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The Comparison Study of Handgrip Pressure on Steering Wheel National Cars

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ABSTRACT

The steering wheel is ergonomically designed to provide optimal comfort to the drivers while grip the steering wheel, especially on the long journey. There are significant design differences between the steering wheel car models. Therefore, the objective of this research are to analyze the data of handgrip pressure towards national cars which is Proton and Perodua. The experiment will be performed by using type 2 (two) cars, Proton Saga and Perodua Myvi. Tekscan Grip System is a system that will be used to perform this analysis. Data of handgrip pressure are collected during driving when the device are installed and connect to the respondents. Selection of the road for this experiment will start at 92.1 KM intersection traffic lights, entering North-South Highway, and will end at Tangkak Toll Exit. During the experiment, all volunteers need to maintain speed in the range of 80-100km / h and most of the time, they have to drive in the left lane unless overtaking other vehicles. Distance from beginning to end is about 68.8km and the time taken is about 30 minutes. Drivers will be driving with the hands on the steering wheel 9 and 3 because it is the safest position to hold the steering wheel. The finding from this study will give a better insight on the effect of steering wheel design to the grip pressure of the driver.

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Introduction

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 [1]-[2]. 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 [3]-[4]. Conversely, if the ergonomic features are incorporated on the steering wheel, the problems that will arise as Musculoskeletal Disorders (MSDs) and Neuromusculoskeletal Disoders which can lead to fatigue in the muscles around the hands[5]-[13]. 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 [14]-[16]. This research will focused on relationship between the ergonomic steering wheel and hand grip pressure of two (2) different types of national cars, Proton and Perodua by using Tekscan Hand Grip sensor. The results was analyzed and the camera system that was installed to provided videos recording to support the results why it is produced.

Methodology

Methodology is the crucial part where this is the first phase of implementation the research as shown in figure 1. 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 respondent (6 male, 6 female) left handed and right handed respondents along the way road selection.

Identifying the Steering Wheel

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 referred on readings of handgrip pressure's results. The figure 2 and figure 3 below show types of Proton and Perodua's steering wheel.

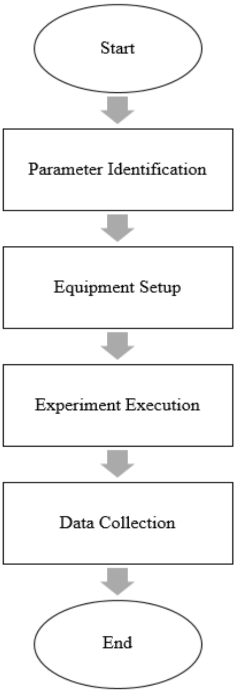


Figure 1: Flow Chart of Experimental Study

Figure 2: Steering Wheel Proton Saga

Figure 3: Steering Wheel Perodua Myvi

Identifying a Steering Wheel Position

For this experimental study, during test drive the best and safe option for the respondent 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 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 [17]-[20]. The figure 4 below show 10 and 2 o'clock and the 9 and 3 o'clock hand position.

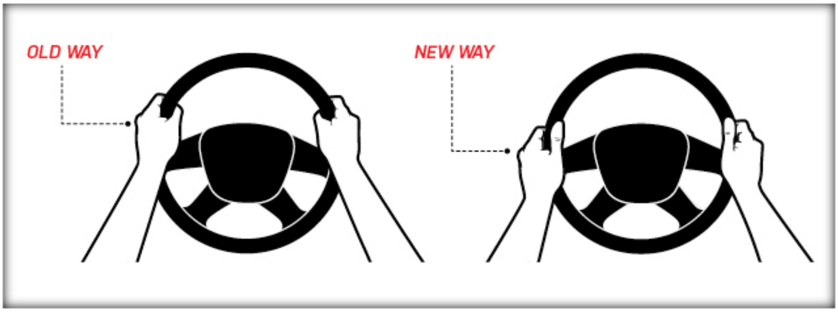


Figure 4: Left: 10 o'clock and 2 o'clock hand positions
Right: 9 o'clock and 3 o'clock hand positions

Grip Force Measurement and Camera System

To obtain accurate pressure measurements, equipment Handgrip Tekscan Pressure System is used during the test drive by respondent. 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 sensor. Each sensor must be calibrated individually and the calibration must be performed before each new respondent or replace new sensor.

