

## **Study And Evaluation on The Reachable of Closing Multi-Purpose Vehicle (MPV) Trunk for Female Participants**

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**Abstract:** Multi-purpose vehicle or MPV had been the common transportation for Malaysian people especially the one that has large number of family members but the tall, opened tailgate or trunk gave the problem for the female user that limited by their height. The main objective of this study is to investigate and evaluate the reach for female participant to close MPV/SUV trunk's door and the study involving any female participants and the less advanced MPV that does not have any automatic system button or kick sensors, in the trunk system. The method being used was through the google form for the survey and the CATIA V5 software on the analysis. The findings obtained from the study is that from the survey there are minority respondents that faced the stated problem, and on CATIA Analysis showed the score of manikin posture. From the study and evaluation, it can be summarized that the RULA score of the posture was quite dangerous for human body, especially the respondents that faced the problem.

**Keywords:** Posture, CATIA, Trunk

### **1. Introduction**

Proton Exora is 1.691 m in height[1], and by opening the rear bonnet door, the door reaches higher than the vehicle's actual height. Other models such as Toyota Avanza (1.695 m)[1], Toyota Estima (1.895 m)[2], Perodua Alza (1.620 m)[3], Hyundai Starex( 1.935 m)[4], Toyota Alphard (1.870 m)[1], those are the data of MPV that available in Malaysia. The massive dimension of MPV not only gives advantages, but also gives few disadvantages such as higher fuel consumptions, parking problems, and the one that will be studied in this project, a long rear trunk door. A long rear trunk door might not give any problems for most of male user to close it. However, it becomes a problem for female user as they have a shorter height compared to male.

### **2. Materials and Methods**

## 2.1 Materials

The methods to run this study were through the online survey via Google form and the CATIA V5 software.

- Online Google form was spread among female respondents with specific questions and answers/options
- CATIA V5 software were used to get the Postural Analysis using RULA analysis.

## 3. Results and Discussion

### 3.1 Results

The first type of results is the online survey results. There are 56 respondents of the survey.

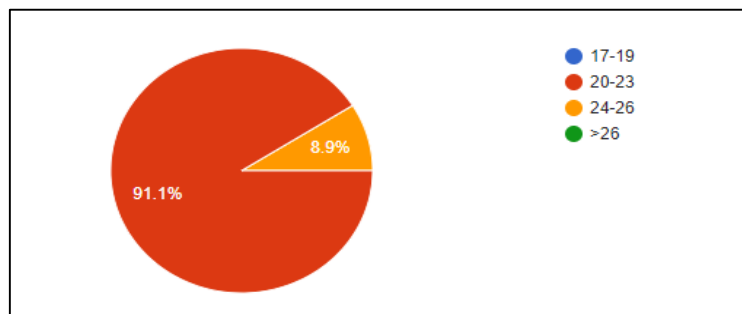


Figure 1: Respondent's age

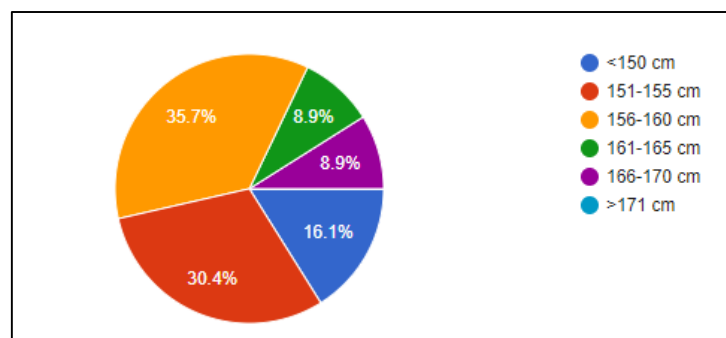


Figure 2: Respondent's height

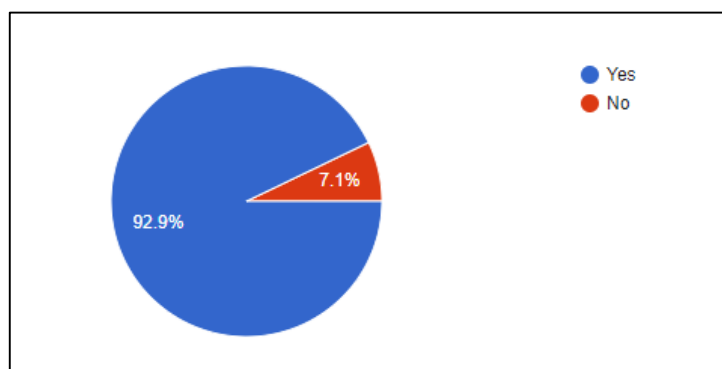
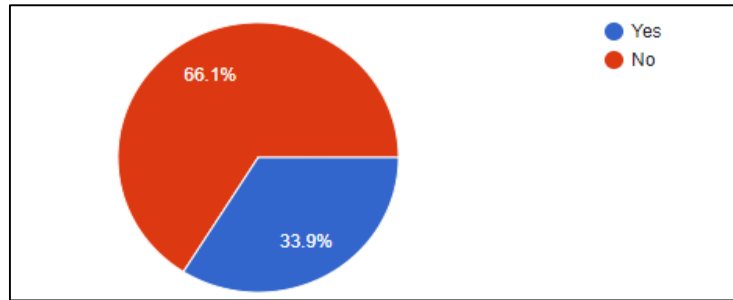
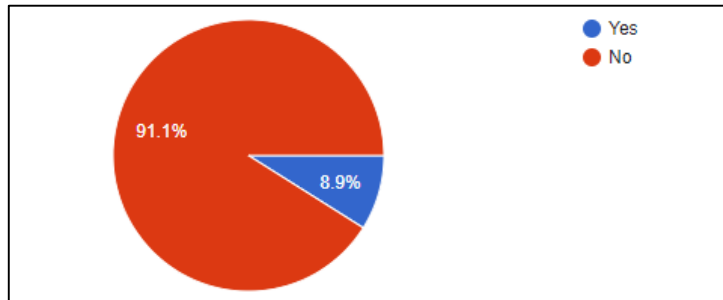


