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Investigation of Ergonomics Design of Car Boot for Proton Saga (BLM) and Perodua (Myvi)

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Abstract – *Ergonomics is as study of human posture. It concentrated on how to achieve mental and physical comfort. This is a new principles, methods and data drawn from a multi sources to develop engineering system in which human play a significant role. In performing ergonomics study, human variability is used as a design parameter. The term success in ergonomics is measured by improved productivity, efficiency, safety, acceptance of the resultant system design and improved quality of human life. This project will concern itself primarily with the ergonomics of car boot specially Proton (BLM) and Perodua (MYVI). The anthropometry study of car boot is one of the most referenced aspects for the ergonomics design process and this project focus on the hand gripping and dimension of car boot with a human body statically and dynamically. This study is to correlate car boot handle dimension to comfort factors by mean of measuring and survey as well as using ergonomic software.*

Key Words: **Ergonomics Design and Analysis, Anthropometry, Rapid Upper Limb Assessment, Human Posture Construction.**

1. INTRODUCTION

Ergonomics is a study of human posture. It concentrated on how to achieve mental and physical comfort. It is also known as human factors engineering, the science of designing machines, products and system to maximize the safety, comfort and efficiency. The ergonomics studies are performed by ergonomist. They draw the principles of industrial engineering, psychology, anthropometry (the science of human measurement), and biomechanics (the study of muscular activity) and all of these information are adapted in designing a product and workplace by considering people sizes and shapes, and their physical strength and limitations. In the studies of ergonomics, human and their products are viewed as one unit and the ergonomics mixes the abilities of human and machines (Jastrzebowski1857).

Ergonomics is new principles, methods and data drawn from a multi sources to develop engineering system in which human play a significant role. In performing an ergonomics studies, human variability is used as a design parameter. The term success in ergonomics is measured by improved productivity, efficiency, safety, acceptance of the resultant system design and improved quality of human life (Kroemer & Kroemer-Albert 2001). The importance of the relationship between humans and tools as it was realized in early development of the product (Christensen 1986).

There is a hierarchy of goals in ergonomics. The fundamental task is to generate tolerable working conditions that do not pose known dangers to human life or health. When this basic requirement is assured, the next goal is generate acceptable conditions upon which the people involved can voluntarily agree according to current scientific knowledge and under give sociological, technological and organizational circumstances. The final goal is to generate optimal conditions which are so well adapted to human characteristics, capabilities and desires. That physical, mental and social well-being is achieved. The multitude of different consumer goods which we encounter in our daily lives safe and comprehensible operation is also included under ergonomics.

In our present civilized world, ergonomics in many different form as general ergonomics, micro-ergonomics and multitude of different consumers goods. The most important field of application is general ergonomics in technical system such as mechanical engineering and road vehicle, air craft and marine vessel engineering. In principle, ergonomics is the study of people and their work. Objective of ergonomics is to optimally match labour and work environment to human being.

The anthropometry study of car boot is one of the most referenced aspects for the ergonomics design process and this project focus on the hand gripping and dimension of car boot with a human body statically and dynamically. The aim of this work is to study customer satisfaction as the passenger or driver to compare car boot dimension to comfort factors by mean of measuring and survey as well as using ergonomics software and to recommend the best dimension of car bot in aspect of anthropometric data percentile.

The human factor aspect of designing automobiles design is considering car boot handle. It is a method to provide comfort for driver and occupant. Other purpose or to provide alternative solution and proposals, to ensure the legal requirements and to ensure all domestic requirements are met. This study is to correlate car boot handle dimension to comfort factors by mean of measuring and survey as well as using ergonomic software.

1.1 Objective

The main objective of this paper is to:

i. To study customer's satisfaction of both Proton Saga BLM and Perodua Myvi's car boot handle.
ii. To compare car boot's handle dimension by measuring and survey using ergonomics software.
iii. To recommend the best dimension of car boot in term of anthropometry data percentile.

1.2 Scope and Limitation

In this project there are two scopes that need to be focus on. The first thing is to focus on ergonomic and safety for vehicle car boot handle for Proton Saga (BLM) and Perodua (MYVI). By means, the comfort of car's user and also their safety. The second scope of this project is anthropometry survey only focuses for those who drives and ride Proton Saga (BLM) and Perodua (MYVI).
There are three limitations of this project which is car selection, ergonomic software and measuring equipment. For car selection, this project only focuses on Proton Saga BLM (1.3) and Perodua MYVI (1.3). Second limitation is ergonomics software; there is few ergonomics software that exists. Lastly, the measuring equipment is to measure dimension of human body which is head, hand, leg and others.