After the calibration for all the respondent is save in laptop, the data is used during the test drive meanwhile the sensors are attached to the both of respondent'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 respondent will wear it during the test driving. The figure 5 and figure 6 below shows the sensor is installed to the glove and how the driver grips the steering wheel while using this equipment.

Figure 5: Eighteen sensors are attach to the glove

Figure 6: While driving using Tekscan Hand Grip System

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.

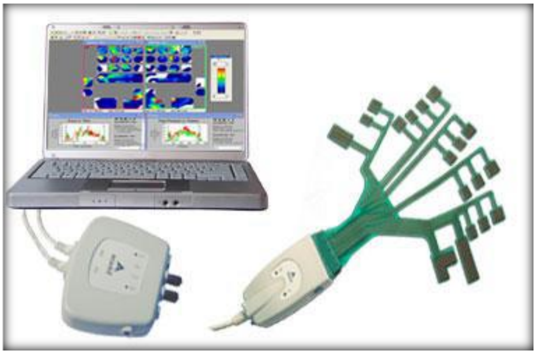


Figure 7: Tethered model

In the figure 7 above and figure 8 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.

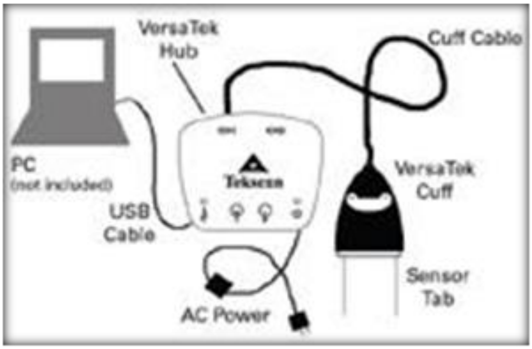


Figure 8: Tethered system

<u>Road Selection</u>

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 respondent have to maintain the car speed 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 respondent 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 respondent 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 installed Tekscan Handgrip System on both sides' hands of all the respondent. 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. Figure 9 below show the road selection for this experiment.

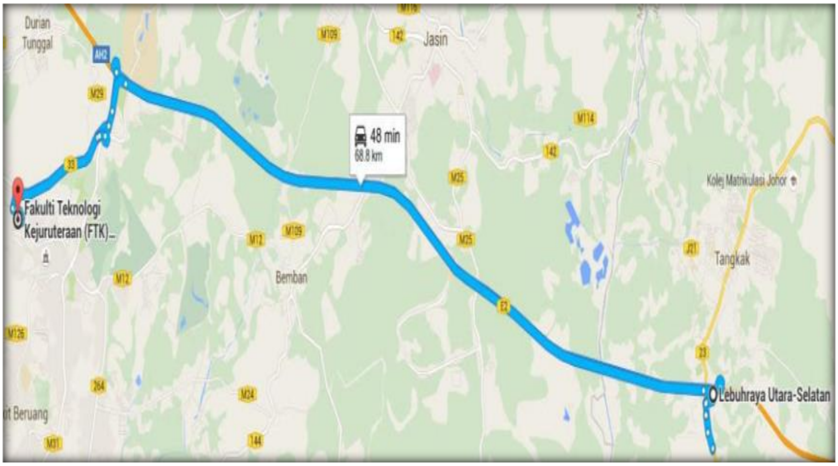


Figure 9: Journey of road selection

Result and Discussion

The data collected by using Tekscan Handgrip System have been recorded together with the whole journey process by using handycam camcorder in order to obtain the relationship between hand movements of left handed and right handed of respondant and road condition. This section aims to elaborate more data collected for 12 respondents. The result show 12 data separately by 6 male (3 right handed and 3 left handed) and 6 female (3 right handed and 3 left handed).

<u>Pressure against time result</u>

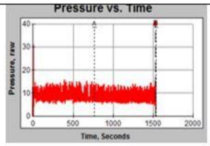
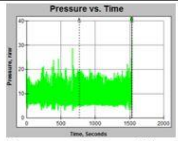
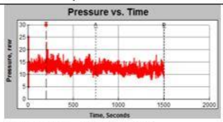
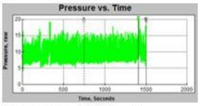
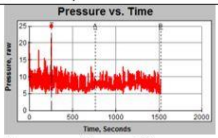
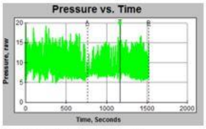
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw = 10	 Pressure, Raw = 15	
SECOND RESPONDANT	 Pressure, Raw = 14	 Pressure, Raw = 9	
THIRD RESPONDANT	 Pressure, Raw = 19	 Pressure, Raw = 8	

