chen, R.a in 2011, there is much less information about effects of factors by focusing on handgrip pattern. According to this paper, novel biometric authentication methods have been proposed for the recognition of drivers' dynamic handgrip on steering wheel. On a steering wheel, a pressure sensitive has been mounted to collect handgrip data of drivers who intend to start the vehicle and the possibility the ratio based on classifier is designed to differentiate rightful driver of a car after analyzed their inherent dynamic features of grasping. Based on this study, the experimental results obtained shows that for the trained subjects of participated have the value of mean acceptance rates, 85.4 percent meanwhile for the mean rejection rates have 82.65 percent after the classifier in two batches of testing for the un-trained ones are achieved. From this study, it can be concluded that, a promising biometric technology can produce verification of driver approach based on dynamic handgrip recognition on steering wheel and there will be further research in the near future for the smart car design.

2.7.4 ROAD CONDITION

On the other hand, in 2016, Seri Rahayu has done a research based on factor road condition. Previously study by Seri Rahayu in 2015, have been used the same road condition which is straight road, winding road and hill road and the same amount participated and type of genders; male and female but the main focus on that research is about constant speed (80 km/h). Contrastly, in these studies the objectives of this paper to obtained hand grip force and muscle fatigue while on the road without bothered about the speed. The force measurement and electromyography (EMG) responses were taken and evaluated by using the tactile grip and pressure measurement (Grip System) and Electromyography (EMG) device. From these studies, the result shows that the winding road produced more muscle fatigue and high hand grip pressure force compared than downhill road, hill up road, and straight road for both male and female subjects. In addition, the comparison of results muscle fatigue and hand grip pressure force between the first 15 minutes and last 15 minutes of driving activity have been made. For the last 15 minutes the muscle fatigue increasingly high compared to first 15 minutes. However, the hand grip pressure forces become high during the winding road for first 15 minutes of driving session. The muscle fatigue become high as the hand grip pressure force value is high. Furthermore, the male drivers exert higher hand grip pressure force and higher muscle fatigue compared to female drivers. For the table 3 until 6, it shows the result which has been obtained from this studies.

Table 2.4: Average EMG responses and hand grip pressure force for male subject:

Road condition	Muscle Fatigue	Grip Force (Right)	Grip Force (Left)
Straight	73.85	297.72 N	4140.37 N
Winding	935.25	330.36 N	4950.49 N
Uphill	75.48	263.63 N	4327.39 N
Downhill	573.93	314.37 N	4588.48 N

Table 2.5: Average EMG responses and hand grip pressure force for female subject:

Road condition	Muscle Fatigue	Grip Force (Right)	Grip Force (Left)
Straight	89.10	79.20	2330.90
Winding	355.53	105.85	2998.84
Uphill	108.88	82.63	2394.11
Downhill	260.68	75.24	2252.55

Table 2.6: Average EMG responses and hand grip pressure force of last 15 minutes for male subject:

Road condition	Muscle Fatigue	Grip Force (Right)	Grip Force (Left)
Straight	208.60	277.91	4125.21
Winding	1035.20	839.78	4799.63
Uphill	645.60	344.99	4729.47
Downhill	650.70	333.00	4751.17

Table 2.7: Average EMG responses and hand grip pressure force of last 15 minutes for female subject:

Road condition	Muscle Fatigue	Grip Force (Right)	Grip Force (Left)
Straight	164.60	78.14	2171.04
Winding	520.20	108.83	2758.18
Uphill	360.00	71.43	2639.11
Downhill	392.00	89.58	2705.60

Surprisingly, hand grip force on steering wheel has still not been scientifically studied focus on Malaysian national cars such as Proton and Produa. The main purpose to do this review, to gain better understanding and explore the influence of factors in the findings of these case studies related handgrip effect on steering wheels. For this purpose, a drive test among left and right handed of female and male volunteers have been choose to get the analysis results of hand grip pressure. The contribution of these studies as the resulting outcomes which can capitalized as guidelines to help more outlines the problem that need to be solved for the future research.

2.8 TEKSCAN HANDGRIP SYSTEM

Most attempts to measure forces developed by the human hand have been implemented by placing force sensors on the object of interaction [24]. Tools to measure and evaluate the static, dynamic pressures gripping and grasping the objects are provided by Tekscan's Grip Pressure Measurement System. Tekscan patented, paper thin within 0.1mm, flexible sensors are minimally intrusive and have fast scanning rates, which means difficult gripping application such as vibration and transients from power tools can easily be measured [25]. Besides that, these sensors is used to help examine grip pressure and vibration transmission to design a more ergonomic product, assisted in designing easier to handle products for the elderly and physically disabled and analyzed carpal tunnel syndrome and it can be used on a hand or glove plus, can instrument both left and right hands.

In addition, grip systems have a high resolution, thin and the sensor directly can be used on hands or installed it to the glove. Each of the sensor have eighteen sensing regions which is at the section of fingers and palm, it can individually have positioned over an important anatomic of it. To allow the joints to be avoided, move freely, and not interfere with grip measurement, this is where the function of gaps between the sensing areas are needed. Besides that, for the pressure points on handoff localized identification, the uses of sensing region that have multiple sensing elements which is sensels is needed.

Furthermore, Tekscan Handgrip Syatem's software display the real-time and recorded data in 2-Dimension and 3-Dimension displays and it can also capture dynamic pressure data. This software is able to Play-back pressure movies and display the data frame by frame, single and / or multi-frame. Pressure, force and area, the data can be shown when there is the graph and analyze real time or stored data. Besides that, Tekscan Hand Grip System use ASCII format to the export data, it can also isolate and analyze specific areas. Lastly, this software capable to enable the multiple tests simultaneously can be view and compare and the center of force and its trajectory can be display.

For the grip system applications in sports application, the usages such as for baseball bat, golf club, tennis racket etc. In addition, this system also can be used for ergonomics such as vibration studies, carpal tunnel syndrome and heavy lifting besides it is use for robotics and to improve the product design.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter is about an explanation and information of the research methodology based on this project. The main objective of this project does the comparison among left and right handed person in term of hand grip pressure between Proton Saga and Produa Myvi. Both of the cars are using standard steering wheel, standard model, and automatic transmission types. The results of comparison are gain from data analysis by using equipment of Tekscan Hand Grip System during the test drive by the 12 volunteers along the way road selection.

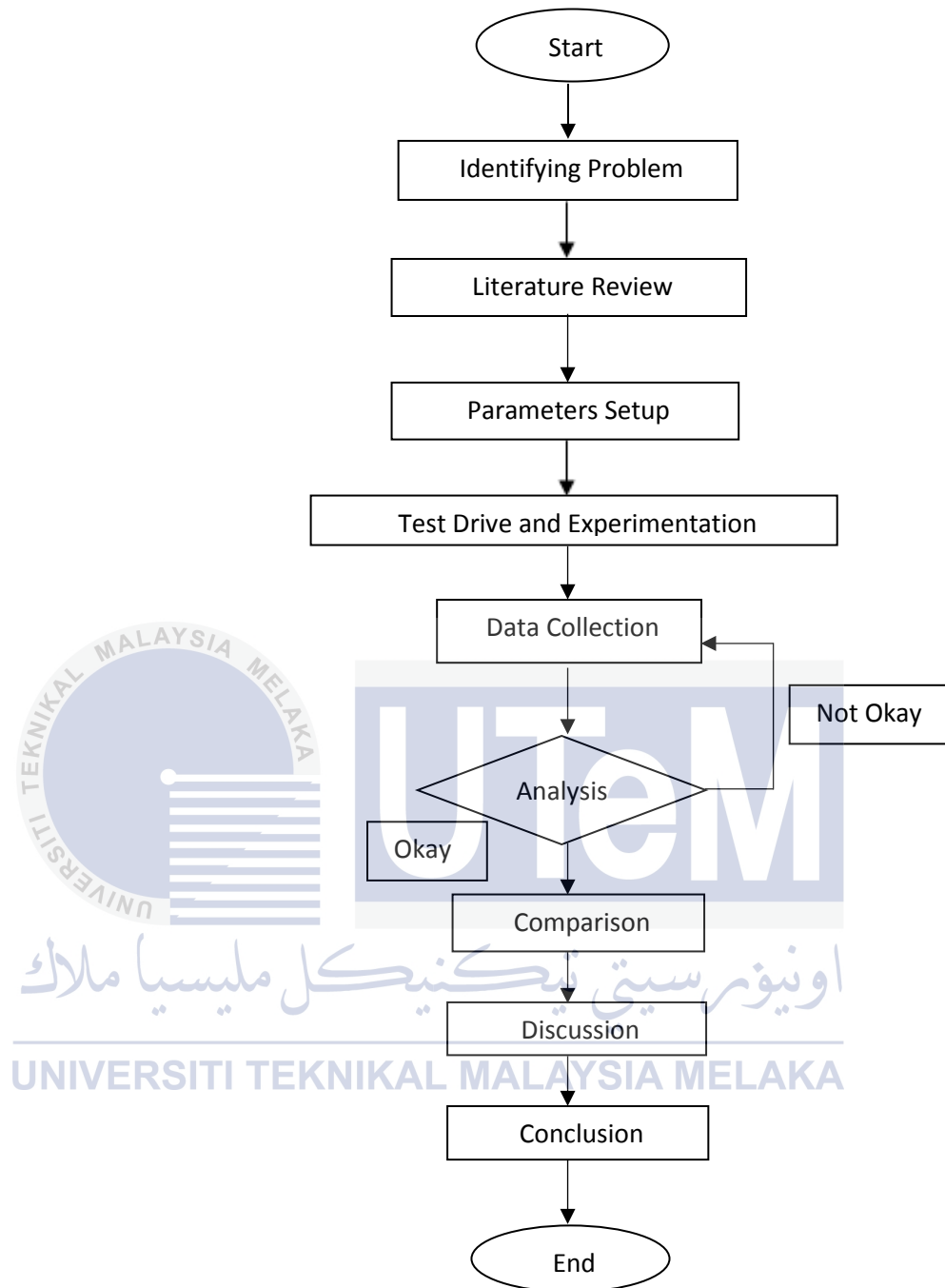


Figure 3.1: Flowchart

3.2 IDENTIFYING THE STEERING WHEEL

For this project, two types of steering wheel are used which; Proton Saga and Perodua Myvi. Both of the cars are using standard steering wheel design. The purpose of using same type of steering wheel is to determine which one have more ergonomic features steering wheel based on readings of handgrip pressure's results. The figure below show types of Proton and Produa's steering wheel.



اونيورسيتي تېكنيكل مليسيا ملاك
Dimension Steering Wheel of Proton Saga:

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Width (Outer): 14.0 inch

Width (Inner): 12.2 inch

Circumference: 4.2 inch

Figure 3.2: Steering Wheel Proton Saga
(Source: <http://paultan.org/2008/01/18/proton-saga-test-drive-report/>)



Dimension Steering Wheel of Produa Myvi:

Width (outer): 14.6 inch

Width (inner): 12.6 inch

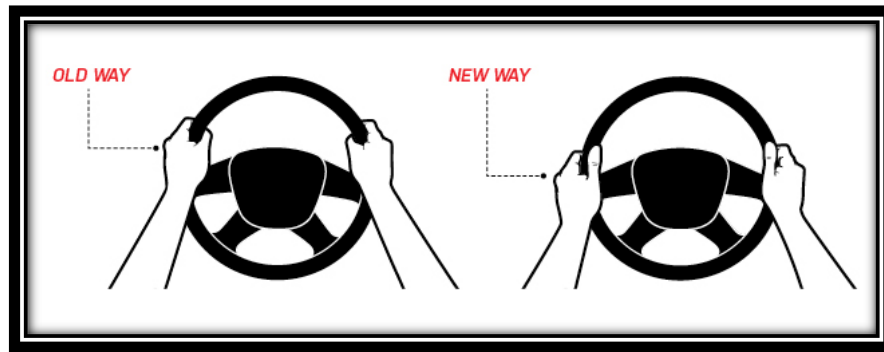
Circumference: 4.0 inch

Figure 3.3: Steering Wheel Proton Myvi

(Source: <http://paultan.org/2008/10/10/2008-perodua-myvi-se-full-details-and-prices/>)

3.3 IDENTIFYING A STEERING WHEEL POSITION

For this experimental study, during test drive the best and safe option for the volunteers put their hand position on the steering wheel, they have been used new way which is 9 and 3 o'clock positions. The purpose of using this hand position instead of 10 and 2 o'clock is because of if an accident happens, the force of airbag deployment can cause the hands at the top of the wheel into driver's head or it can cause the break thumbs. The figure 10 and 2 o'clock and the 9 and 3 o'clock hand position shown as below.



**Figure 3.4: Left: 10 o'clock and 2 o'clock hand positions
Right: 9 o'clock and 3 o'clock hand positions**

(Sources: <http://www.popularmechanics.com/cars>)

3.4 GRIP FORCE MEASUREMENT AND CAMERA SYSTEM

In this experimental study, to obtain accurate pressure measurements, equipment Handgrip Tekscan Pressure System is used during the test drive by volunteers. First of all, the calibration process must be carried out. Calibration is a method of sensor convert to actual pressure units such as PSI or kPA by the raw digital output. The procedures of the calibration require that a known weight be placed on the sensels. Each sensor must be calibrated individually and the calibration must be performed before each new patient session and whenever a new sensor is used.

Next, after the calibration for all the volunteers is save in laptop, the data is used during the test drive meanwhile the sensors are attached to the both of volunteer's hand which connected to the laptop to display the reading of handgrip pressure. This Tekscan Hand Grip System can be individually positioned over important anatomic sections of the fingers and palm which have eighteen sensing regions. During the test drive, the function of this sensor to collect the dynamic pressure data while grip the steering wheel.

For these experimental studies, the sensor is attached to the glove and the driver will wear it during the test driving. The figure below shows the sensor is installed to the glove and how the driver grips the steering wheel while using this equipment.



Figure 3.5: Eighteen sensors are attach to the glove
(Source: www.tekscan.com)



Figure 3.6: While driving using Tekscan Hand Grip System
(Source: www.tekscan.com)

The Cuffs which is known as VersaTek, is a connection to the sensor which is specially designed scanning electronics. The function of it to collect data and the data is

processed and send it to the computer through the USB connection. Besides that, it is also having the ability to add in shoe, prosthetic, grip and seating and positioning capabilities to Tekscan Hand Grip System.



Figure 3.7: Tethered model
(Source: www.tekscan.com)

In the figure below it shows that how the system was set up. During the test drive, the connection between the system and power supply is needed to make it function.

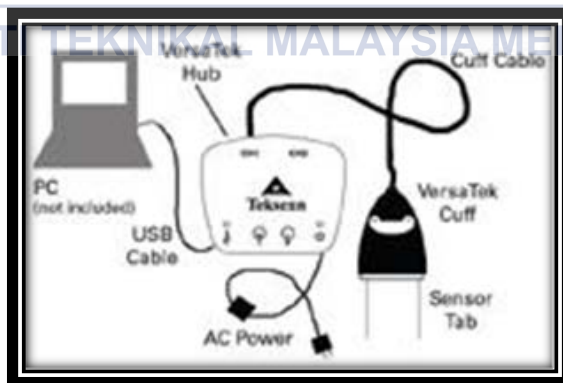


Figure 3.8: Tethered system
(Source: www.tekscan.com)

While handgrip pressure is collected, at the same time the camera system (Handycam Camcorder) has been held without tripod to record the state of hands gripping on the steering wheel as the condition of the road and also driver's hand positions. All of this situation can affect the results of handgrip pressure.



Figure 3.8: While driving record by Handycam Camcorder
(Source: www.sony.com)

3.5 ROAD SELECTION

For this experimental study, the road selection was started from KM 92.1 traffic light junction, entering North South Highway, and is ended at the Exit of Toll Tangkak. During the test drive, all volunteers have to maintain the speed of car in range 80km/h until 100km/h. Besides, most of the time they have to drive in left lane unless to overtaking other vehicles. The purpose of choosing 80km/h until 100km/h is because of to standardize the speed of car among the volunteers because it will affect the results if the speed fluxes. Besides that, distance from the beginning until the end is about 68.8km and will take about 30 minutes. The reason why road selection is used North South Highway is because to ease all the volunteer to avoid the traffic light. Besides that, the usage auto transmission type of both cars has been chosen to reduce the hand movements, to change the gear which will be installed Tekscan Handgrip System on both sides hands of all the volunteer. The uses of these type of cars are also to get more accurate reading of the pressure with the hands more focus on hand grip on the steering wheel. The google maps below show the road selection for this experimental study.

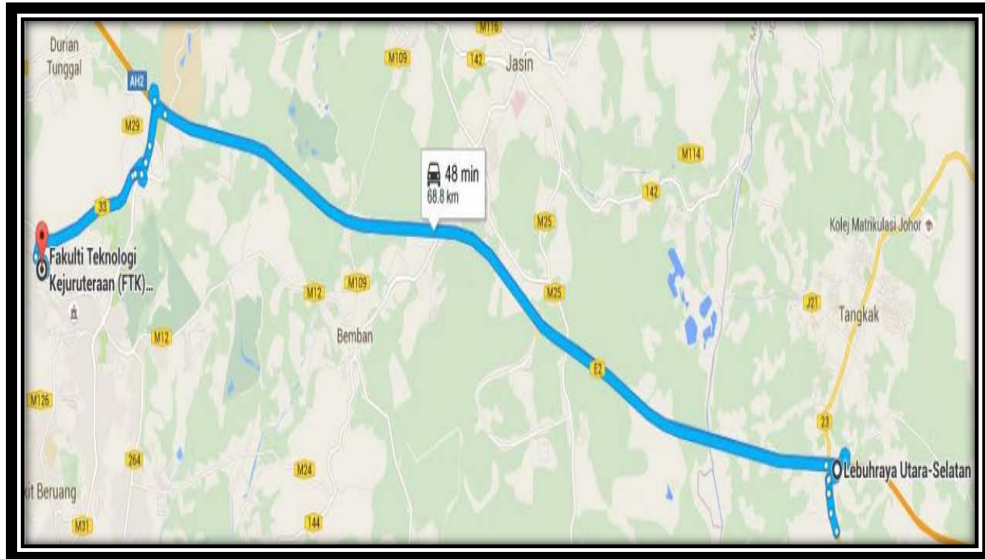


Figure 3.9: Journey of road selection
(Source: Google Maps)

3.6 PARTICIPANTS

To ensure the success of this experimental studies, 12 volunteer of students from Faculty of Technology of Engineering (FTK), were selected. 6 of them are male and the rest were female. Due to the work scope of this case studies more focused on the comparison between handgrip pressure of left and right handed driver, hence each 6 of gender consist of 3 left handed users and 3 others are right-handed users.