1.3 Problem Statement

There will always be a need well-designed hand tools. Most tasks at work and private lives involves grasping, holding, turning, pressing and many other manipulations done with our digits on objects held between the thumb and four fingers and the palm of the hand. Good handle design is important at work and in all kinds of daily activities for items that are efficient to use and safe. A car boot handle is an attached mechanism used to open or close a car boot.
Hand force depends on the combined effect of intrinsic and extrinsic muscle. Intrinsic muscles and their tendons are completely contained in the hand whereas extrinsic muscles are located in the forearm they extend their tendons across the wrist join to the hand with it digits. Most intrinsic muscles contributes to finely controlled action of the digits, whereas the extrinsic muscle primarily generate large force for moving the whole hand about the wrist joint and for exercising the individual digits.

2. LITERATURE REVIEW

Ergonomics or human factors is the scientific discipline concerned with the understanding of interactions among humans and the others elements of a system and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.
It focused on the study of human fit and decreased fatigue and discomfort through product design. The application of scientific principles, methods and data drawn from variety of disciplines to the development of the engineering system in which people play a significant role. Among the basic disciplines are psychology, cognitive science, physiology, biomechanics, applied physical anthropometry and industrial system engineering.
Ergonomics can be an integral part of design, manufacturing and use. Knowing how the study of anthropometry, posture, repetitive of motion and workspace design affects the user is critical to a better understanding of ergonomics as they relate to end-user need.
The reason that every system is life needs ergonomics is to ensure that our knowledge of human characteristics is brought to bear on practical problems of people at work and in leisure. In many case, humans can adapt to unsuitable conditions, but such adaptation lead often to inefficiency, errors, unacceptable stress and physical and mental cost.
There is a hierarchy of goals in ergonomics. The fundamental task is to generate "tolerable" working conditions that do not pose known dangers to human life and health. When this basic requirement is assured, the next goal is to generate "acceptable" conditions upon which the people involved can voluntarily agree, according to current scientific knowledge and under given sociological, technological and organizational circumstance.
The final goal is to generate "optimal" conditions which are so well adapted to human characteristics, capabilities and desires, that physical, mental and social well-being is achieved. The multitude at different consumer goods which we encounter in our daily lives, save and comprehensible operation is also included under "ergonomics". Specifically, ergonomics also called human factor or human engineering in United Stated may defined as the study of human characteristic for the appropriate design of the living and work environment.

3. METHODOLOGY

In order to meet the objective, two passenger cars are selected to be measured in order to investigate for the

dimension parameters that contributed the automotive ergonomics consideration. Car selected are Proton Saga (BLM) and Perodua (MYVI). Cars users input will be taken into account from questionnaire that are intended to seek user's preference in term of ergonomics. Through dimension measurement and CAD data will be analyzed. Virtual comfort measurement will be made to use for comfort and clearance study to 95% men and 5% women population. The end, result will report on the finding from surveys, measurement and analysis.

3.1 Questionnaire

The survey was meant to get the general idea of satisfaction for each car boot handle. Only questionnaire could be asked to make it easier for them to answer all questions. From the surveys form, the answers are divided into five categories from scales 1 to 5 which is consists very comfort, comfort, moderate, discomfort and very discomfort. The survey was evaluated by 100 respondents which are UniKL students, PTSB students and people around Kulim.

3.2 RULA Analysis

RULA or Rapid Upper Limb Assessment is a survey method for ergonomics investigation of workplace where work related upper limb disorders report. RULA is a well-established, fully validated method for scoring postures that is used worldwide. RULA is a screening tool that assesses biomechanical and postural loading on the whole body with particular attention to the neck, trunk and upper limbs. RULA assessment needs a little time to complete and scoring generate an action list which indicated the level if intervention is required to reduce the risk of injury due to physical loading on the operator (McAtamney & Corlett, 1993).

RULA was developed to investigate the exposure of individual workers to risk factors associated with work related upper limb disorders. Part of the development took place in the garment-making industry where assessment was made of operators who performed task including cutting while standing at the cutting block, machining using on a variety of sewing machines, clipping and inspection operators also packing. RULA was also developed through the evaluation of the postures adapted, forces required and muscle action.