Figure 10: Hand grip pressure against time of Proton Saga for Male Right Handed Respondent

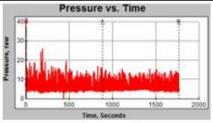
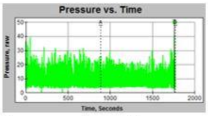
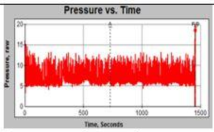
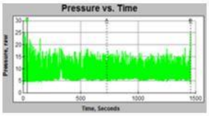
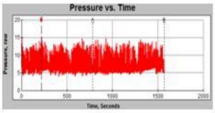
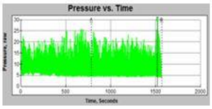
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw = 8	 Pressure, Raw = 5	
SECOND RESPONDANT	 Pressure, Raw = 4	 Pressure, Raw = 5	
THIRD RESPONDANT	 Pressure, Raw = 6	 Pressure, Raw = 5	

Figure 11: Hand grip against time of Perodua Myvi for Male Right Handed Respondent

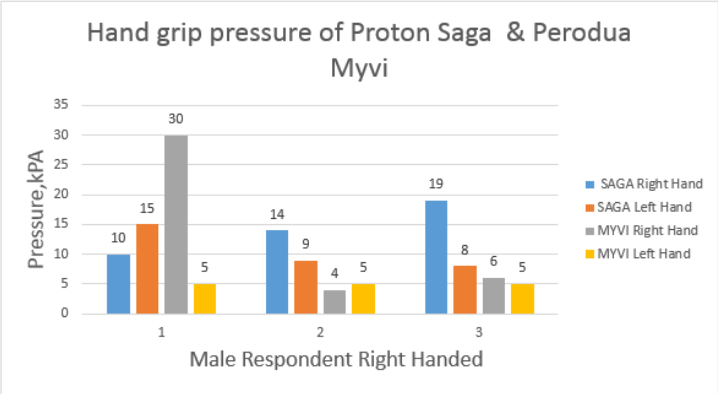


Figure 12: Graph Hand grip of Proton Saga and Perodua Myvi for Male Right Handed Respondent

Based on Figure 10 above for the Proton Saga and Figure 11 above for Perodua Myvi, it shows that both of the graph have the higher pressure towards right hand. Figure 12 shows graph hand grip of proton saga and perodua myvi for male right handed respondent. Most of the graph of respondant have high pressure on right hand side, it it because respondant is a right handed.

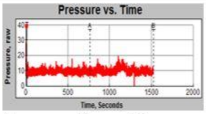
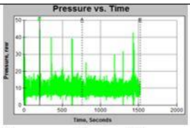
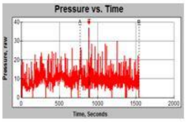
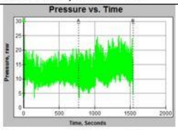
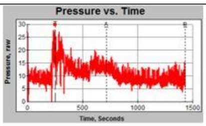
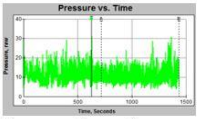
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw = 18	 Pressure, Raw = 15	
SECOND RESPONDANT	 Pressure, Raw = 6	 Pressure, Raw = 16	
THIRD RESPONDANT	 Pressure, Raw = 26	 Pressure, Raw = 4	

Figure 13: Hand grip pressure against time of Proton Saga for Male Left Handed Respondent

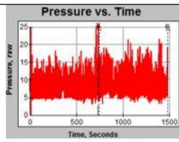
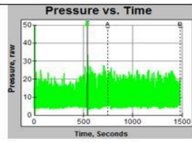
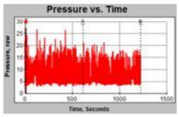
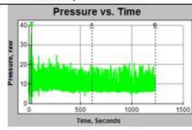
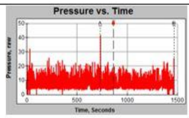
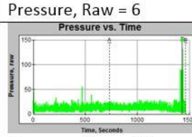
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw = 7	 Pressure, Raw = 5	
SECOND RESPONDANT	 Pressure, Raw = 5	 Pressure, Raw = 6	
THIRD RESPONDANT	 Pressure, Raw = 12	 Pressure, Raw = 10	