3.7 SURVEY / QUESTIONNAIRE

Apart from the test drive among the volunteers, questionnaire was distributed to 20 students of FTK including the volunteers. The purpose of this questionnaire, to find out the methods they have used while drive a vehicle.

3.8 RESULTS ARRANGEMENT

Based on this experimental study, the result obtained is compared between Proton Saga and Perodua Myvi. Besides, the result of handgrip pressure was showed which of these cars have steering that is more ergonomic and convenient for long journey. Other than that, it can help to prevent driver fatigue occurs against the driver.



CHAPTER 4

RESULT & DISCUSSION

In this chapter discusses about data collection of pressure against time between Proton Saga and Perodua Myvi. The collected data was measured by using Tekscan Handgrip System and at the same time the whole journey during the driving was recorded by using handycam camcorder to obtain the relationship between hand movements of left handed and right handed of volunteers and road condition. This chapter aims to elaborate more data collected for 12 respondents and feedback of questionnaire that had been distributed to FTK students. The objectives of this chapter, should match with the methodology and results in order to achieve the requirement of project. End of this chapter, the results both of the car is compared.

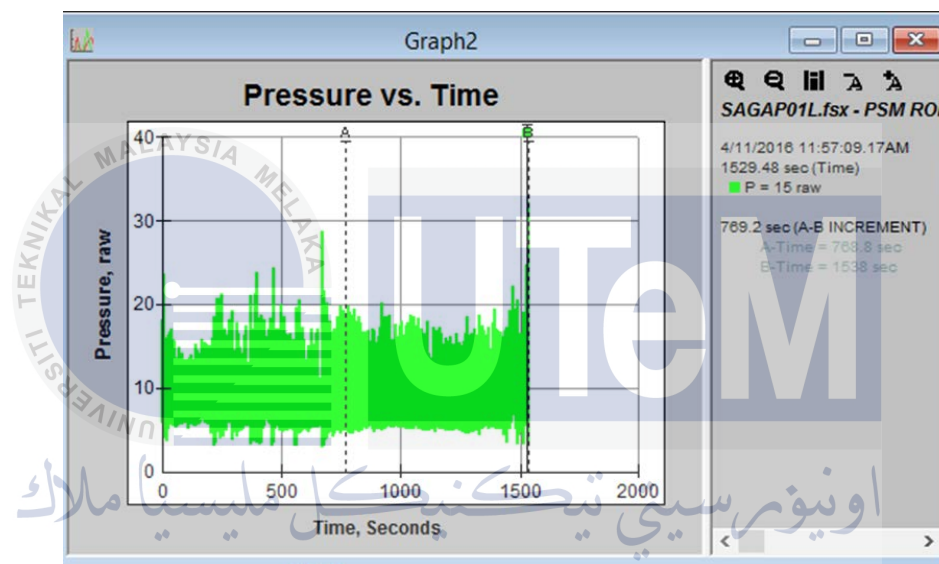
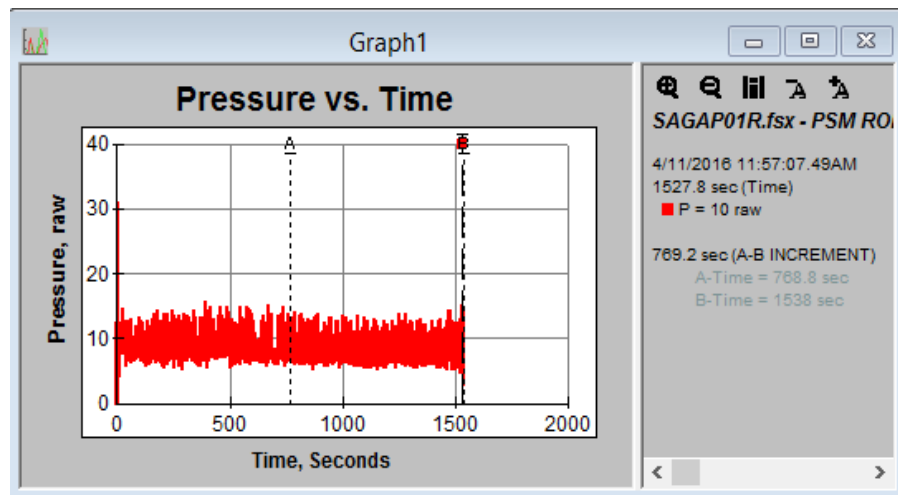
4.1 PRESSURE AGAINTS TIME RESULT

4.1.1 MALE RESULTS

4.1.1.1 RIGHT HANDED

(a) First Respondent

(i) Proton Saga



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Figure 4.1: Graph of pressure against time of Proton Saga for first male respondent

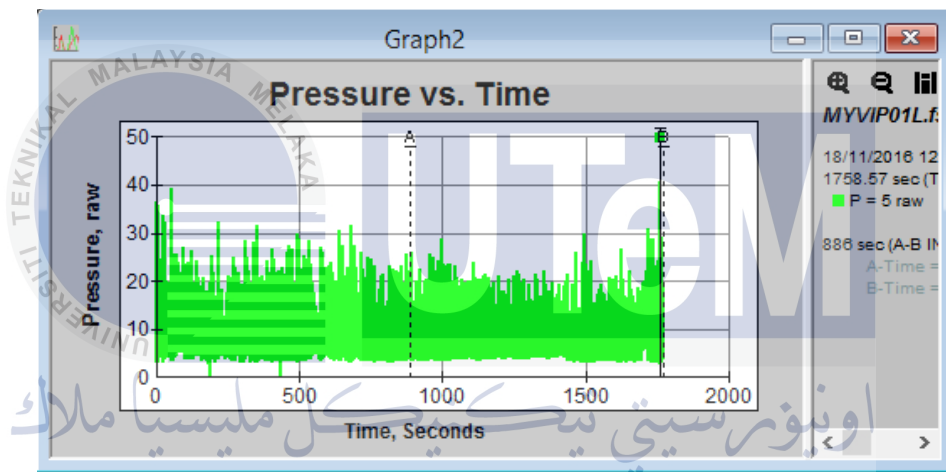
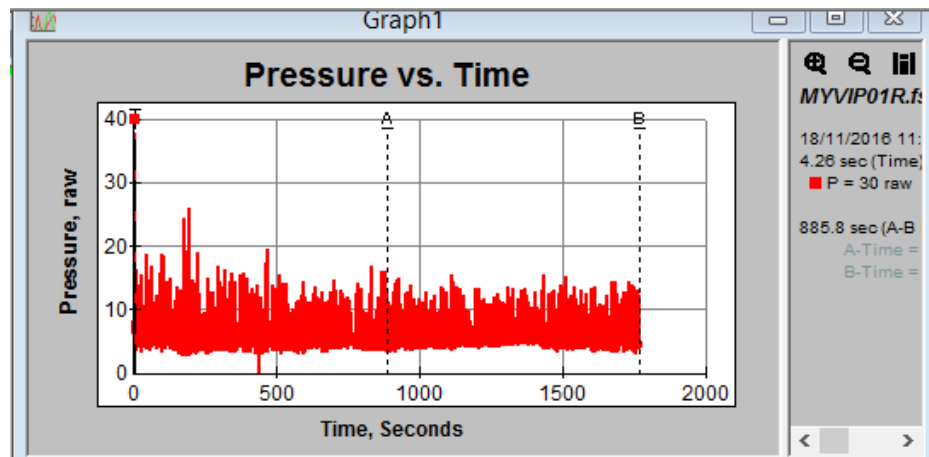


Figure 4.2: The car was steered to the left at the end of the highway



Figure 4.3: The car was crossed the road-bridge boarder

(ii) Produa Myvi



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Figure 4.4: Graph of pressure against time of Perodua Myvi for first male respondent



Figure 4.5: There is a trailer at the right lane when driver attempt to overtake a trailer at the left lane



Figure 4.6: There was a hilly road

Based on Figure 4.1 for the Proton Saga and Figure 4.3 for Perodua Myvi, it shows that both of the graph have the higher pressure towards right hand. Since this male driver is a right handed person, he was produce a correct data collected referring to the strength that he have which is to steer and handle the steering wheel.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	10	15
Perodua Myvi	30	5

Table 4.1 Comparison Pressure Between Proton Saga and Perodua Myvi

(b) Second Respondent

(i) Proton Saga

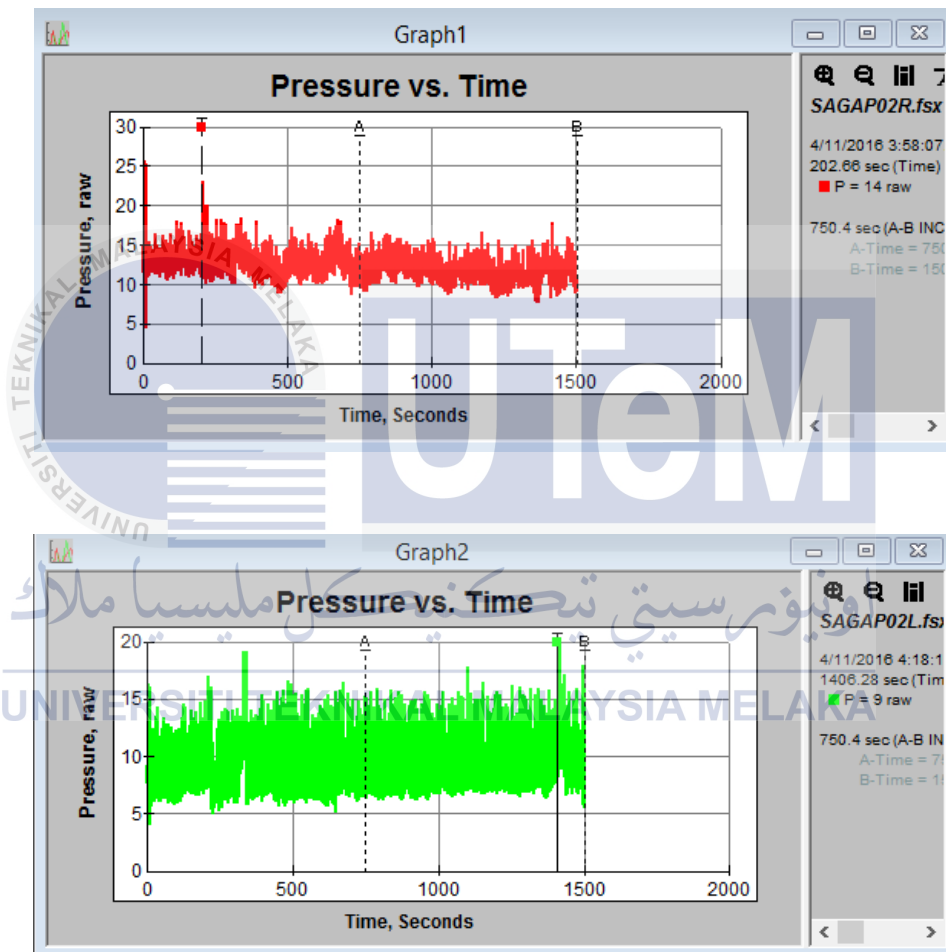


Figure 4.7: Graph of pressure against time of Proton Saga for second male respondent



Figure 4.8: The road condition was bumpy



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Figure 4.9: Driver steered to right at KM 92.1 traffic light junction

(ii) Perodua Myvi

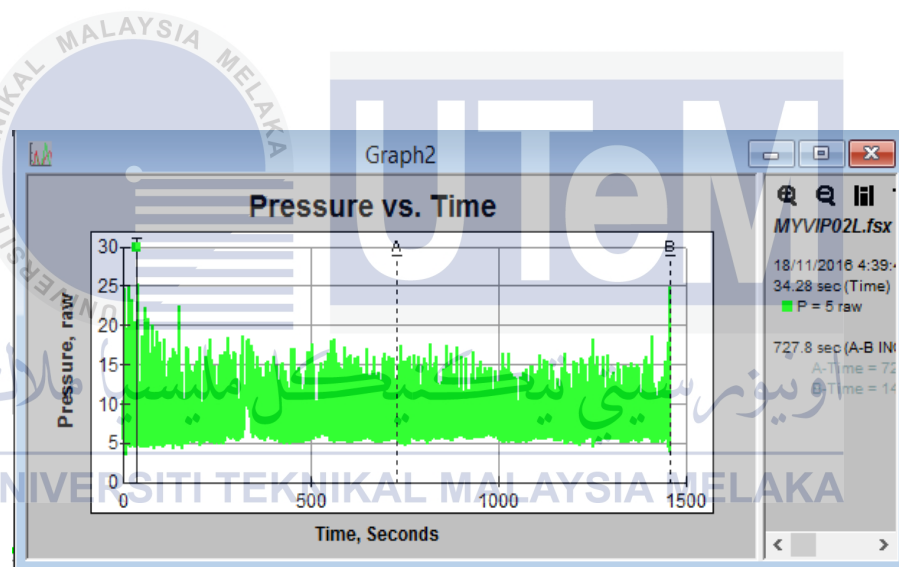
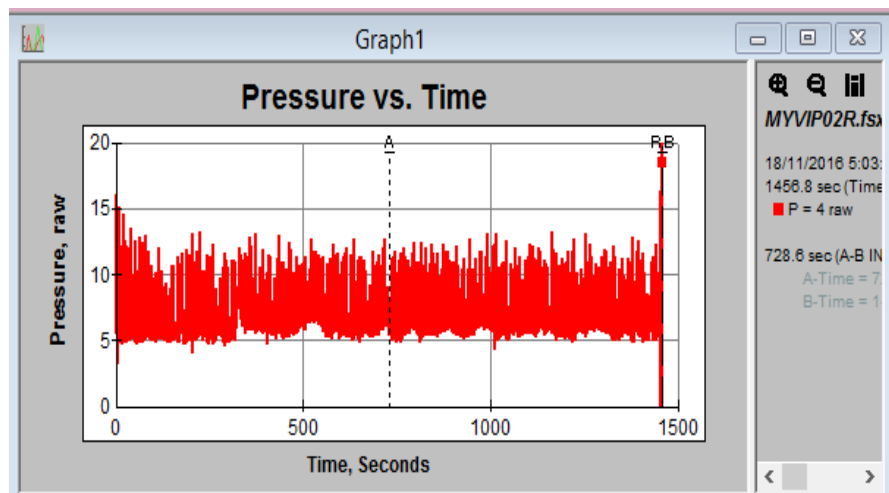


Figure 4.10: Graph of pressure against time of Perodua Myvi for second male respondent



Figure 4.11: The driver attempt to overtake a lorry

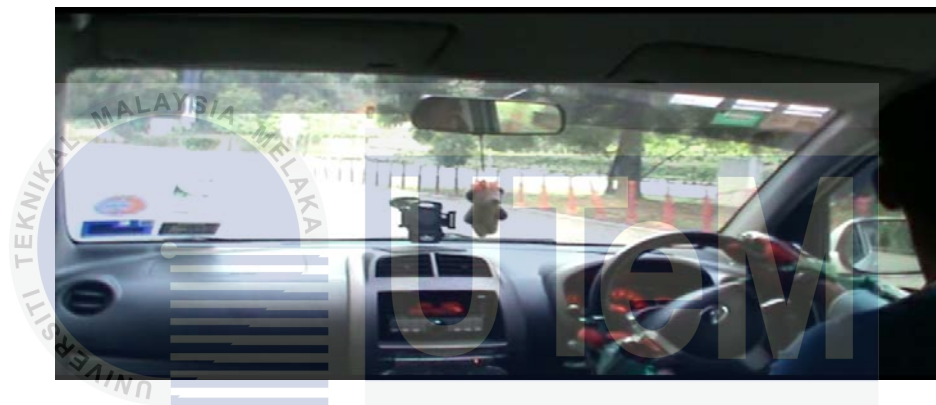


Figure 4.12: Driver steered to left at the end of Highway SPA

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Based on the Figure 4.7 for the Proton Saga and Figure 4.10 for Perodua Myvi, shows that only Proton Saga produce high pressure of the right hand. This male driver should get high pressure of right hand for both of the data collected since he is a right handed person. But, by referring to the Figure 4.11 it shows that he steered to the left to overtake a lorry. However, this thing might be because of he already feels tired and face the fatigue. Therefore, he just grips the steering by using right hand effortless.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	14	9
Perodua Myvi	4	5