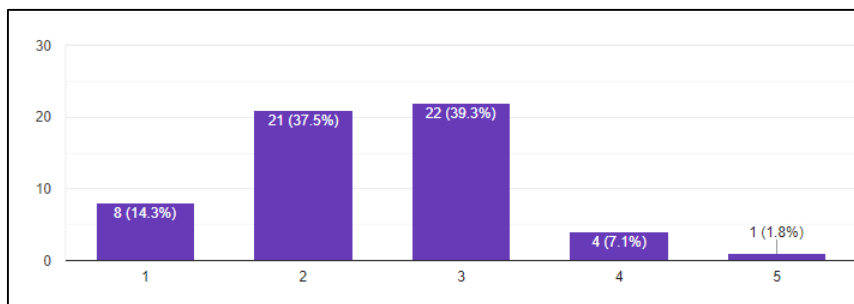
Figure 3: Percentage of responders have drove or being a passenger of MPV/SUV



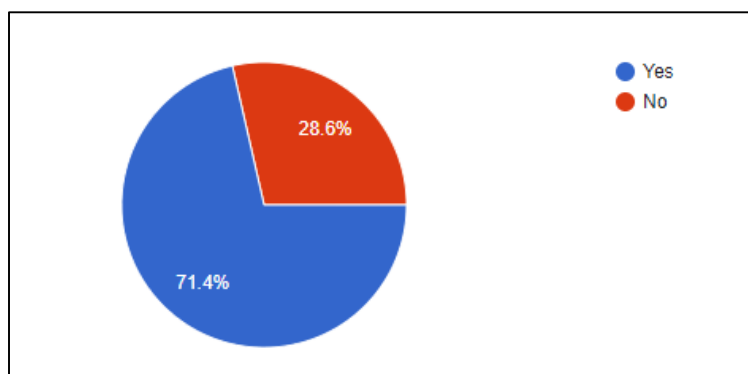
**Figure 4: Percentage of responder had the problem on reaching a car's trunk (MPV/SUV) due to their height**



**Figure 5: Percentage of responder that had faced an accident / caused injury or sore while reaching/during closing the car's trunk**



**Figure 6: Percentage of difficulties level to reach an opened car's trunk**



**Figure 7: Percentage of responders thought about manufacturers should put an end to the manual way of opening and closing the trunk of modern cars especially MPV and SUV**

The second result is the Postural Analysis on CATIA V5 with the RULA analysis.