Figure 14: Hand grip pressure against time of Perodua Myvi for Male Left Handed Respondent

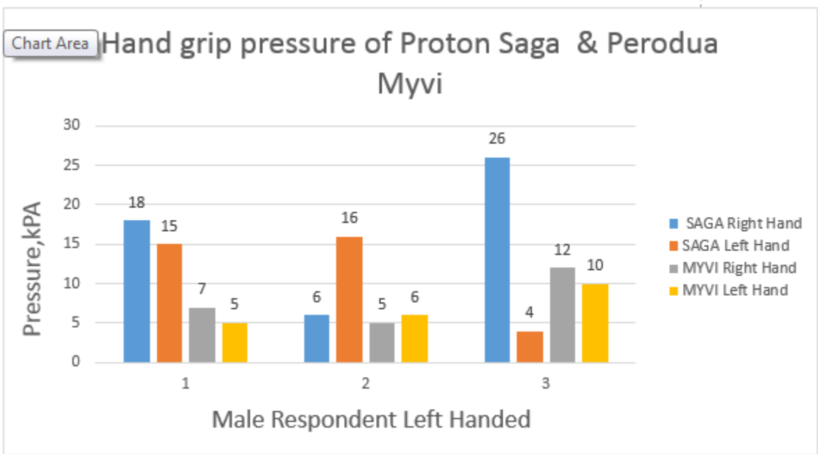


Figure 15: Graph Hand grip of Proton Saga and Perodua Myvi for Male Left Handed Respondent

Based on the Figure 13 for the Proton Saga and figure 14 for the Perodua Myvi, The graph have highest pressure on left hand showed highest pressure on left because the male driver is a left-handed. Figure 15 shows graph hand grip of proton saga and perodua myvi for male left handed respondent .Some of the grapgh showed that right hand pressure is higher that left, it depend the road condition, driver using his strength to grip the steering wheel.

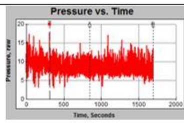
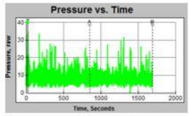
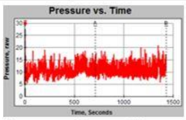
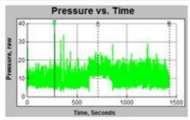
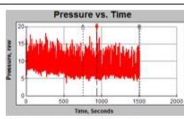
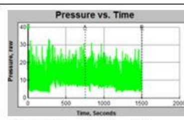
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw = 7	 Pressure, Raw = 6	
SECOND RESPONDANT	 Pressure, Raw = 20	 Pressure, Raw =6	
THIRD RESPONDANT	 Pressure, Raw = 6	 Pressure, Raw = 17	

Figure 16: Hand grip pressure against time of Proton Saga for Female Right Handed Respondent

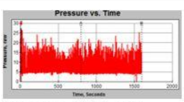
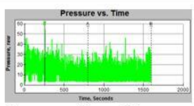
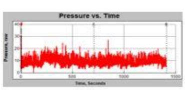
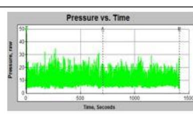
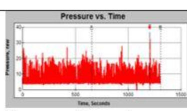
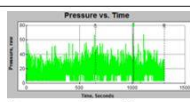
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw =22	 Pressure, Raw =16	
SECOND RESPONDANT	 Pressure, Raw =17	 Pressure, Raw =18	
THIRD RESPONDANT	 Pressure, Raw =4	 Pressure, Raw =7	

Figure 17: Hand grip pressure against time of Perodua Myvi for Female Right Handed Respondent

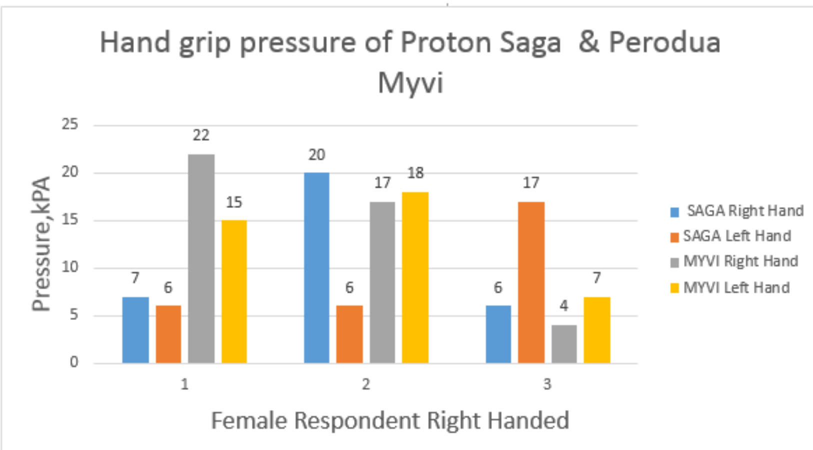


Figure 18: Graph Hand grip of Proton Saga and Perodua Myvi for Female Right Handed Respondent