Table 4.2 Comparison Pressure Between Proton Saga and Perodua Myvi

(c) Third Respondent

(i) Proton Saga

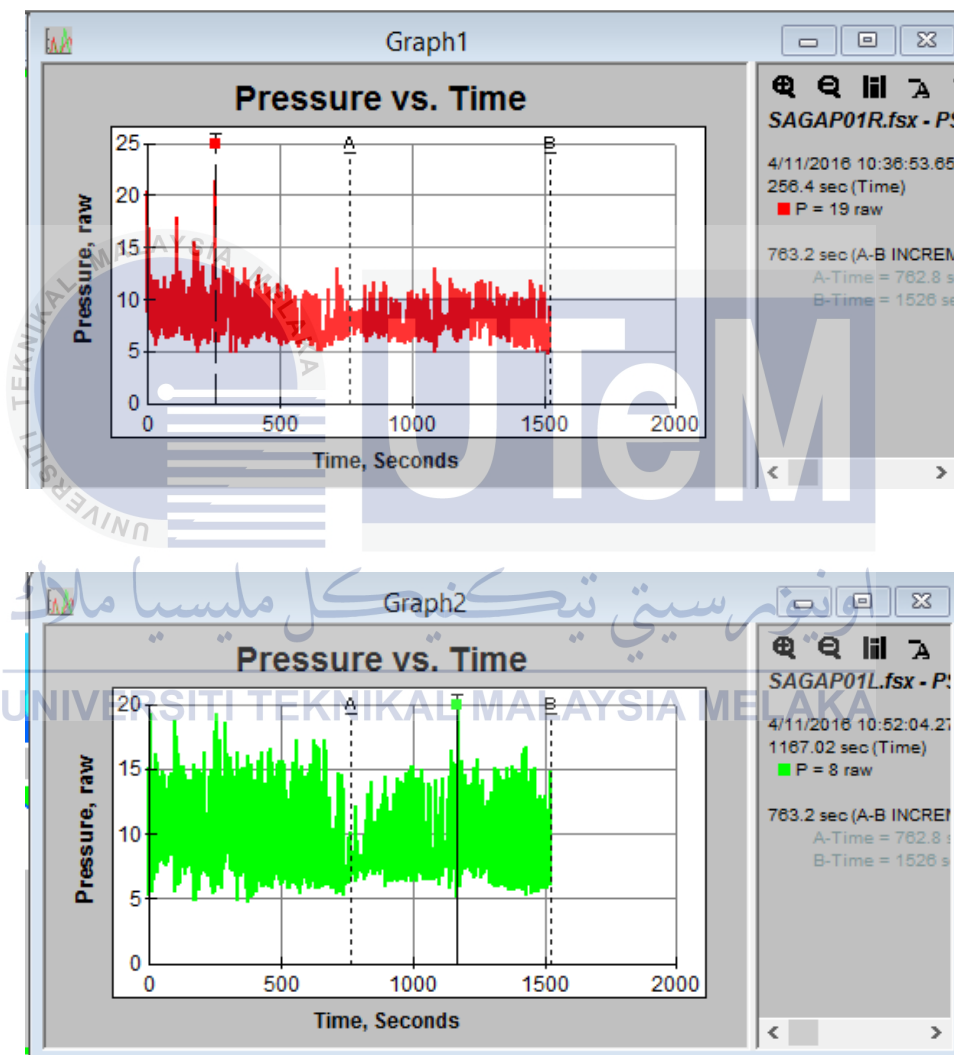


Figure 4.13: Graph of pressure against time of Proton Saga for third male respondent



Figure 4.14: A lorry overtake driver's car



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Figure 4.15: Driver steered to the right near to the Exit Tangkak

(ii) Perodua Myvi

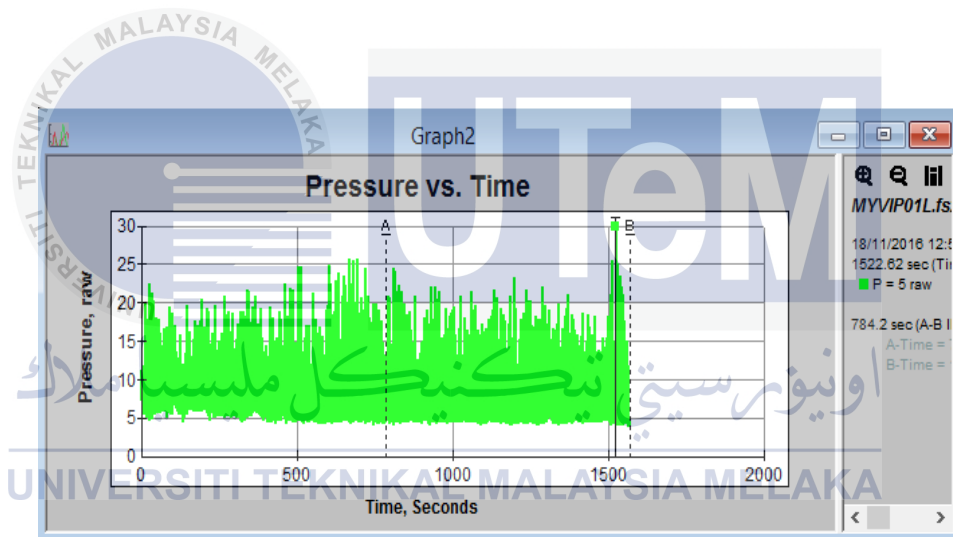
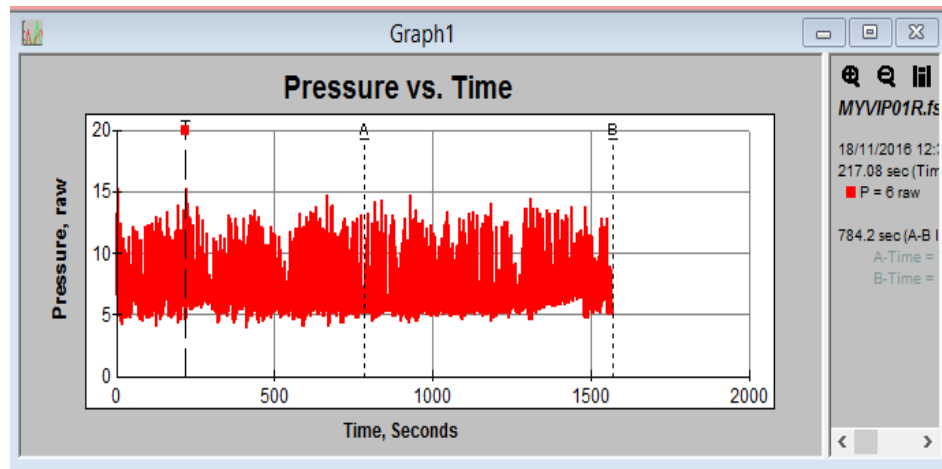


Figure 4.16: Graph of pressure against time of Perodua Myvi for third male respondent



Figure 4.17: Driver try to be careful behind oil truck at the beginning of highway



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Figure 4.18: There was a hilly road

Based on the graph 4.13 for Proton Saga and 4.16 for Perodua Myvi, as a right handed, the driver is achieved the objective which is to compare pressure between left and right handed. The graph shows that, both of these cars have highest pressure for the right hand compare to the left hand's pressure. Figure 4.17 and 4.18 it is an evidence while video recording is taken to support the collected data.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	19	8
Perodua Myvi	6	5

Table 4.3 Comparison Pressure Between Proton Saga and Perodua Myvi

4.1.1.2 LEFT HANDED

(d) First Respondent

(i) Proton Saga

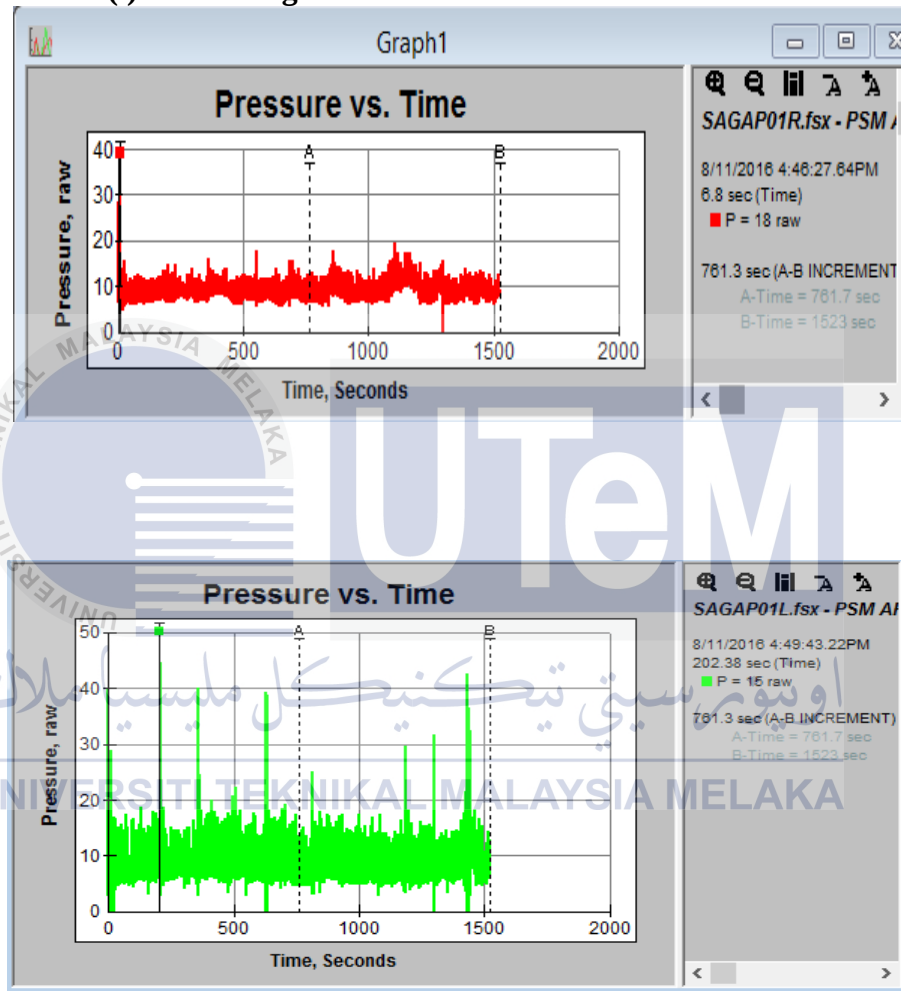


Figure 4.19: Graph of pressure against time of Proton Saga for first male respondent



Figure 4.20: A lot of cars at right lane



Figure 4.21: The car was crossed the road-bridge boarder

(ii) Perodua Myvi

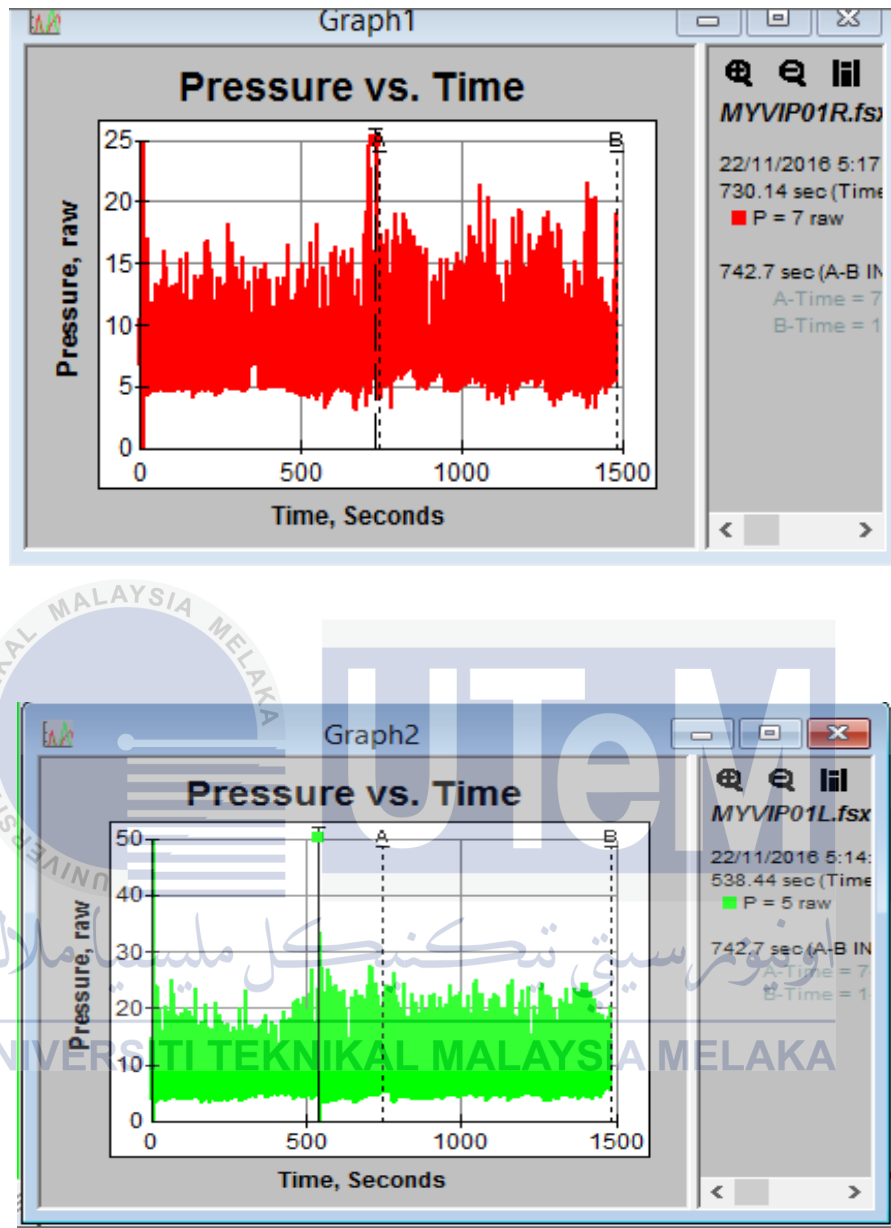


Figure 4.22: Graph of pressure against time of Perodua Myvi for first male respondent



Figure 4.23: Driver steered to the right



Figure 4.24: Driver attempt to overtake a lorry and there is a car at the front

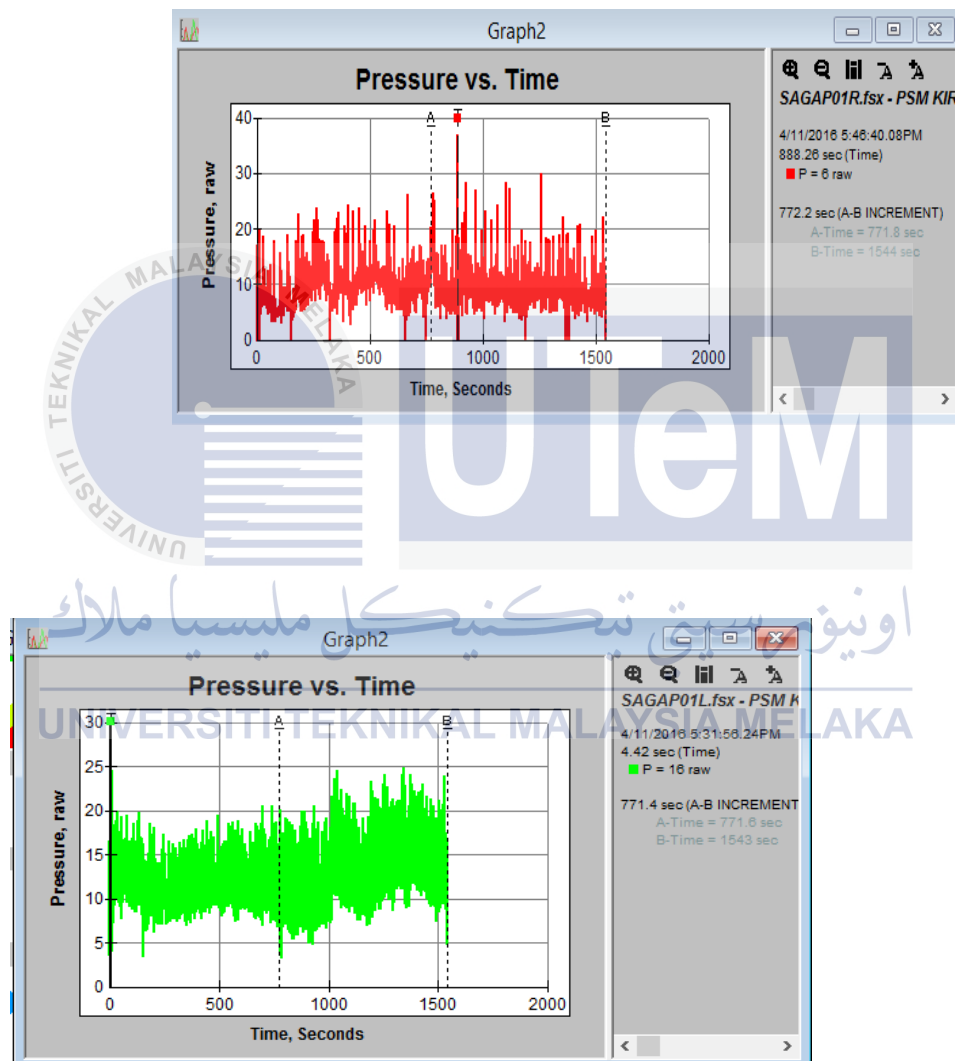
Based on the Figure 4.19 for the Proton Saga and 4.22 for the Perodua Myvi, even though this male's driver is a left-handed person, but both of the results shows in that he produces highest pressure on right hand compare to left hand. This might happen due to the road condition, especially for the Perodua Myvi, in Figure 4.23 ; when the highest right hand's pressure he was at the corner of the highway, steered to the left which used more energy from right hand.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	18	15
Perodua Myvi	7	5