RULA was developed without the need for proposal equipment. This provided the opportunity for a number of investigators to be trained including the assessment without additional equipment expenditure. In the investigator only requires a clipboard and pen. RULA assessment can be done in confined workplace without disruption to the workplace. RULA aimed to make a rapid measurement on neck and upper-limb in mainly sedentary task. Positions of individual body segments will be observed and the more there is a deviation from the neutral posture the higher will the score of each body part be. In ergonomics studies, RULA analysis becomes a part of important task to be considered.

Table-1: Scoring for RULA (McAtamney & Corlett 1993)

RULA score	Action Level	Description
1-2	1	Posture is acceptable if it is not maintained for long periods.
3-4	2	Further investigation is needed and changes may be required.
5-6	3	Investigation and changes are requires soon
7	4	Investigation and changes are required immediately

3.3 Ergonomics Analysis in CATIA

CATIA is computer aided design software developed by Dassault Systemes. This software consist basic and advanced engineering design and analysis and was included with Ergonomics Design and Analysis (EDA) module. Based on the human builder, the ergonomics analysis could be performed effectively. Using CATIA software, we could easily generate the RULA analysis. The data from RULA analysis can be used in analyzing ergonomics and thus helps in design process. Other than that, CATIA can be used to evaluate Lift-Lower Analysis, Push Pull Analysis and Carry Analysis. By implementing and using the ergonomics facilities, CATIA is generated the ergonomics design processes are defined by four sub modules:

a. Human Builder

Human Builder provides very accurate simulation of human and interaction with product to ensure they will operate naturally in a workplace tailored to the task. This module specifically focuses on creating and manipulating digital human for "first level" human-product interaction analysis. This module can define and create the probable user of the product of system that is in fact the human operator represent by a manikin. To define a new user, the new manikin command must be selected taking into consideration the product or system where the manikin will be implemented. The human interface then has to define. The module allowed percentile (%) for human body dimension corresponding to the problem worker's body dimension by considering Gauss normal distribution.

b. Human Measurement Editor

Human Measurement Editors specifically focuses on creating detailed digital humans for advanced human factors analysis and global target audience accommodation. This module allows the designer to personalize the manikin. There are two possibilities for the variable action. The designer can be either tape the variable value or adjust it. The second possibility is better because the variable value cannot exceed the limits determined by the manikin construction. After establishing the manikin's type and dimension, user must choose the work position by correct manipulation of the

object. The Forward Kinematics command allows the user to move the different body segment easily and directly. The posture edition command makes it possible to modify the manikin's body segments by selecting them form an additional list. Finally, the correct posture established.

c. Human Posture Analysis

Human Posture Analysis permits user to quantitatively and qualitatively analyse all aspects of manikin posture. This module allows the designer to develop the posture analysis after manikin definition is complete. By using the posture analysis command, the designer can edit the angular limits of some human body (manikin) segment. After all the angular limitations for the entire human body segment have been analysed, the user has to evaluate the posture. The system can easily establish the global score of the posture and the score for some details corresponding the different manikin segment position.

d. Human Activity Analysis

This module enables development of dynamic strain analysis for an adopted position of work activity. In this context user can evaluate the tiredness degree for a human operator that lift a weight with a particular frequency. The user can also determine the maximum weight that can be pushed or pulled by human operator. The ergonomics study use four type of analysis which is RULA Analysis, Lift/Lower Analysis, Push/Pull Analysis and Carry Analysis. The analysis starts by establishing the initial and final position of the move. Then, the tiredness degree can be evaluated by using NIOSH 1981 based on the tiredness degree analysis in the case of weight lift using symmetric move of both hands without turning the superior part of the body, with a maximum average of 75cm. NIOSH 1991 is an extended method of the first where applied in the case of weight lifted but allowed user to determine the tiredness degree depending on the length of the movement.

4. RESULTS AND DISCUSSION

In order to find the result, SPSS Statistic Tools used to perform data entry and analysis and to create tables and graphs. SPSS is capable of handling large amounts of data and can perform all of the analyses covered in the text and much more. SPSS is commonly used in the Social Sciences and in the business world. From the surveys result, the answer are divided onto 5 categories form scale 1 to 5 which consist very comfort, comfort, moderate, discomfort and very discomfort. The survey was evaluated by 100 respondents which is divided 50 respondents are the Myvi user and other 50 respondents are the Saga BLM user. The surveys were meant to get the general idea of satisfaction for each car boor handle.