Figure 8: Manikin Properties

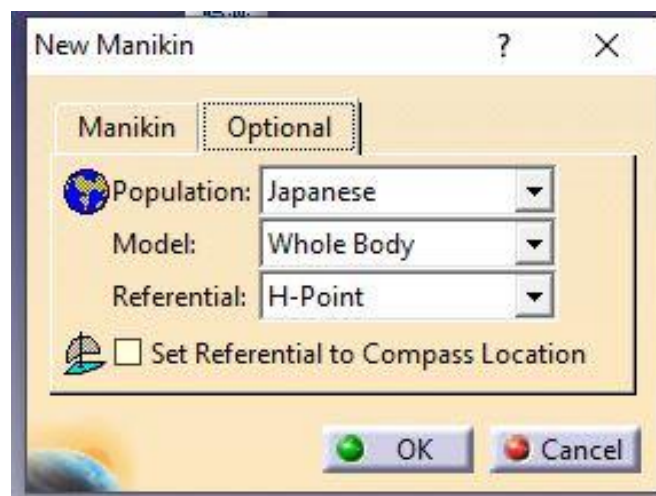


Figure 9: Manikin Properties ii

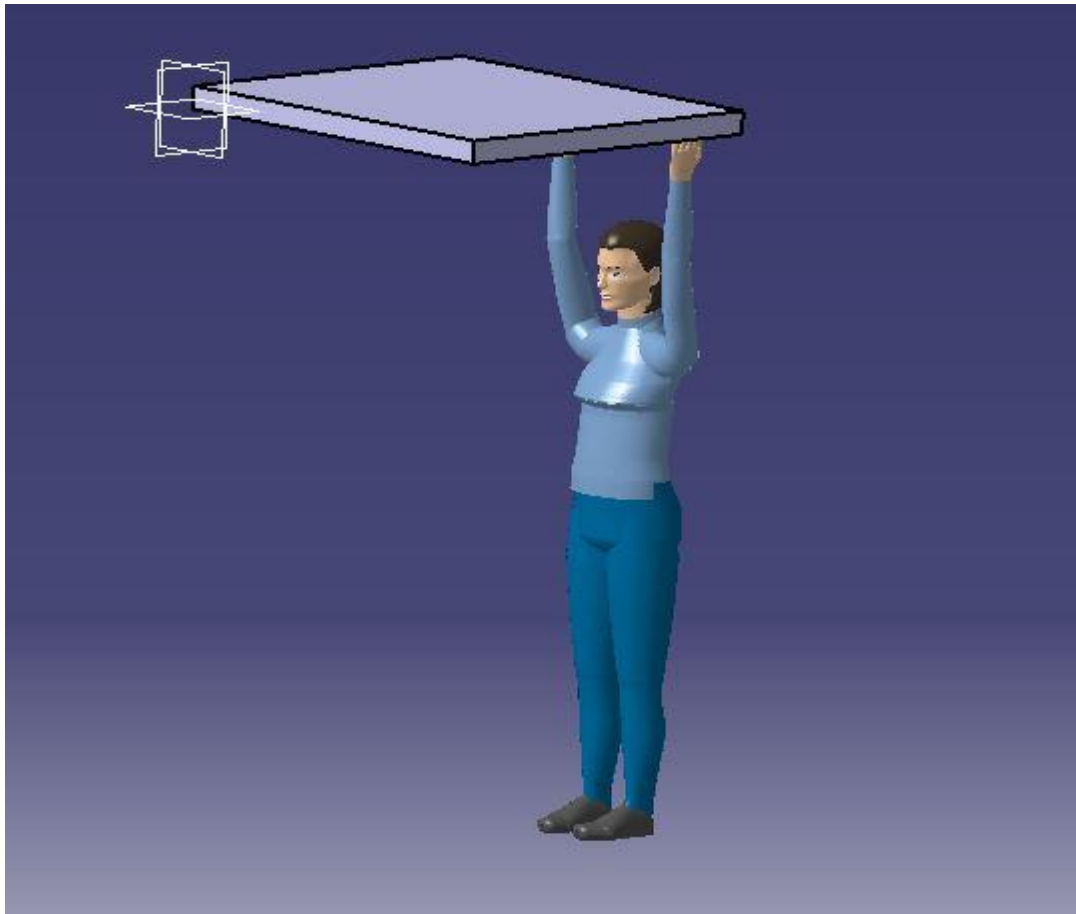


Figure 10: Manikin in standing and reaching object using hand

RULA Analysis (Manikin1) ✕

Side:  Left  Right

Parameters

Posture  
 Static  Intermittent  Repeated

Repeat Frequency  
 < 4 Times/min.  > 4 Times/min.

Arm supported/Person leaning  
 Arms are working across midline  
 Check balance

Load:  ⬆️ ⬇️ ⬆️

Score  
 Final Score: 6 ■ ⏪  
 Investigate further and change soon

Details

+ Upper Arm:	4	■
+ Forearm:	2	■
+ Wrist:	2	■
+ Wrist Twist:	1	■
Posture A:	4	■
Muscle:	1	■
Force/Load:	2	■
Wrist and Arm:	7	■
+ Neck:	1	■
+ Trunk:	1	■
Leg:	1	■
Posture B:	1	■
Neck, Trunk and Leg:	4	■

Close

Figure 11: RULA Analysis of the manikin

### 3.2 Discussions

Based on the above data collected, 19 or 33.90 % of respondents had faced the problem on reaching an opened car's trunk. Other than that, 8.90 % of respondents that had faced any accident / caused injury or sore while reaching/during closing the car's trunk. 71.40 % of the respondents thought about manufacturers should put an end the manual way of opening and closing the trunk modern cars especially MPV and SUV

The RULA analysis on the manikin shows that the final score is 6 with orange colour indicates that investigation and changes are required soon. In addition, on the details part, the RULA analysis showed the upper arm with 4 in score and yellow in colour. Yellow colour means that the posture needs a further investigation only. The forearm and wrist scored the same number that is 2 and also in yellow colour. The load was 3kg that is around 29.43 N had been placed on the wrist and arm. Therefore, the wrist and arm experienced the score 7 that is require investigate and change immediately.

### 4. Conclusion

According to the data collected on whether all car manufacturers should eliminate the manual method of opening and shutting the trunk, 72.7 percent of respondents agreed that all car manufacturers should eliminate the manual method in the future. As a result, it may be argued that future cars, particularly MPVs and SUVs, should include automatic trunk opening and shutting. The overall RULA score displayed by the CATIA program is 6, indicating that it requires further examination and adjustment. As a result, reaching for the trunk might be regarded a risky and detrimental posture for humans. The installation of a device positioned on the tailgate is recommended for this section.

### Acknowledgement

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