Table 4.4 Comparison Pressure Between Proton Saga and Perodua Myvi

(e) Second Respondent

(i) Proton Saga



Figure

4.25: Graph of pressure against time of proton Saga for second male respondent



Figure 4.26: Driver steered to the right at the end of Highway SPA



Figure 4.27: Driver attempt to overtake 2 lorries

(ii) Perodua Myvi

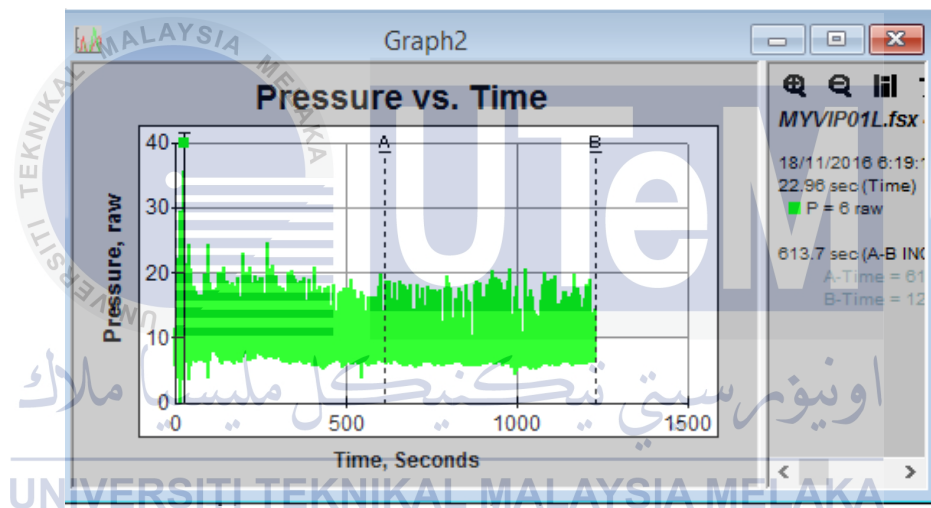
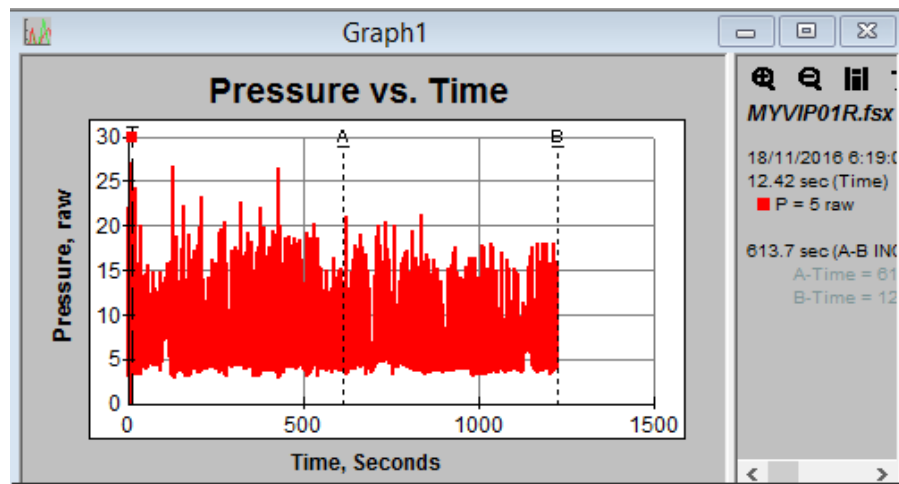


Figure 4.28: Graph of pressure against time of Perodua Myvi for second male respondent



Figure 4.29: Speeding cars at right lane



Figure 4.30: There was a hilly road

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Based on Figure 4.25 for the Proton Saga, and Figure 4.28 the Perodua Myvi shows that both of the graph have highest pressure on left hand. This can happen due to the male driver is a left-handed person. Video recorded in Figure 4.26, Figure 4.27, Figure 4.29 and Figure 4.30 is all the evidence situation of this male driver that he had face using his strength to grip the steering wheel from left hand.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	6	16
Perodua Myvi	5	6

Table 4.5 Comparison Pressure Between Proton Saga and Perodua Myvi

(f) Third Respondent

(i) Proton Saga

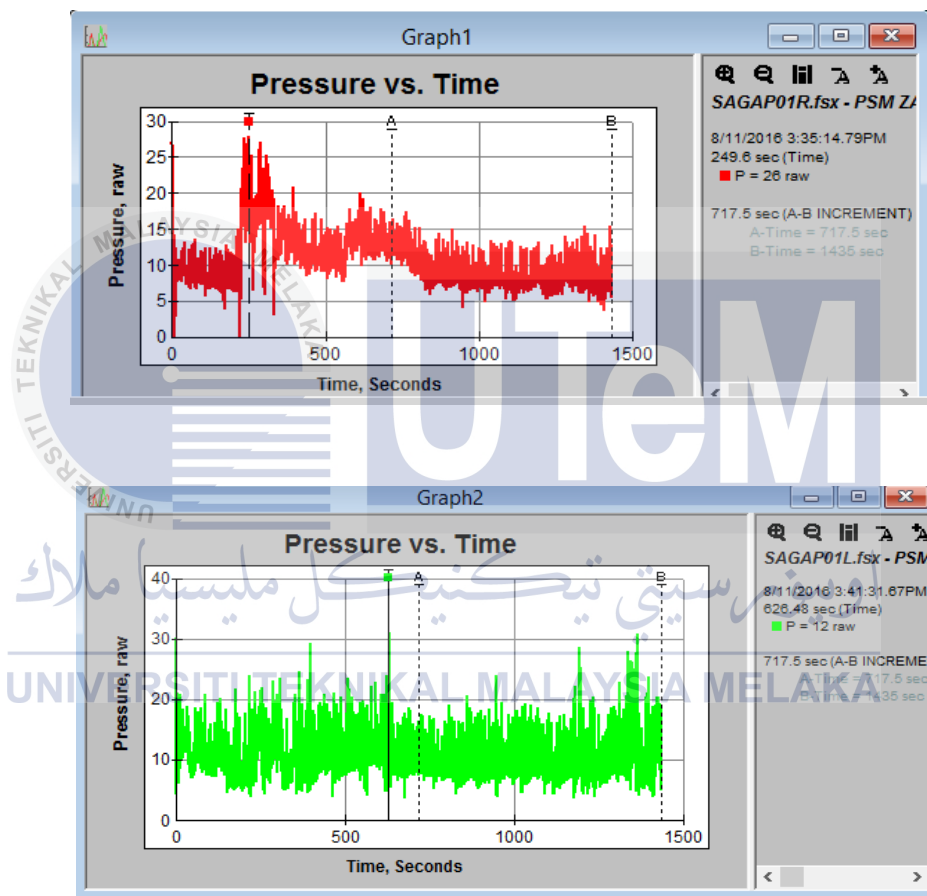


Figure 4.31: Graph of pressure against time of proton Saga for third male respondent



Figure 4.32: Driver steered to the right at the end of highway



Figure 4.33: Driver steered to the right at the KM 92.1 traffic light junction

(ii) Perodua Myvi

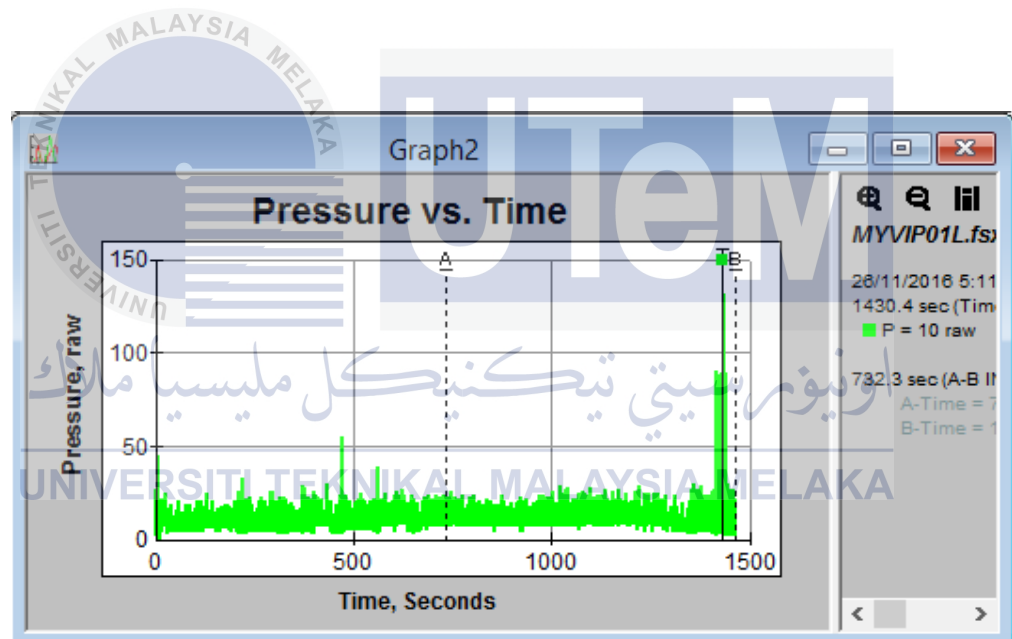
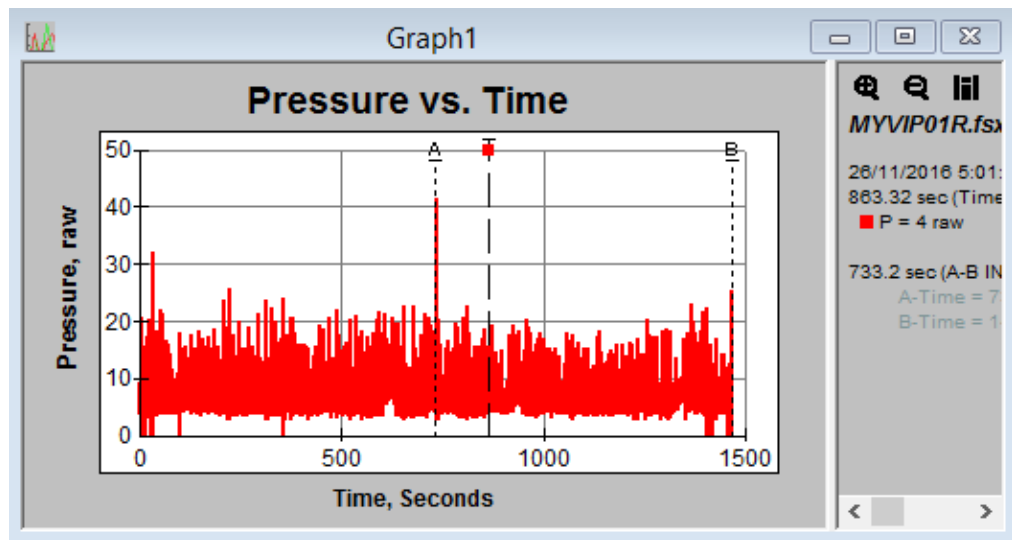


Figure 4.34: Graph of pressure against time of Perodua Myvi for third male respondent



Figure 4.35: Speeding car at the right lane



Figure 4.36: Right lane and front of driver's car have lorry and a car

Based on the Figure 4.31 for the Proton Saga and Figure 4.34, this male respondent also have collected data that shows both of the graph have highest value of pressure for the left hand. Frequently, this respondent might be only have been used his left hand to do the works instead of shifted with the right hand. Therefore, while driving he is also apply the same thing while gripping the steering wheel.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	26	4
Perodua Myvi	12	10

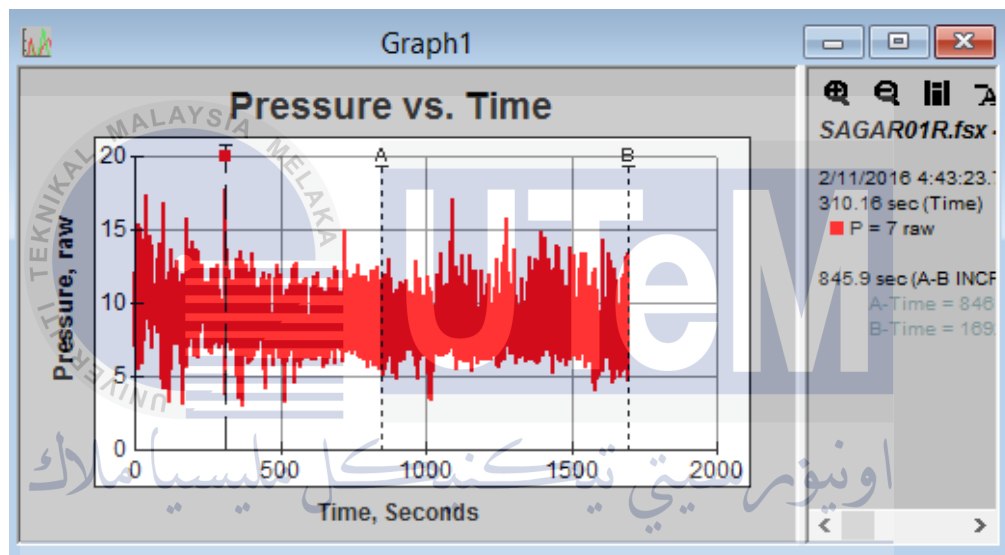
Table 4.6 Comparison Pressure Between Proton Saga and Perodua Myvi

4.1.2 FEMALE RESULTS

4.1.2.1 RIGHT HANDED

(a) First Respondent

(i) Proton Saga



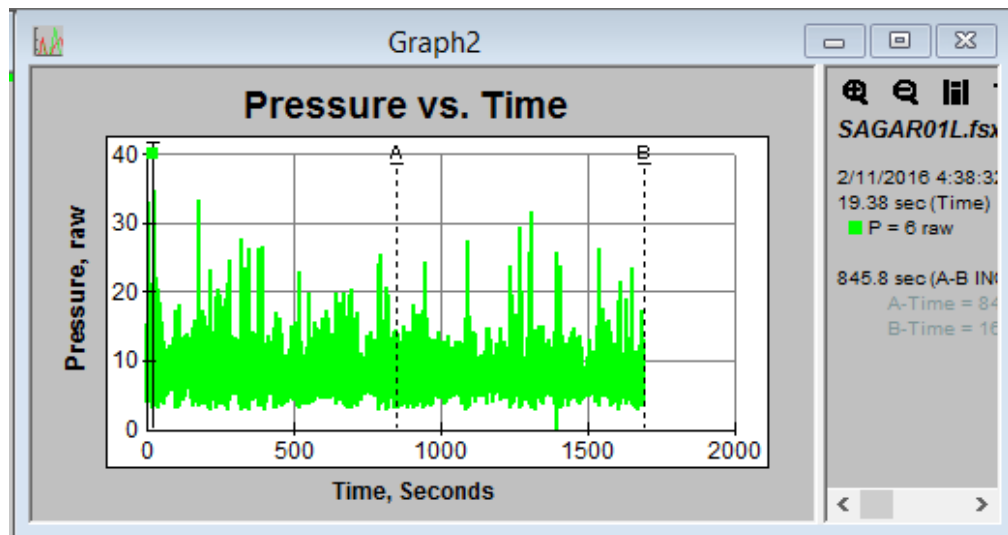


Figure 4.37: Graph of pressure against time of Proton Saga for first female respondent

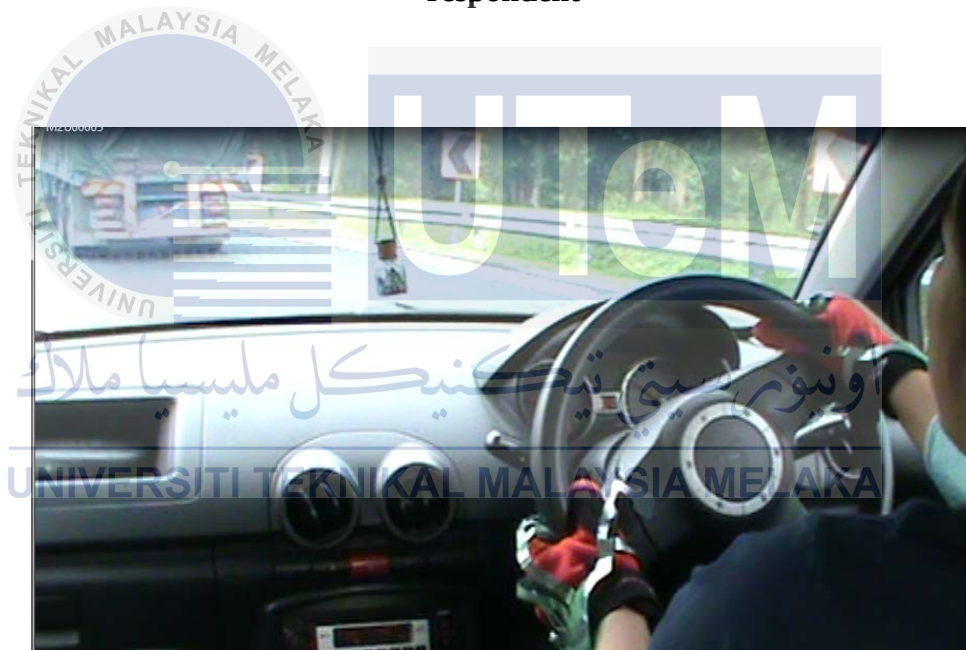
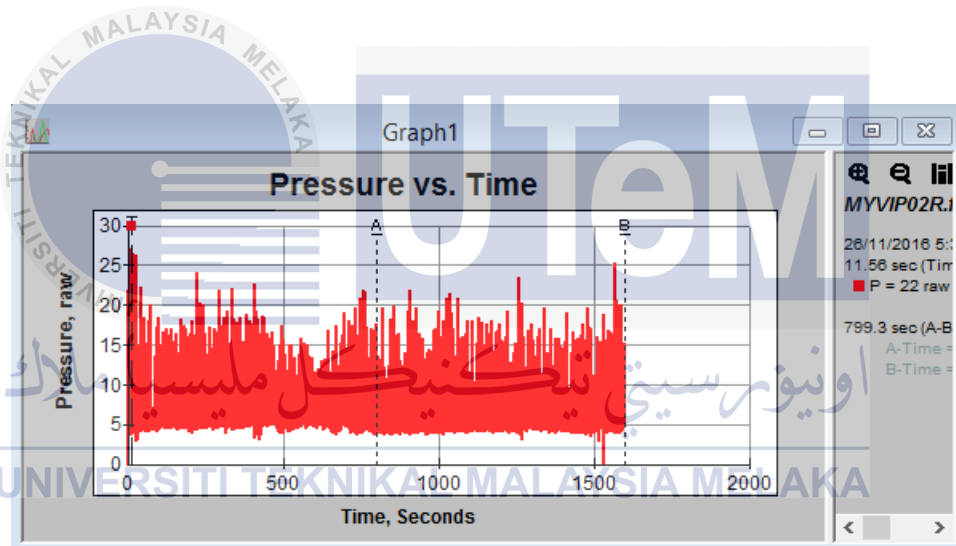


Figure 4.38: Driver steered to the right at the end of highway and there was a trailer at front