4.1 Cronbach's Alpha and Mean

Cronbach's Alpha (α) is a coefficient of internal consistency. It is commonly used as an estimate of the reliability of a psychometrics test for a sample of examines. Here are the results of cronbach's alpha based on surveys questionnaire that have been made. The table shows the value of cronbach's alpha of respondent rating. And the Mean of respondent's rating are calculated and put into the table below with the result of Cronbach's Alpha.

Table-2: Cronbach's Alpha Scoring

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent (High-Stakes testing)
$0.7 \leq \alpha < 0.9$	Good (Low-Stakes testing)
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Table-3: Mean and Cronbach's Alpha of Responding Rating

	PERODUA MYVI		PROTON SAGA BLM	
	Mean	Cronbach's Alpha	Mean	Cronbach's Alpha
Car Boot Handle	1.50	0.531	2.92	0.140
Car Boot Handle Design	1.62		2.90	
Car Boot Handle Location	2.34		2.82	
Handling Car Boot Difficulty	1.50		2.48	

4.2 Bar Chart Rating

Based on figure 1(a), the bar charts above represent four statements of car boot handle. Users of Perodua Myvi are satisfying with the car boot handle, no big issue about Myvi's car boot handle. The car boot handle are desirable. The users or Myvi have no problem with their car boot handle. For figure 1(b), the bar charts showed the statements of car boot handle for Proton Saga BLM. 8% of respondents are very discomfort with the car boot handle at the same time no respondent choose very discomfort. The design of the handle is the factor respondents choose very discomfort. While open the car boor of Saga BLM, a key or need to use the button inside the car meaning that this is the problem for users.

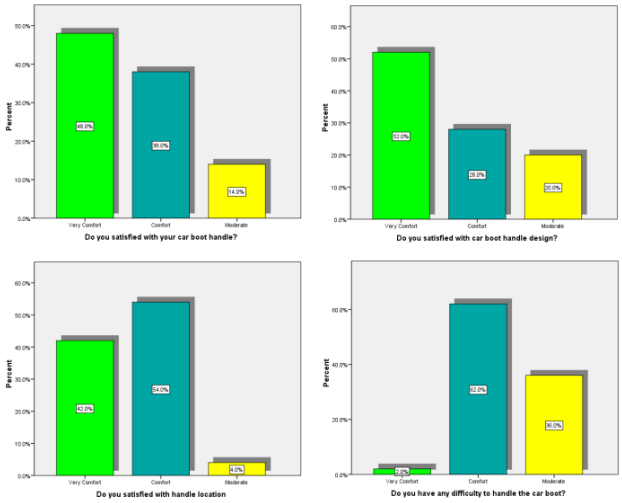

Figure-1(a): Bar Chart of Perodua Myvi Car boot handle

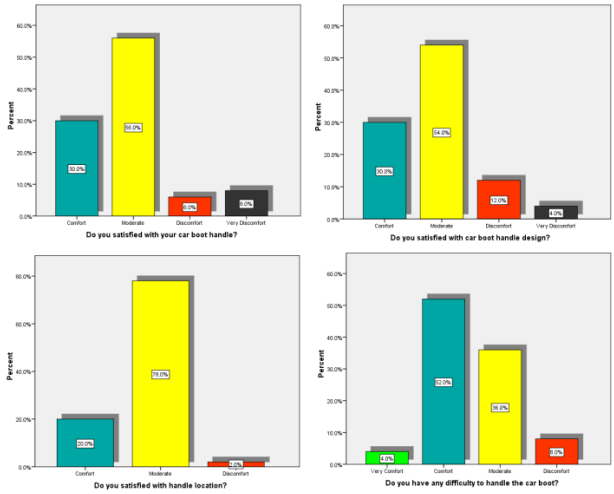

Figure-1(b): Bar Chart of Proton Saga Car boot handle

Since users of Myvi mostly a female, only small percent of female know about how to handle car and what ergonomics is so can conclude that this result may be affected by emotion. Since the survey was conducted only in local area, the result may not accurate. Compared to Saga BLM user which is users is a man so that the result is more rational.