Based on the Figure 16 for the Proton Saga and Figure 17 for the Perodua Myvi. Figure 18 shows graph hand grip of proton saga and perodua myvi for female right handed respondent, since this female driver is a right-handed person, both of graph shows that highest value of pressure is right hand side.

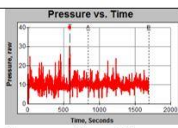
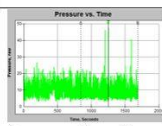
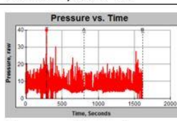
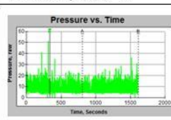
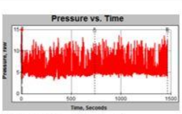
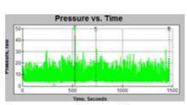
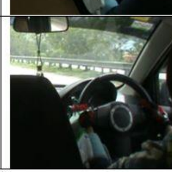
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw =19	 Pressure, Raw =6	
SECOND RESPONDANT	 Pressure, Raw =4	 Pressure, Raw =14	
THIRD RESPONDANT	 Pressure, Raw =4	 Pressure, Raw =4	

Figure 19: Hand grip pressure against time of Proton Saga for Female Left Handed Respondent

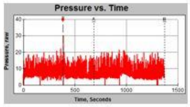
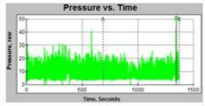
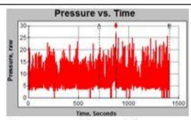
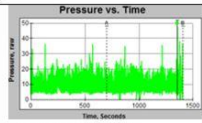
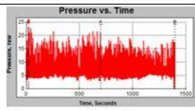
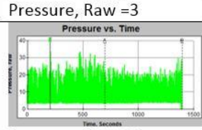
	Right Hand Side	Left Hand Side	Driver
FIRST RESPONDANT	 Pressure, Raw =6	 Pressure, Raw =4	
SECOND RESPONDANT	 Pressure, Raw =5	 Pressure, Raw =3	
THIRD RESPONDANT	 Pressure, Raw =6	 Pressure, Raw =6	

Figure 20: Hand grip pressure against time of Perodua Myvi for Female Left Handed Respondent

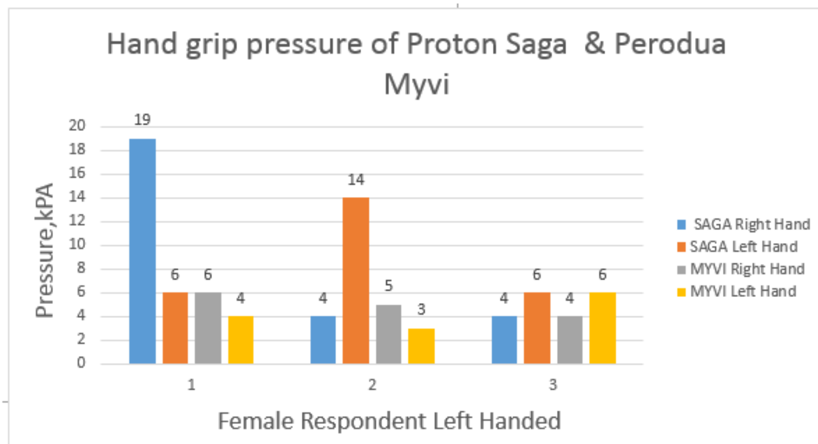


Figure 21: Hand grip pressure against time of Proton Saga for Female Left Handed Respondent

Based on Figure 19 for the Proton Saga and Figure 20 for the Perodua Myvi. Figure 21 shows graph hand grip of proton saga and perodua myvi for female right handed respondent, some of the graph have same result of the hand to lead pressure, 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.

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.

Conclusion

Based on the research 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 research. 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 research 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 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.

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