Figure 4.39: Construction, narrow road and a car at the right side

(ii) Produa Myvi



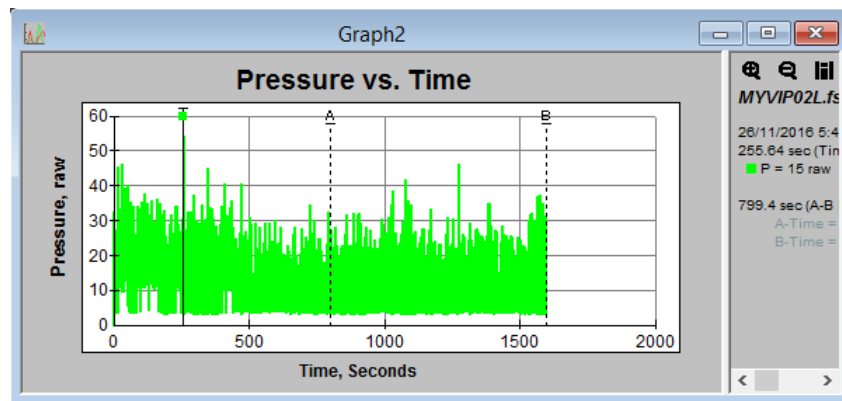


Figure 4.40: Graph of pressure against time of Perodua Myvi for first female respondent



Figure 4.41: Queue for Touch n Go



Figure 4.42: Driver steered to the right near to the Exit Tangkak

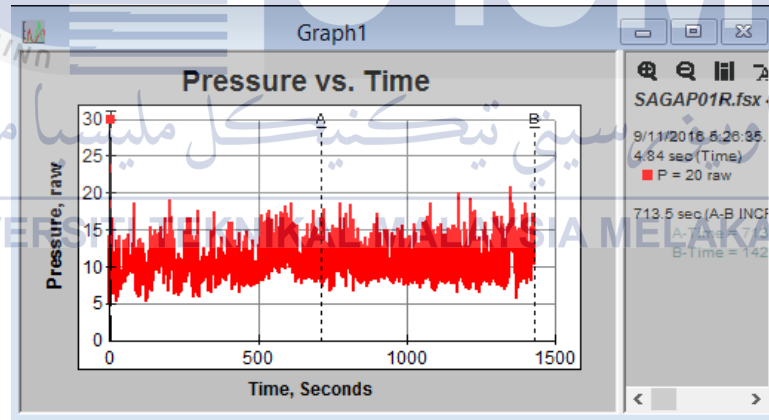
Based on the Figure 4.37 for the Proton Saga and Figure 4.40 for the Perodua Myvi, since this female driver is a right-handed person, both of her graph shows that she has highest value of pressure for the right hand. Based on the video recording in Figure 4.38, Figure 4.39, figure 4.41 and Figure 4.42, all of this situation during the experiment, have been handle by using her strength to grip the steering wheel from the right hand.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	7	6
Perodua Myvi	22	15

Table 4.7 Comparison Pressure Between Proton Saga and Perodua Myvi

(b) Second Respondent

(i) Proton Saga



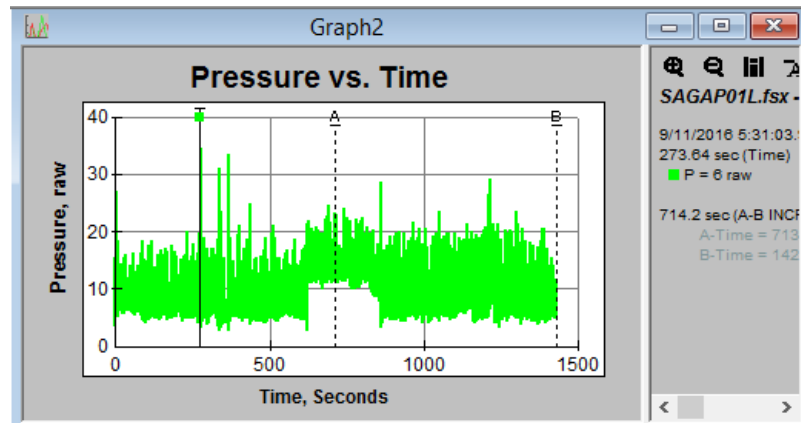


Figure 4.43: Graph of pressure against time of Proton Saga for second female respondent



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Figure 4.44: Driver attempt to overtake oil truck



Figure 4.45: Driver steered to the left due to the corner at Highway SPA

(ii) Perodua Myvi

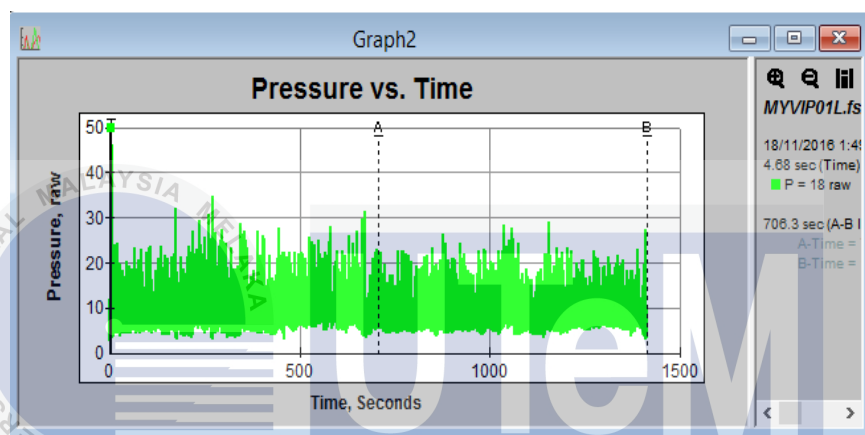
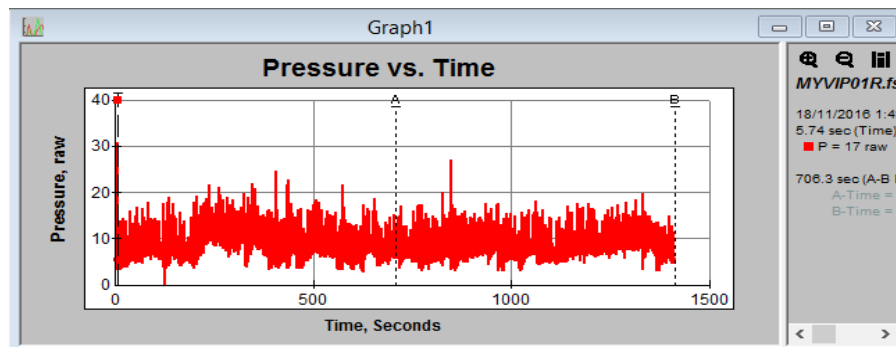


Figure 4.46: Graph of pressure against time of Perodua Myvi for second female respondent



Figure 4.47: The road was bumpy



Figure 4.48: Driver attempt to overtake a lory

Based on the both graph, Proton Saga in Figure 4.43 shows the highest pressure from the right hand. Meanwhile, In Figure 4.46 for the Perodua Myvi left hand lead the pressure. Since this female respondent one of the right handed person, this situation happen might be due to the driver's desire steered to the right lane to overtake a lory as shown in Figure 4.48

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	20	6
Perodua Myvi	17	18

Table 4.8 Comparison Pressure Between Proton Saga and Perodua Myvi

(c) Third Respondent

(i) Proton Saga

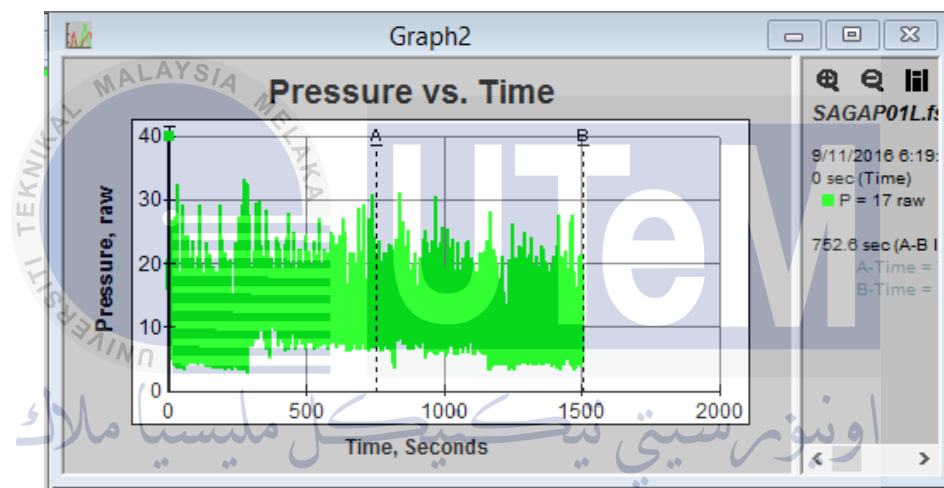
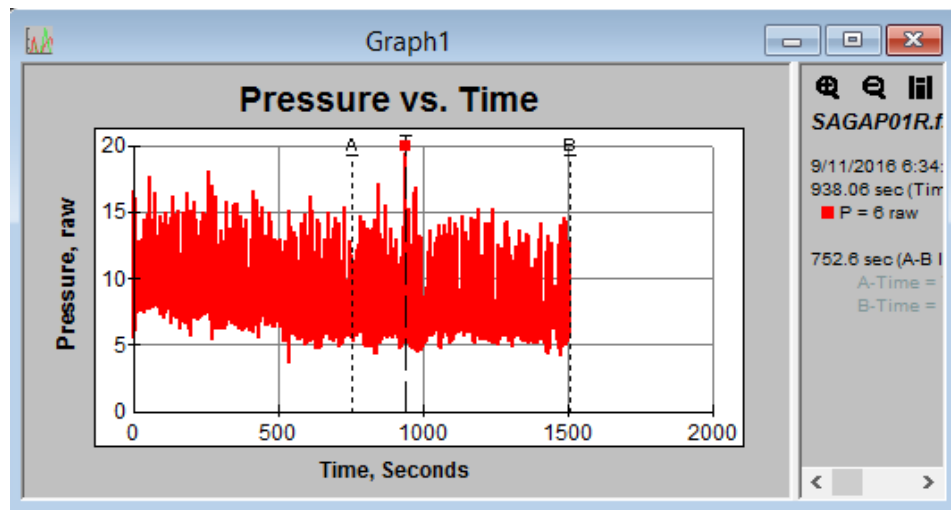


Figure 4.49: Graph of pressure against time of Proton Saga for third female respondent



Figure 4.50: Driver try to careful due to the trailer at the front



Figure 4.51: Driver attempt to overtake trailer

(ii) Perodua Myvi

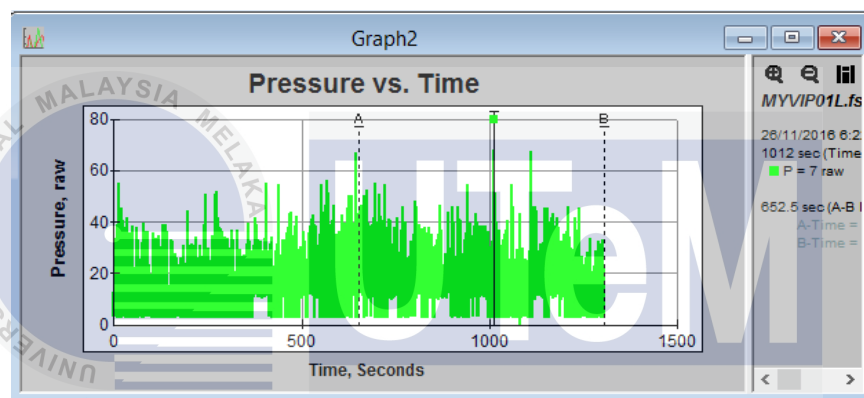
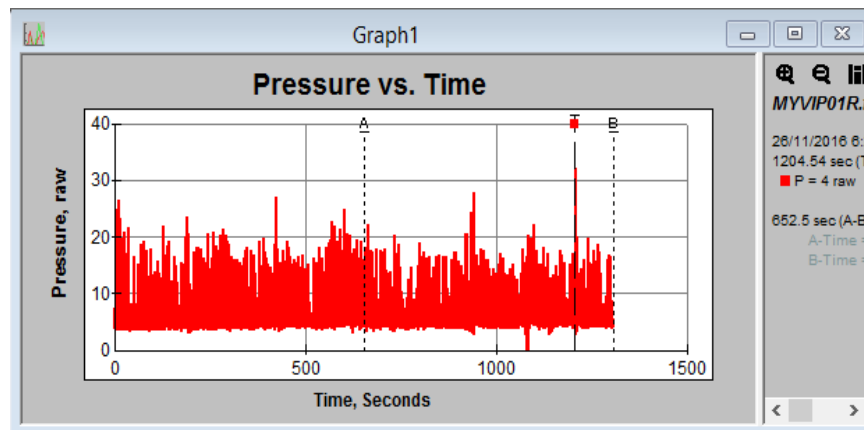


Figure 4.52: Graph of pressure against time of Perodua Myvi for third female respondent



Figure 4.53: There was a hilly road



Figure 4.54: Driver attempt to overtake car at the front, but the car also want to do the same

Based on the Figure 4.49 for the Proton Saga and Figure 4.52 for the Perodua Myvi, shows that both of the graph have highest value of pressure towards left hand. Even though this female driver is one of the right handed person, but both of collected data do not show as she has such characteristics. This thing can happen maybe because of static posture during experiment been held. Hence, she just relies on hand which does not feel more fatigue to grip the steering wheel.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	6	17
Perodua Myvi	4	7

Table 4.9 Comparison Pressure Between Proton Saga and Perodua Myvi

4.1.2.2 LEFT HANDED

(d) First Respondent

(i) Proton Saga

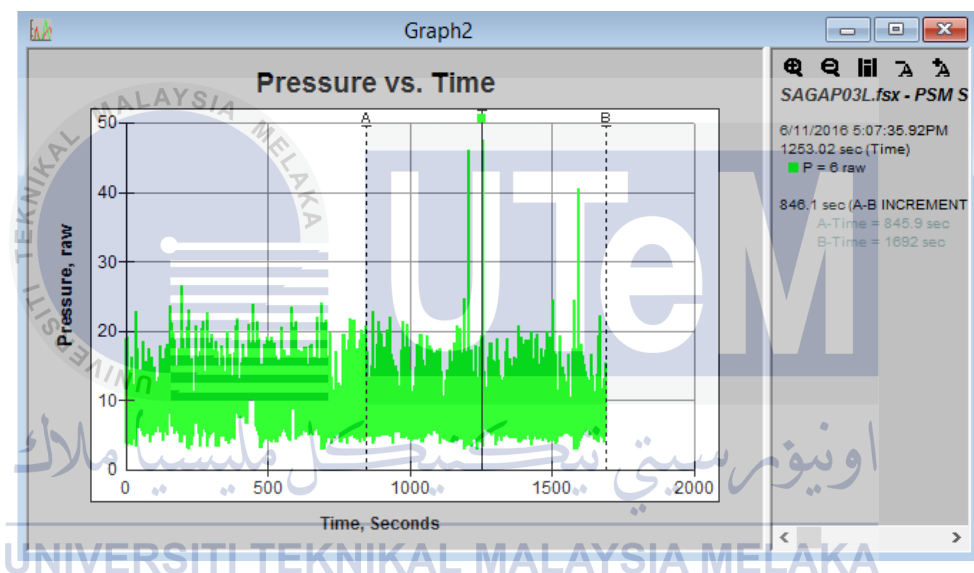
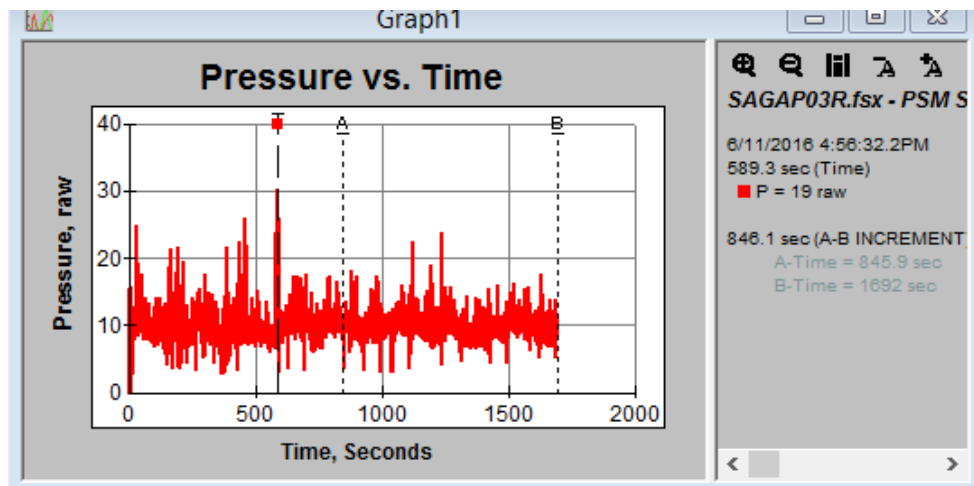


Figure 4.55: Graph of pressure against time of Proton Saga for first female respondent