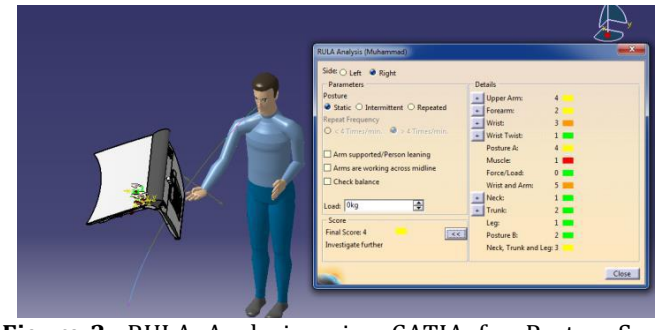

Figure-3: RULA Analysis using CATIA for Proton Saga BLM

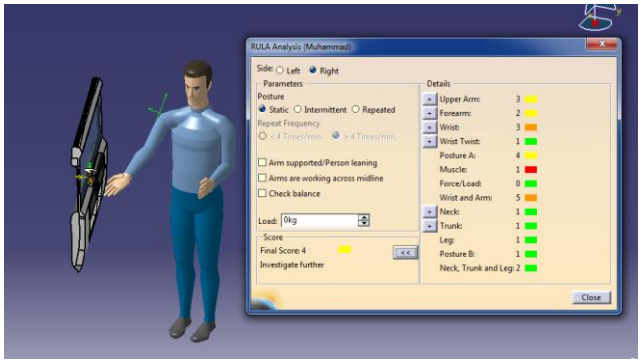

Figure-4: RULA Analysis using CATIA for Perodua Myvi

Figure 3 and 4 are the result of RULA Analysis using CATIA. By place the manikin and edit. From the result of RULA Score, both car boot handle need to have further investigation is needed and changes may be required, which mean this analysis's final score of RULA Analysis are 4.

4.3 Bar Chart Rating

The result in table 4 came from the Ergonomics Design Analysis using Human Posture Analysis. This CATIA software can calculate the scoring by refer to the manikin and the car boot. Final score of both car boot handle is 4 which mean further investigation is needed and changes may be required.

Table-5: Rating score using RULA analysis in term of RULA analysis score using worksheet (Concept rating 0-7 based on RULA scoring)

No	Criteria	(Car Boot Handle) Proton Saga	(Car Boot Handle) Perodua Myvi
1	Upper Arm	4	3
2	Forearm	2	2
3	Wrist	3	3
4	Wrist Twist	1	1
5	Posture A	4	4
6	Muscle	1	1
7	Wrist and Arm	5	5
8	Neck	1	1
9	Trunk	2	1
10	Leg	1	1
11	Posture B	2	1
12	Neck, Trunk and Leg	3	2
13	Final Score	4	4

Based on RULA analysis of the existing design, all of them acceptable score for the ergonomics. So both of the passenger cars Proton Saga BLM and Perodua Myvi can be conclude as desirable car. Here also can be said that current car boot handle was suitable and comfortable because it fulfil the ergonomics required for users.

For RULA Assessment Worksheet show that the car boot handle for Proton Saga BLM and Perodua Myvi get 4 final score which is further investigation is needed and changes may be required.

5. CONCLUSION

This project can be further study upon safety aspect as well as ergonomics study. This is because, ergonomics is not only term for comfortable but also as safety aspect and styling also can be included. As recommendation, this project can be further study upon safety aspect as well as ergonomics study. This is because, ergonomics is not only term for comfortable but also as safety aspect and styling also can be included.

REFERENCES

[1] Kroemer, K. H. 1986. (1986). Coupling hand with handle. Human factors 28(3) 337-339.
[2] Bridger, R. (2009). *Introduction to Ergonomics Third Edition*.
[3] Grandjean, E., & Kroemer, K. H. E. (1997). *Fitting the task to the human: A textbook of occupational ergonomics (5th Ed.)*.
[4] Hansen, L. S. (2007). *Applied Catia V5*.
[5] Lämkull, D., Hanson, L., & Örtengren, R. (2007). The influence of virtual human model appearance on visual ergonomics posture evaluation. *Applied Ergonomics*, 38(6), 713-722. http://doi.org/10.1016/j.apergo.2006.12.007
[6] Seok, C. B., Bahari, F. B. @ H., & Mutang, J. A. (n.d.). *SPSS Prinsip dan Analisis Data dalam Sains Tingkah Laku*.
[7] Stephen, J. G. (2006) *"Human Factor Engineering and Ergonomics"*. Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc., Publisher.