Figure 4.56: Traffic congestion to enter Ayer Kroh Toll



Figure 4.57: Driver steered to the right near to the Exit Tangkak

(ii) Perodua Myvi

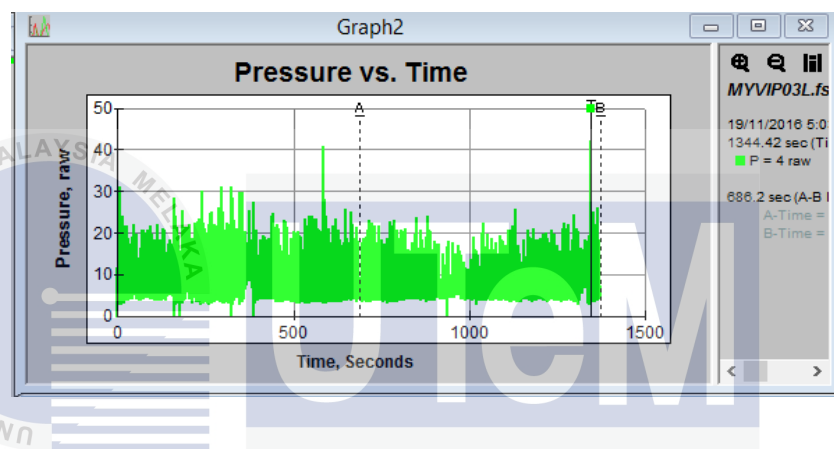
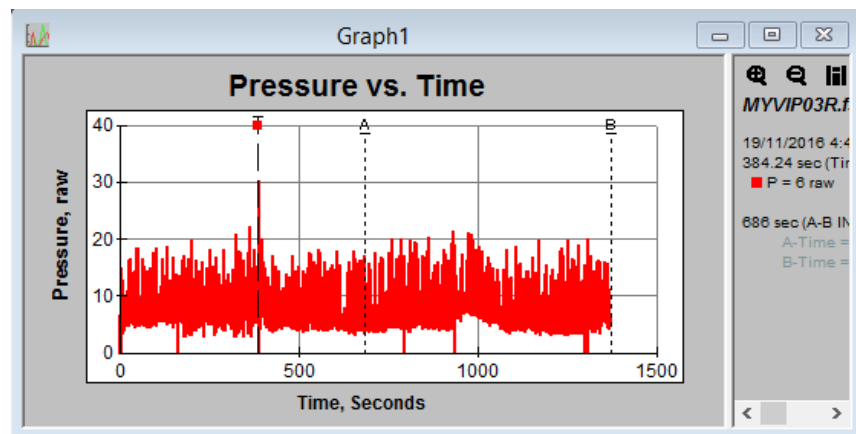


Figure 4.58: Graph of pressure against time of Proton Saga for first female respondent

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Figure 4.59: Driver steered to the right at the end of the highway



Figure 4.60: Driver steered to the left to queue at the empty space Touch n Go

Based on Figure 4.55 for the Proton Saga and Figure 4.58 for the Perodua Myvi, both of the graph have same result of the hand to lead pressure. This female driver is a left handed person. The result of data collected might due to the size of the glove that she worn. She has the smallest size of hand. Feeling discomfort while wearing big glove can be the main reason why she cannot produce the correct data.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	19	6
Perodua Myvi	6	4

Table 4.10 Comparison Pressure Between Proton Saga and Perodua Myvi

(e) Second Respondent

(i) Proton Saga

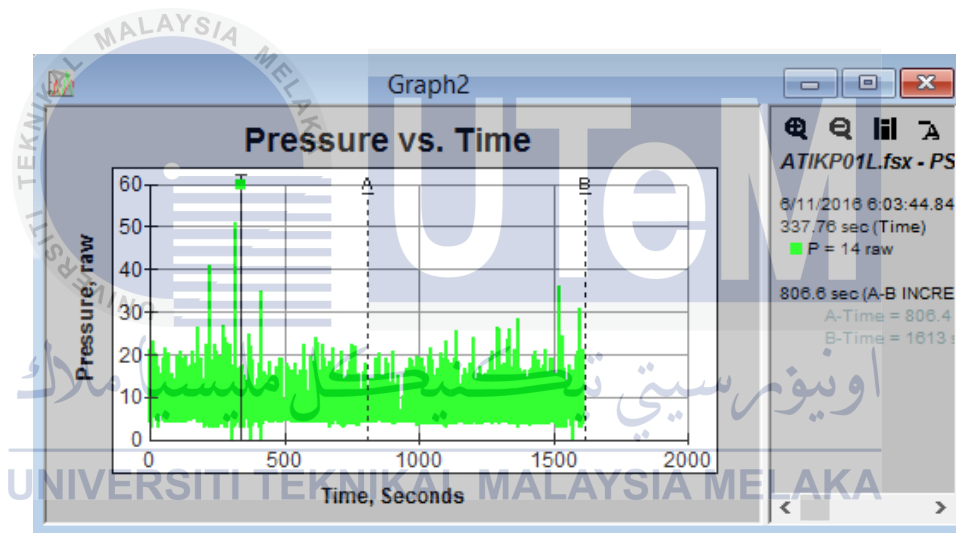
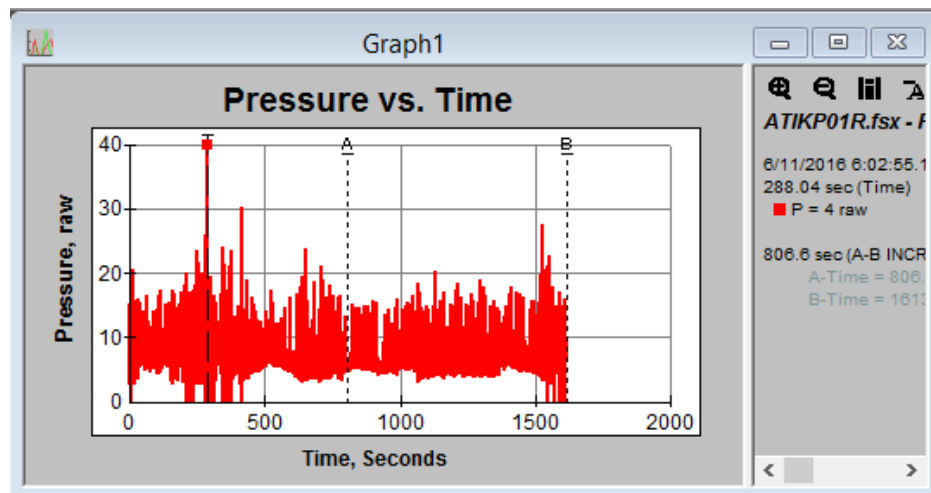


Figure 4.61: Graph of pressure against time of Proton Saga for second female respondent



Figure 6.62: A lot of vehicles at left and right lane



Figure 4.63: There was construction near to the left lane

(ii) Perodua Myvi

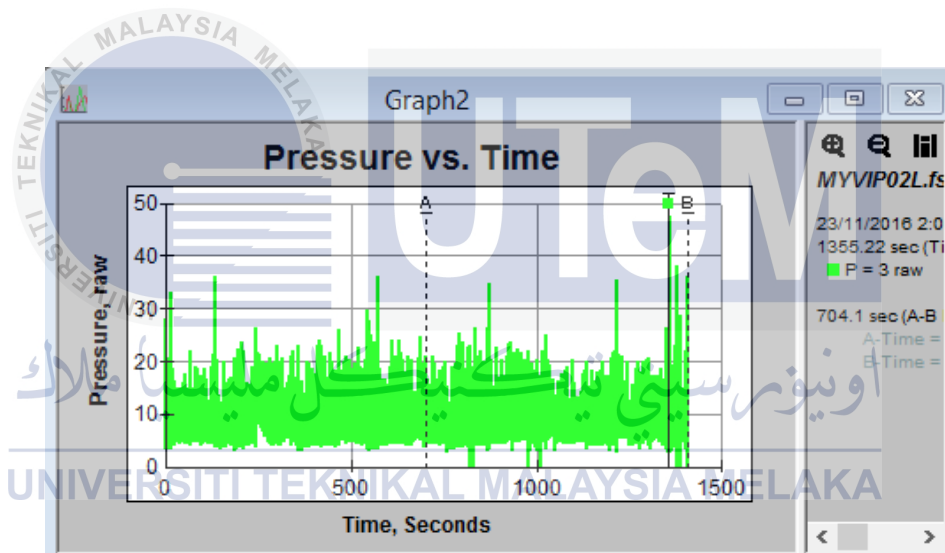
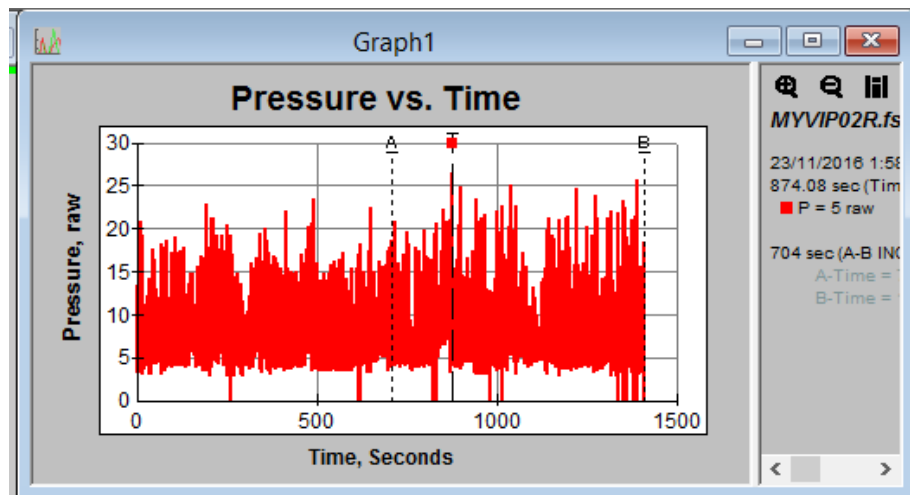


Figure 4.64: Graph of pressure against time of Perodua Myvi for second female respondent



Figure 4.65: A trailer at the front and speeding car at right lane

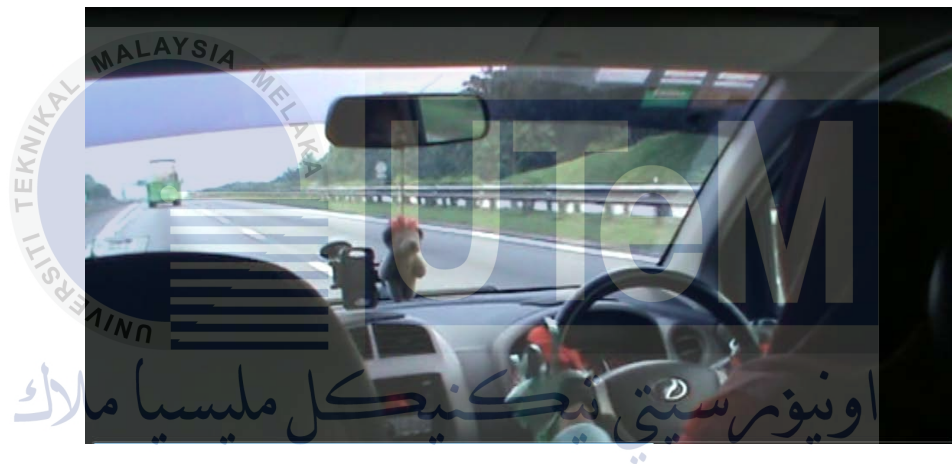


Figure 4.66: There was a hilly road

Based on the Figure 4.61 for the Proton Saga and Figure 4.64 for the Perodua Myvi, the graph shows that only Proton Saga have the highest value of pressure for the left hand and vice versa to the Peodua Myvi. It should be bot of the hand produce highest value of pressure foe the left hand since this female driver is a left handed person, According to the Figure 4.65, it shows that there was a speeding car on the right lane. This might be the reason she grips the steering wheel more stronger and produce highest pressure on right hand.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	4	14
Perodua Myvi	5	3

Table 4.11 Comparison Pressure Between Proton Saga and Perodua Myvi

(f) Third Respondent

(i) Proton Saga

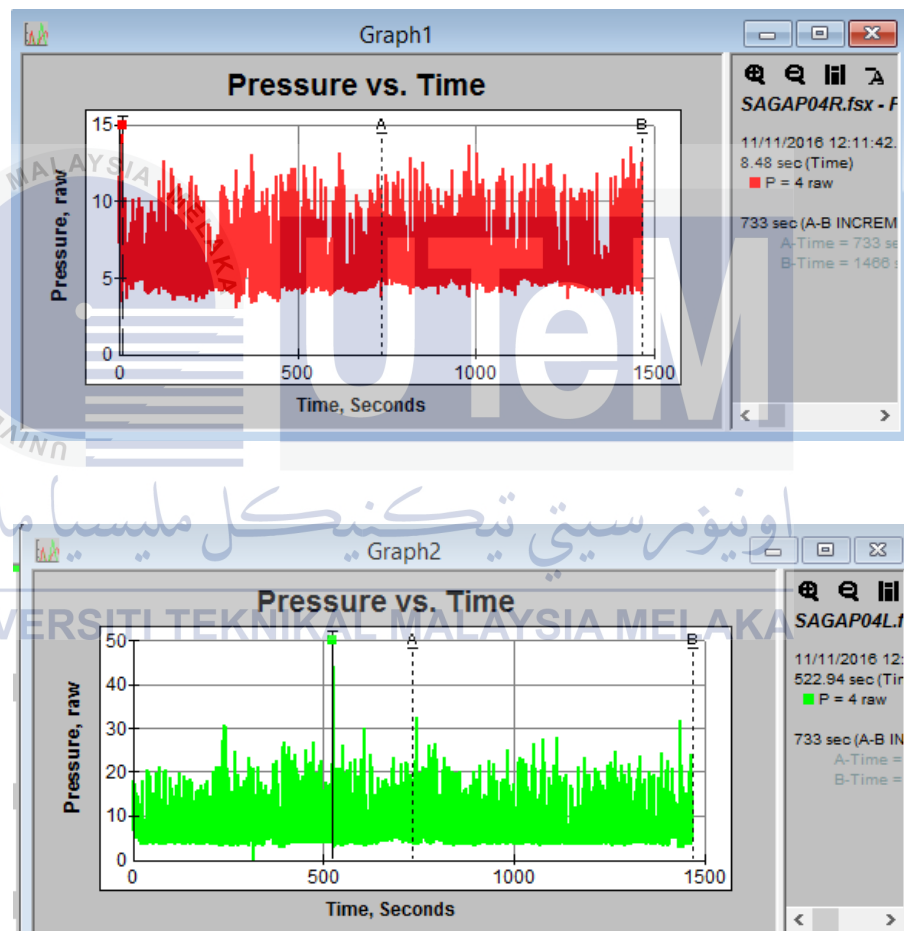


Figure 4.67: Graph of pressure against time of Proton Saga for third female respondent



Figure 4.68: The road was bumpy



Figure 4.69: Driver attempt to overtake a lorry

(ii) Perodua Myvi

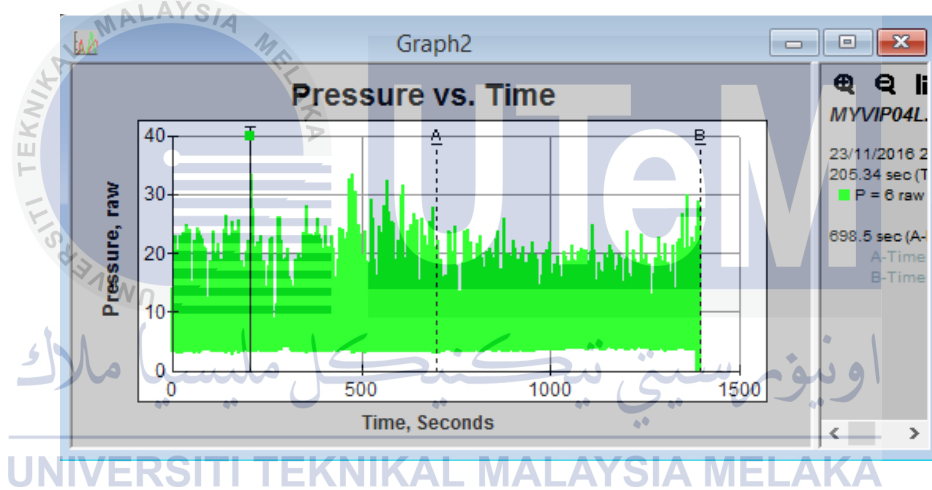
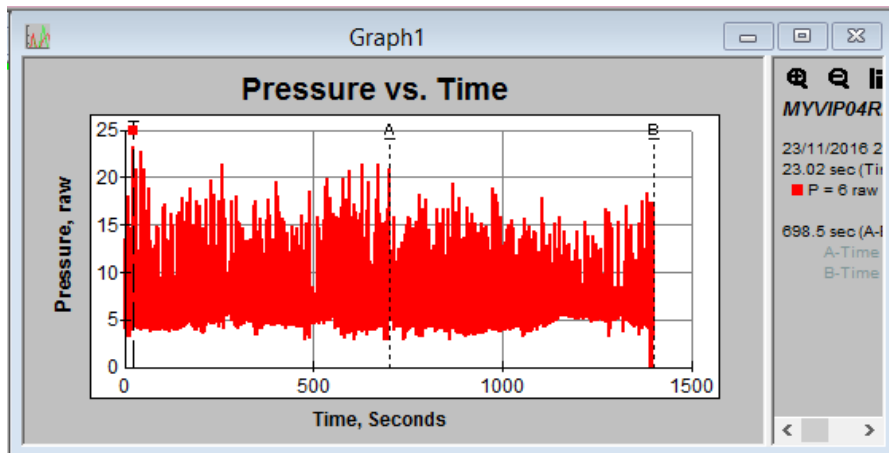


Figure 4.70: Graph of pressure against time of Perodua Myvi for third female respondent



Figure 4.71: There was a hilly road



Figure 4.72: Tow truck and broken car at left lane side

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Based on the Figure 4.67 for the Proton Saga and Figure 4.70 for the Perodua Myvi, this left handed female driver was produce same value of handgrip pressure for the both of car. It can happen because of some people are gifted to use both of the hand equally. Therefore, while she grips the steering wheel, she using the same strength on it.

	Right Hand Side (Raw)	Left Hand Side (Raw)
Proton Saga	4	6
Perodua Myvi	4	6

Table 4.12 Comparison Pressure Between Proton Saga and Perodua Myvi

4.2 ERGONOMIC RISK FACTOR

During the experiment, there are some ergonomic risk factors that can be listed. Firstly, in order to get an accurate data form sensor which attached to the hand, have caused limited or static movement to the respondent. They can only hold the steering without raising their hands from the steering by using 9-3 hand position's concept from beginning to the end of experiment. In addition, one of the national car did not have suitable height of the driver seat towards steering wheel because it determines the level of arm being hanging which help to reduce the fatigue. Next, in highway some of the areas not in good condition due to the work of repairing the tar road and there are also bumpy areas. Hence, most of the respondent have to grasp the steering wheel more stronger and because of that grip strength, can lead to the vibration on both hands of respondent.

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4.3 QUESTIONNAIRE RESULTS

Based on the graphs below, it shows that the feedback of questionnaire that was distributed to 20 students of FTK. They were 10 males and 10 females which consist of 11 Malay, 7 Chinese and 2 Indian.

4.3.1 FIRST QUESTION

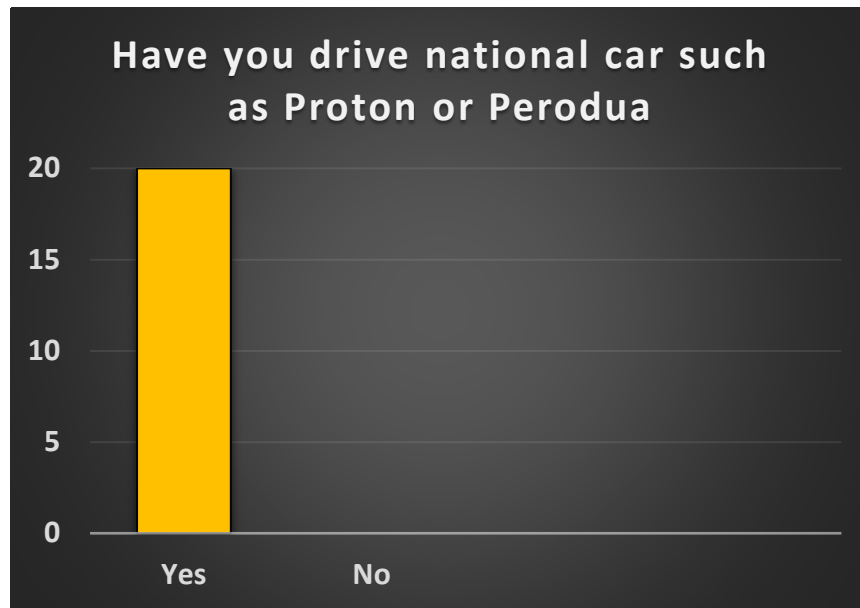


Figure shows a data collected for the questionnaire about the experience of driving national car. From the bar chart above, all of the students have been driving national car such as Proton or Perodua and none of them have no experience drive this type of cars.

4.3.2 SECOND QUESTION

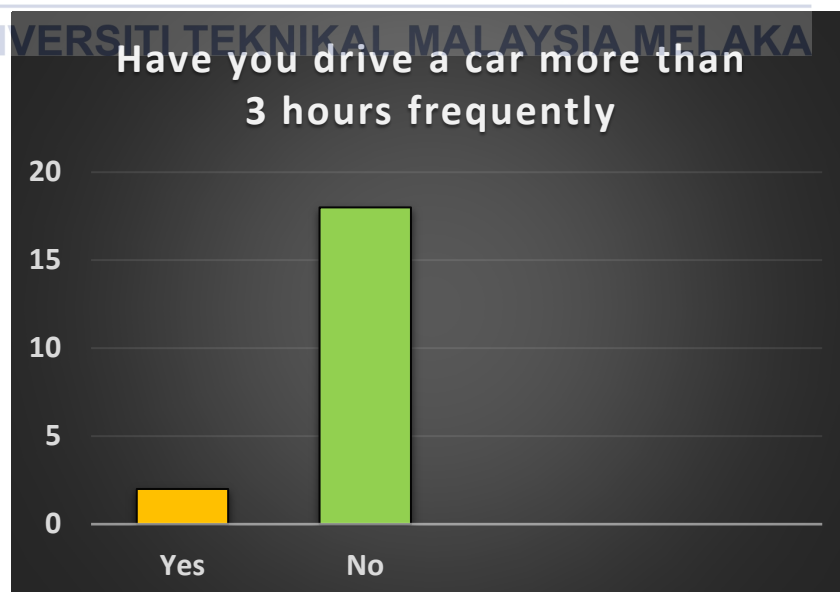


Figure shows a data collected from questionnaire for the question about the number of students who drove more than 3 hours frequently. 18 students have been answered “NO” and the rest have answered “YES”.

4.3.3 THIRD QUESTION

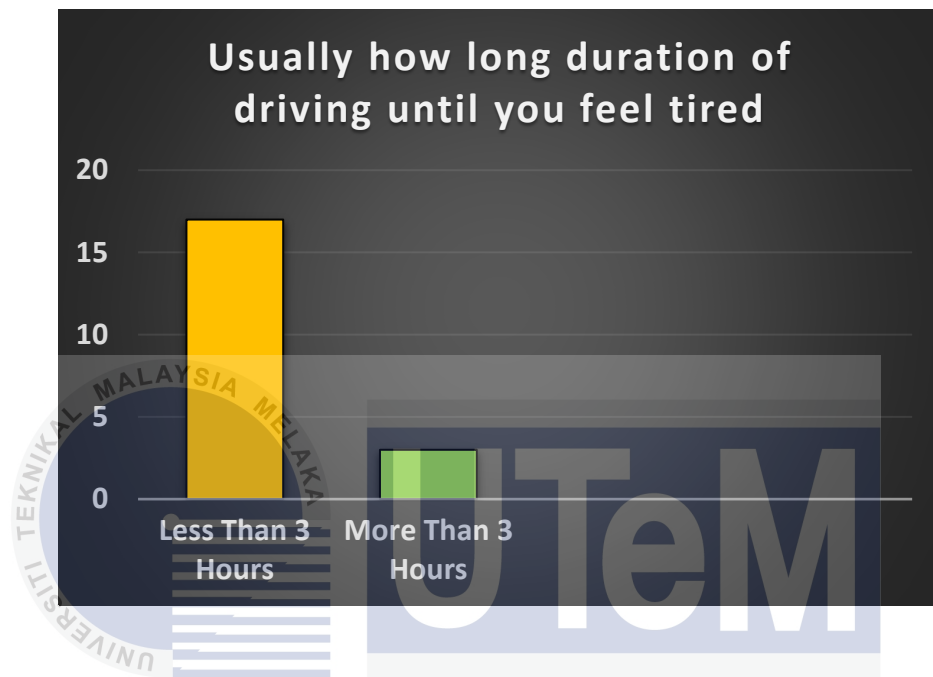
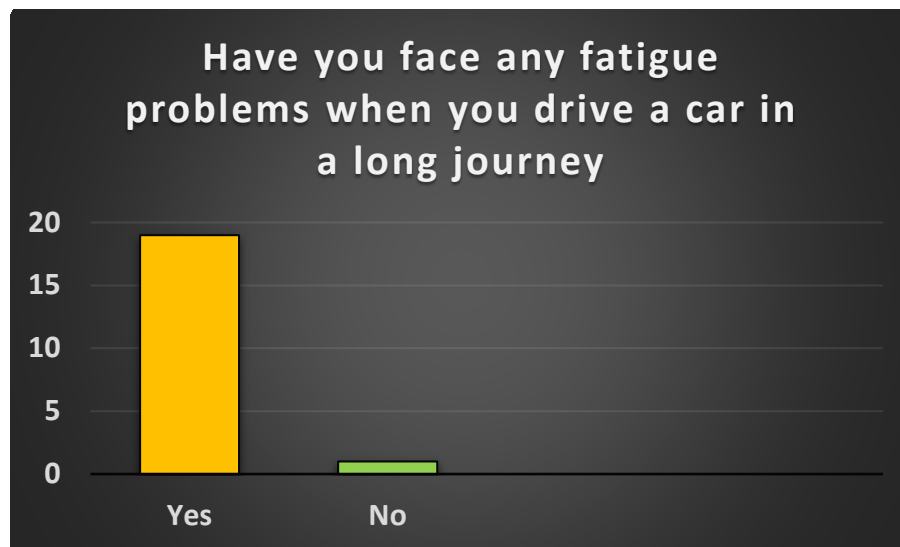


Figure shows a data collected from questionnaire for question duration of riving until students feel tired. From the data collected, 17 students began to feel tired while driving when less than 3 hours. Meanwhile, the rest 3 people does not feel tired although they have been driving for more than 3 hours.

4.3.4 FORTH QUESTION



From shows a data collected from questionnaire for the question fatigue problem when students drive in a long journey. Based on the bar chart above it shows that 19 students experiencing fatigue problem when they drive a car for a long journey. However, there was a student who did not experience the same problem.

4.3.5 FIFTH QUESTION

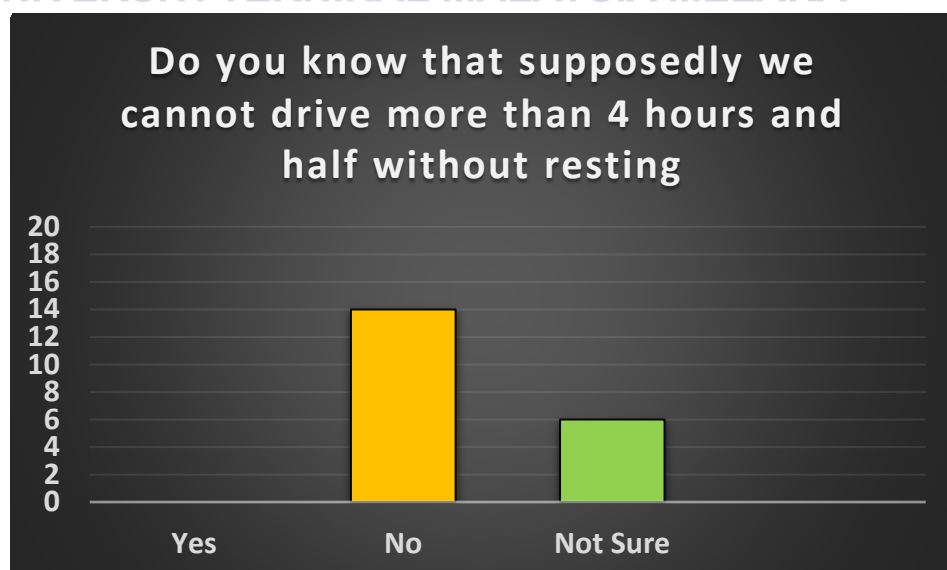
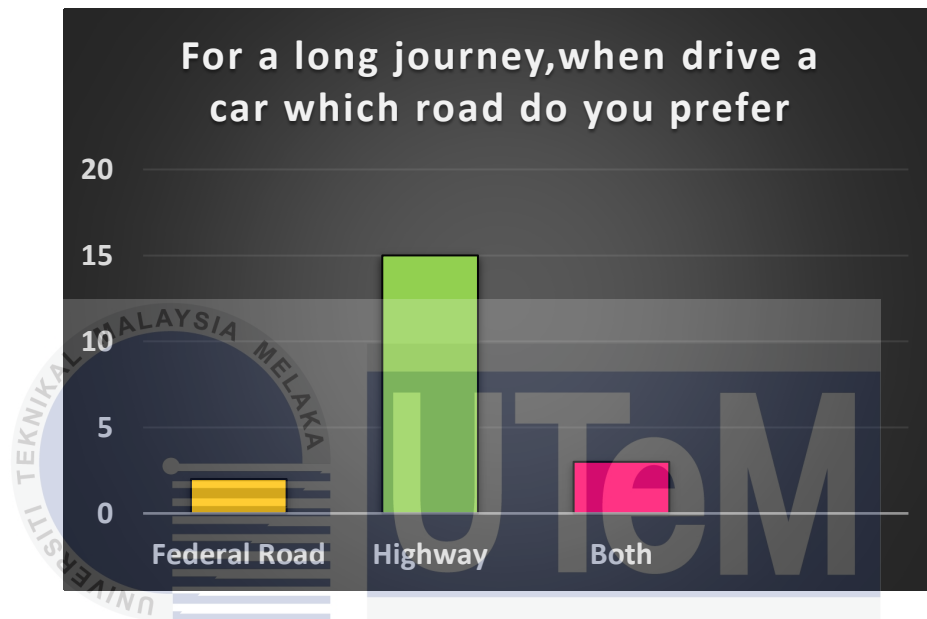


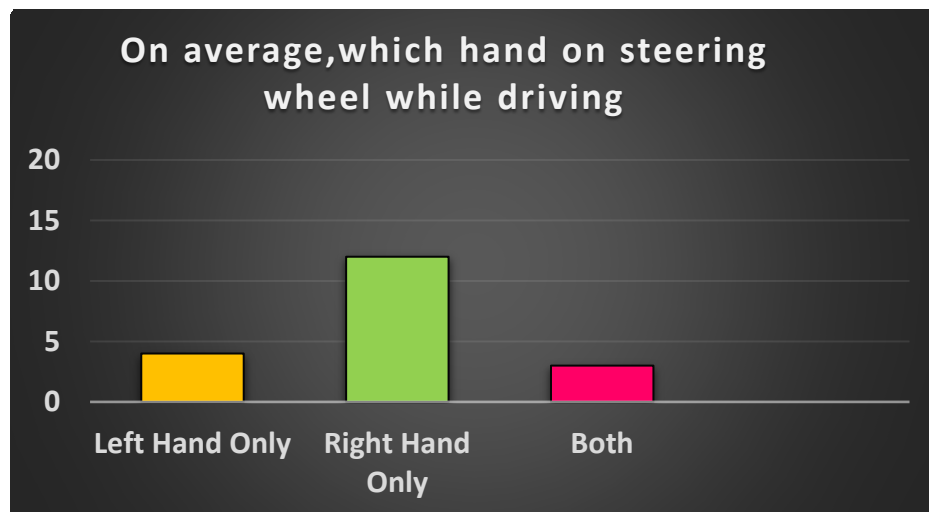
Figure shows a data collected from the questionnaire, knowledge about drive a vehicle over 4 hours and half that is something not recommended. Based on the answer obtained, only 14 students are aware of this matter and 6 students do not know. None of them answered “YES” to this statement.

4.3.6 SIXTH QUESTION



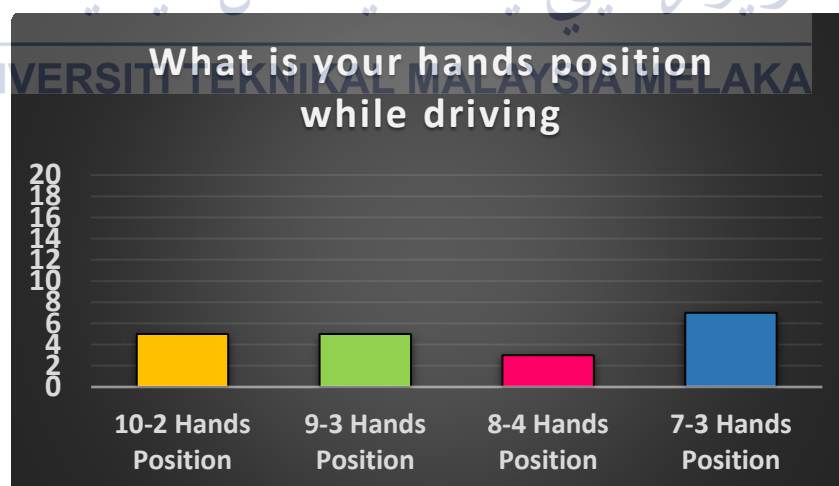
— From shows a data collected from questionnaire for the question which road student prefer for a long journey. According to the bar chart above, the majority of the students choose highway with total number of 15 people. Meanwhile, students who have been chosen the federal road is 2 and the rest of the students have been chosen both of it.

4.3.7 SEVENTH QUESTION



From shows a collected data from questionnaire about average which hand on steering wheel while driving. For the left hand, there were 4 students choose this statement and 12 students have chosen the right hand. However, the rest 3 students have chosen both of this hand on steering wheel while they were driving.

4.3.8 EIGHTH QUESTION



From shows that a data collected for questionnaire regarding student's hand position while driving. Based on bar chart above, there are similarities number of

students who have chosen the answer for 10-2 and 9-3 hands position on the steering wheel: 5 students for both of that. Next, there are also 3 students who have chosen the 8-4 hands position and the remaining number of the students with the most, 7 peoples have chosen 7-3 hands position.



CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Based on the study that have been made by using national car which are Proton Saga and Perodua Myvi as a comparison, was successfully meets the objectives of this project. The comparison of the handgrip pressure between these two cars for left handed and right handed among male and female respondent has been successfully done by using Tekscan Handgrip System. However, there were some unexpected error occurred from the device itself which is supposedly the measurement should be in kPA unit but it turns to raw for the pressure.

Besides that, from this project some of the ergonomic limitation between Proton Saga and Perodua Myvi 's steering wheel were able to identify. Even though both of the steering wheel only have slightly difference in term of circumference, but most of the respondent more comfort to drive by using Perodua Myvi instead of Proton Saga's steering wheel. It is because of the width for the outer and inner of the steering also play an important role.

Referring to the research have been done towards these two type of steering wheel, it shows that Perodua Myvi have smaller size for outer and inner width, but bigger circumference compared to the Proton Saga. In addition, based on observations that have been made the reason why Perodua Myvi's steering wheel is more comfortable is because during the experiment, drivers have difficulty to fully grasping at the back-Proton Saga's steering wheel while they are using 9-3 hand position's concept. Therefore, the study of handgrip pressure between left handed and right handed among this national car has proven that Perodua Myvi has lower handgrip pressure by having

ergonomic feature compared to the Proton Saga and by referring to the project scope that have been stated, data collected from all the drivers shows that the characteristics of right handed and left handed grip strength is following to the preferential use of the hands. However, there are also respondent which have hand grip strength does not based on their characteristics. This is because they are the ones who able to use both hands equally.

Next, due to the static hand and body posture along the way, most of respondents complain they started feel tired and face the problem of fatigue on their arm because they have to grip steering wheel for a long period of time and too hard to make sure all of the sensor is touched on the steering. Besides that, there is some areas of the highway which have bumpy and not stable road condition. The impact from this condition, respondents have to grip the steering wheel more harder and at the same time this road condition has resulted vibration which is one of the ergonomic risk factors. Hence, regarding to the collected data from Teskcsan Grip Sytem and the video that have been recorded, it shows that there was relationship between grip pressure and road condition.

5.2 RECOMMENDATIONS

The recommendations for the future study are:

1. Do a test drive to make sure all the devices in good condition before an actual experiment is carried out,
2. Use various size of glove according to driver's hand to attach the sensor. To ensure all of the sensor will hit each finger.
3. Make sure both of car is serviced before the experiment, especially on tire alignment.
4. Use wireless device of Tekscan Grip System for a comfortable situation during the experiment, due to the limited space in the car.
5. Use the same type of car but do the comparison between ergonomic steering wheel and vice versa.
6. Make sure the weather is good, not cloudy and rain because it can affect the video recording and result of data analysis.

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APPENDICES

APPENDIX A

PROJECT PLANNING																																			
List down the main activity for the project proposal. State the time frame needed for each activity.																																			
Project Activity	2016																				2016														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Selection Of Title																																			
2. Literature Review																																			
3. Proposal Writing																																			
4. Submission Of Proposal																																			
5. Project Research																																			
6. Analysis																																			
7. Discussion																																			
8. Conclusion																																			
9. Submission Of PSM 1 Repost Writing																																			
10. Presentation PSM 1																																			
11. Submission Of PSM 2 Report Writing																																			
12. Final Year Project Presentation																																			

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APPENDIX B



QUESTIONNAIRE

HANDGRIP PRESSURE ON STEERING WHEEL BETWEEN NATIONAL CARS (PROTON & PERODUA)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
HANG TUAH JAYA, 76100
DURIAN TUNGGAL MELAKA
MALAYSIA

ANSWER ALL THE QUESTIONS BELOW

SECTION A: RESPONDENT'S INFORMATION

1. GENDER: ☐ MALE ☐ FEMALE
2. AGE : ☐ 0 - 20 ☐ 21 - 40 ☐ 41 - 60
3. NATION : ☐ MALAY ☐ CHINESE ☐ INDIAN
☐ OTHER

SECTION B: RESPONDENT'S ANSWER

1. Have you drive national car such as Proton or Perodua?
☐ Yes ☐ No

2. Have you drive a car more than 3 hours frequently?
- ☐ Yes ☐ No
3. Usually how long duration of driving until you feel tired?
- ☐ Less than 3 hours ☐ More than 3 hours
4. Have you face any fatigue problems when you drive a car in a long journey?
- ☐ Yes ☐ No
5. Do you know that supposedly we cannot drive more than 4 hours and half without resting?
- ☐ Yes ☐ No ☐ Not Sure
6. For a long journey, when drive a car which road do you prefer?
- ☐ Federal Road ☐ Highway ☐ Both
7. On average, which hand on steering wheel while driving?
- ☐ Left Hand only ☐ Right Hand only ☐ Both
8. What is your hand position while driving? [Refer figure 1]
- ☐ 10 - 2 ☐ 9 - 3 ☐ 8 - 4 ☐ 7 - 3



Figure 1: Hand position on steering wheel
(Source: www.paradigmshiftracing.com)

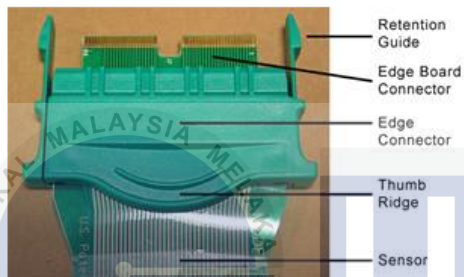
APPENDIX C

Standard of Procedure Using Tekscan Handgrip System

Procedure:

1. SET UP PROCESS (Cuff) :

The Sensor Edge Connector and Sensor



The VersaTek Cuff. Note the scalloped edges on both sides where the Retention Guides snap into place.



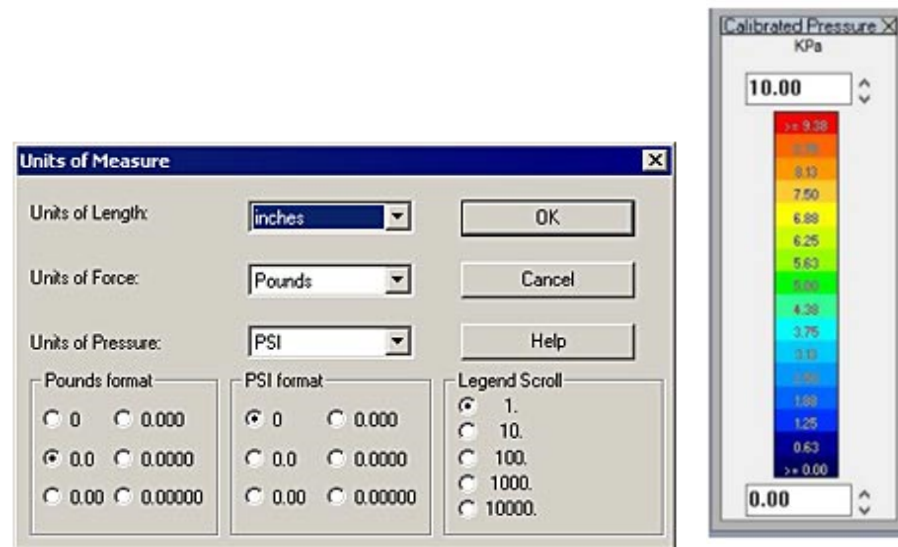


Notes:

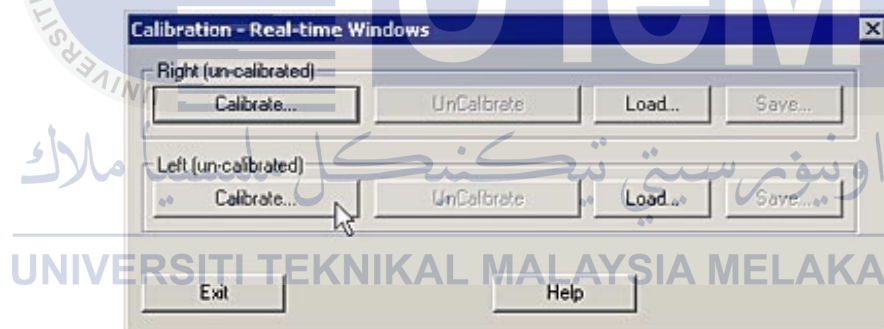
1. Make sure from the beginning until the end of the experiment the VersaTek Cuff and sensor did not switch left to right or vice versa (will be affect the results).
2. Besides, treat the sensor with care, not to bend or fold the sensor or sensor neck, as this may result in creasing or crinkling and can damage the sensor.
3. When the hardware and software are properly installed, a sensor is properly inserted into the Cuff, and the correct sensor type is selected, the yellow LED light is displayed on the Hub unit. This indicates the sensors are connecting with the software on laptop.

2. CALIBRATION DATA

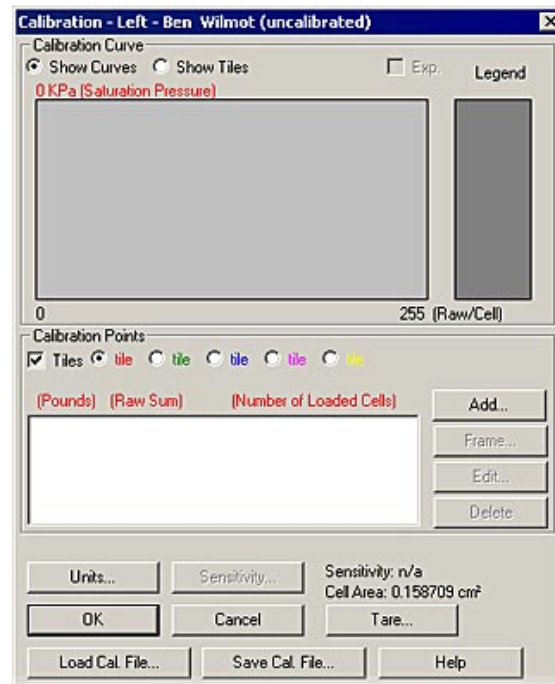
1. Select the force and pressure units you want to use in the calibration. Select Measurement Units from the Options pull-down menu, and make your changes.
 - Based on previous experiment, unit kPA for pressure, kg for force and millimeter for length.
 - Value in calibrated pressure can be change (in the box), determined by user what pressure suitable in your case.



2. Select Calibration from the Tools pull-down menu. Besides, you can also access the "Calibration" dialog by clicking the Calibration Status icon on the Toolbar.



3. Click on the "Calibrate" button for the Right or Left hand, depending on which one is being calibrated.

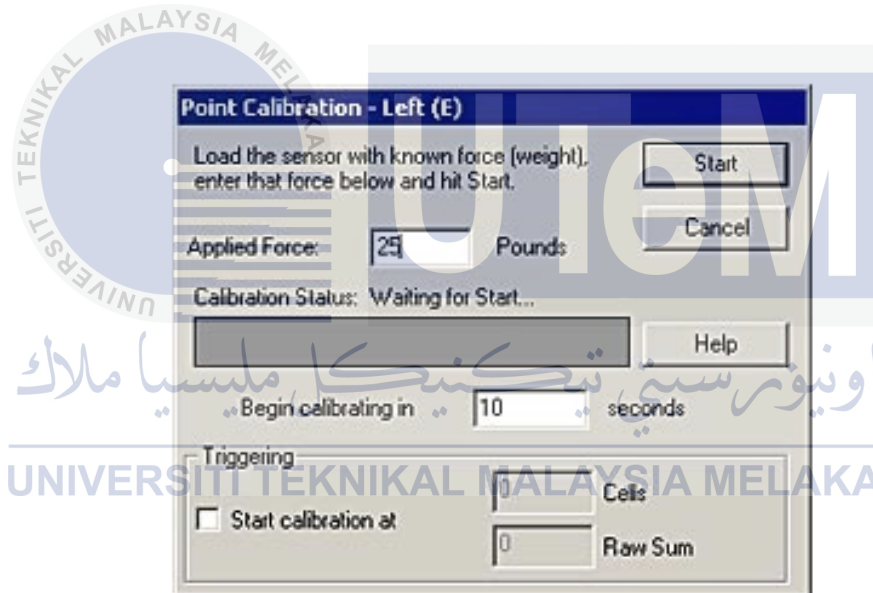
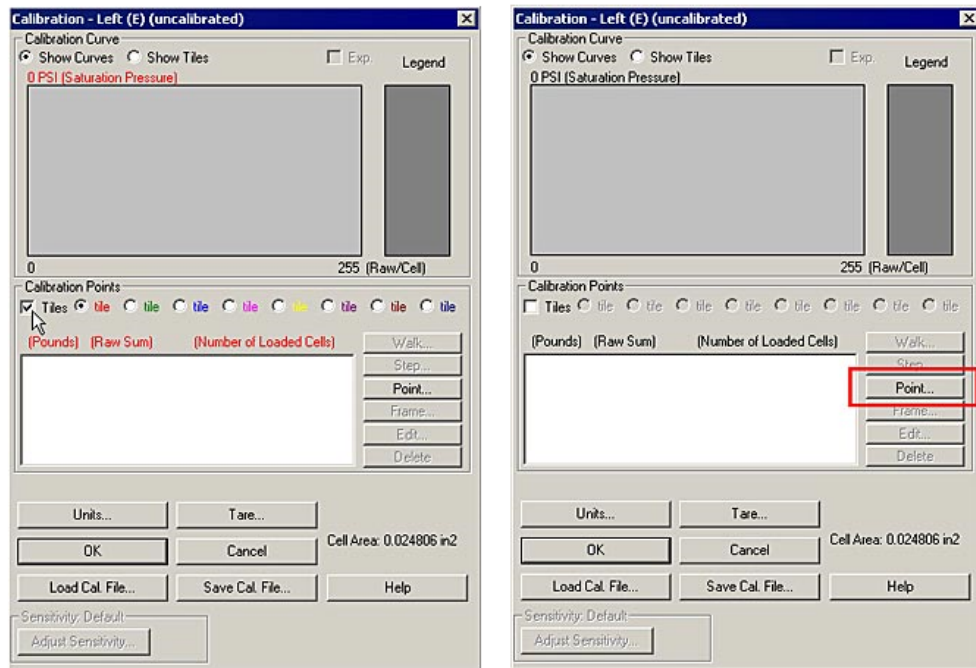


4. You can also access the "Calibration Point" dialog box (for the active window) by selecting Settings from the Options pull-down menu, clicking on the "Calibration" tab, and then clicking on the Calibrate button.

- Point > insert applied force (weighed each finger by using weight scale, 2kg)
- > click start while finger on weight scale > maintain the weight until 10 second finish.

— Color of “tile” word: indicate which area of sensor located. —
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- Repeat step above for the rest “tile”.
- “tile” = no calibration
- “TILE” = calibration done
- Delete: highlight which tile according what color you want, and press button delete
- Click "Exit" to return to the Main Window after all the “tile” become “TILE”.



Note: If you want to discard current calibration data (to recalibrate during the same patient session, without exiting the application)

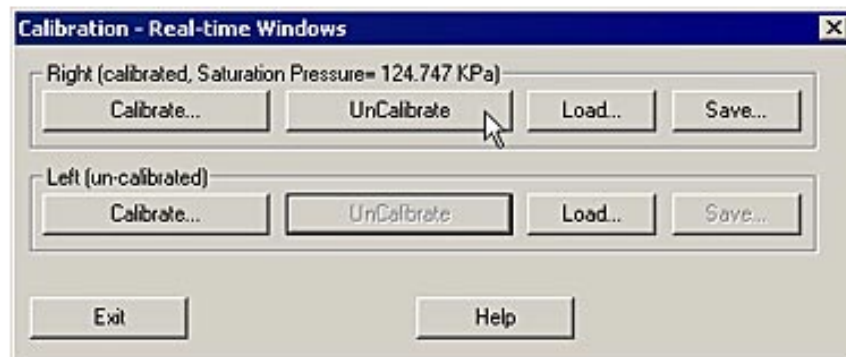
- Select Calibration from the "Tools" menu > click UnCalibrate button for the desired window (hand).

OR

- Click > UnCalibrate button in the "Calibration" tab of the "Settings" dialog.

OR

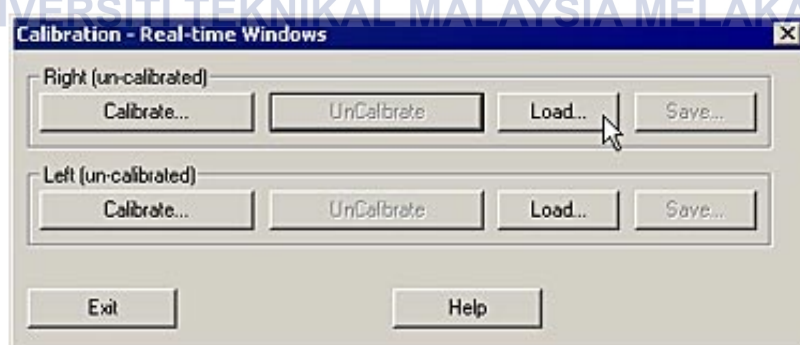
- Select New Patient from the "File" menu.



3. LOAD CALIBRATION FILE

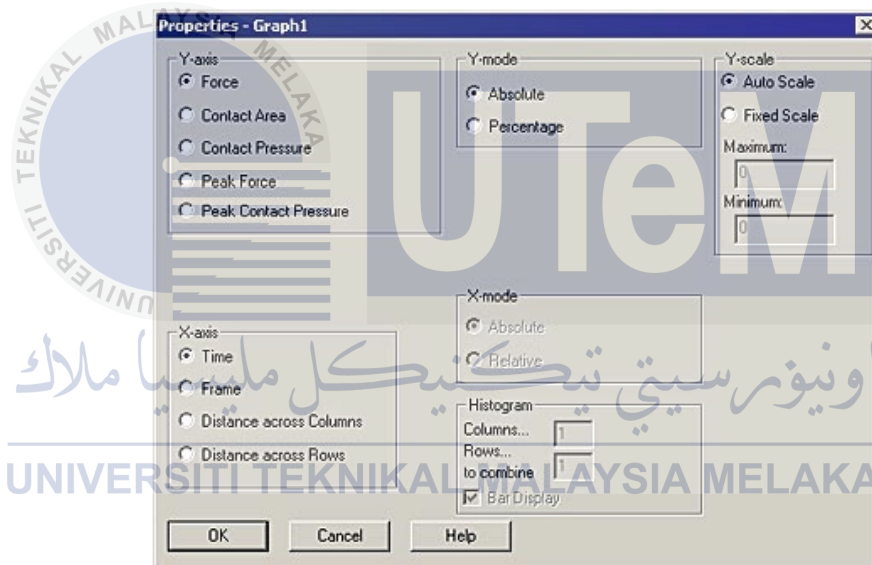
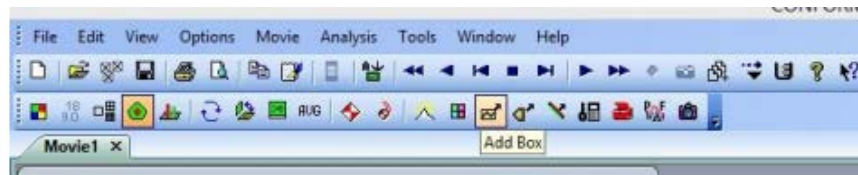
Note: You will need it when you want to start the test drive (in the car) after calibration data among the volunteers have been done (step Calibration Data). Most important thing, remember name of the folder to avoid mismatched volunteers and their calibration data.

1. Select Calibration from the "Tools" menu to open the "Calibration" dialog box.



4. GRAPH

1. Click on the Graph window to make it active.
2. By clicking the right mouse button while the cursor is on the graph, and selecting Properties.
3. Click "Add Box" to select the area you want to produce graph.



Note: Under Y-axis you can choose what graph you want to produce.

- Force: Total force in each box or pane.
- Contact Area: Area of only the loaded, or "contact" sensels inside the box or pane.
- Contact Pressure: Pressure on the loaded, or "contact" sensels inside the box or pane, which is calculated by dividing the force by the "contact" area.

An image of the Movie windows containing the pressure data (in "Peak/Stance" mode)

