ORIGINAL ARTICLE

KANSEI ERGONOMICS APPROACH TOWARDS AUTOMOTIVE HEAD-UP DISPLAY CONTROL PANEL DESIGN

Muhammad Shah Afendy MOHD AMIR[1], Malek HAMID[1,]*

[1]Department of Manufacturing and Materials Engineering, Faculty of Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia
[*] Corresponding Author: abdmalek@iium.edu.my

ABSTRACT

Head-up Displays (HUD) is a new technology available in the automotive industry. Basically, this technology used to project a piece of important information required by the drivers towards the windshield of the vehicle. Due to the fact that the HUD system is still new in the market, so its mechanism, function, and interface design still can be improved by adding some values to the system. In this study, the focus is more on the improvement of the HUD control panel design to minimize the design complexity as well as to reduce the distraction of the drivers while driving. Nowadays, the application of the Kansei Ergonomics is growing rapidly due to many researchers and product designer are attracted to explore and trying to relate the Ergonomics concept into the Kansei Engineering concept in order to optimize the design that can fit to the human and their preferences. The study is started by identifying the suitable design properties and Kansei Ergonomics concept words that related to the HUD system. Eighteen design properties and nine Kansei Ergonomics concept words were determined. This finding was used to develop the Semantic Differential Question using the Google Form. Then, an Online Survey was conducted with one hundred respondents using the semantic differential question in order to evaluate the relationship between the design properties against the Kansei Ergonomics words. After completing the evaluation phase, the finding were used to recommend a new interface design for the HUD control panel. In the end, this finding will provide a piece of information regarding the HUD system.

***Keywords**: Kansei Engineering, Kansei Ergonomics, Displays Ergonomics, Contol Panel Design*

INTRODUCTION

Kansei Engineering is a useful methodology used to deal with the emotional needs of a consumer. Generally, Kansei is one of the prominent studies in product design that aims to create a newly invented product that can satisfy the consumer. As mentioned by Nagamachi (2008), the definition of Kansei is "to translate the consumers psychological feeling into the product design specification". Meanwhile, Ergonomics is defined as the branches of science that concern with the understanding of interactions between human, systems, and environments in order to optimize human well-being and overall system performance (Naeini & Heidaripour, 2011). The application of Ergonomics in the design process has proven to optimize the interaction between human and design. Thus, it is important to apply both Kansei and Ergonomics concept together in the design stage to ensure the outcome of the design would fit the human and their preferences.

Head-up displays (HUD) is a new technology used in the automotive industry that projects the driving information onto the windshield of the car in order to help the drivers to maintain focus when driving (Chin Pow & Syed Mohamed, 2016). Some of the basic driving information that is presented by HUD includes speedometer, tachometer (RPM meter), a navigation system, fuel level, warning signals, and estimated destination time. HUD system is capable to improve the driving performance of the driver as the driver is able to acquire necessary information from the system and at the same time remains focused on the driving. However, frequent usage of the HUD systems somehow could produce distraction to the driver because of the driver subconsciously focusing more on the driving information presented by HUD instead of the roadway (Tufano, 1997). Distraction normally can be caused by switching of the vision between two sources which are the HUD system as well as the road environment. Therefore, the design of the HUD system should be simple and easy to understand so that the time for the driver to look at the HUD display can be reduced. If the driver needs to think and analyze the meaning of the symbols and icons appear on the HUD, it will cause a distraction to the driver and the driver is not able to focus on the road condition. Therefore, this research was conducted in order to develop and design a new HUD control panel that can minimize the problems.

Nowadays, a majority of the manufacturers are focusing more on developing the functionality of the system. Less focus is given to the interface design of the system that can fit the user's preferences. Kansei Ergonomics is a combination knowledge of Kansei Engineering – that focus more on the consumer's feeling – and Ergonomics

– that focus more on optimizing the interaction between the human and system. Thus, Kansei Ergonomics concepts also can be applied to develop a new control panels design of the HUD. Generally, this study will focus more on the design of control panel for the HUD that will minimize the frequency of the driver to look down onto the dashboard of the car. The aim of the project is to recommend the interface design of the HUD control panel based on the user preferences by applying the basic concept of Kansei Ergonomics. In order to achieve the aim of the project, the following objectives need to be achieved: (i) To study the HUD system and determined the design properties of the system that relate to ergonomics principles; (ii) To select the suitable Kansei Ergonomics concept words that related to Ergonomics principles and the HUD design; (iii) To develop the Semantic Differential Question used for the Online Survey (iv) To analysze the relationship between the design properties of the HUD systems with the selected Kansei Ergonomics concept words using One-Way ANOVA in SPSS; (v) To recommend a new control panel design for the HUD system based on the finding in part (iv).

METHODS

Identification of the relevant design properties for the HUD control panel design

The design properties of the HUD control panel were collected by identifying and evaluating the available existing products and concept designs of the system from the internet and published literature. Eighteen design properties were identified, and they are: (i) indicator display of the speedometer; (ii) indicator display of the tachometer; (iii) indicator display of the fuel gauge; (iv) color of the speedometer; (v) color of the tachometer; (vi) color of the fuel gauge; (vii) color of the warning indicator; (viii) center scale of the speedometer; (ix) scale style of the fuel gauge; (x) pointer design of the speedometer; (xi) pointer design of the tachometer; (xii) pointer design of the fuel gauge; (xiii) labelling style of the speedometer; (xiv) labelling style of the fuel gauge; (xv) state of warning indicator sysmbol; (xvi) layout design of the warning indicator; (xvii) transparency of the display; and (xviii) shape of the speedometer. For each design property, three design options were provided to give the opportunity for the respondents to choose the best design. Design property (i) which is the indicator display of the speedometer will be used to describe the details of the method for this part.

Indicator displays of the speedometer is a device used to provide information to the drivers that relates with the speed of the car. Design considerations that suitable for this design property are: (i) Which indicator display will be the best for checking the current speed of the car?; (ii) Is the indicator display can be readable and interpretable by the drivers?; and (iii) Is the indicator display is capable to provide the information to the drivers related to the change of speed of the car?. Based on these considerations, three design options for the indicator display of the speedometer were designed as illustrated in Figure 1. The details of the indentifcation of the other design properties can be found in Amir (2017), and Table 1 lists the summary of three design options that relevant to the eighteen design properties for the HUD control panel design.

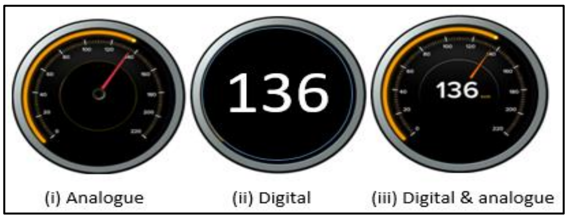

Fig. 1 Indicator display of the speedometer: (a) analogue; (b) digital, and (c) digital & analogue

Table 1 Summary of the relevant design properties for the HUD control panel design

Design Properties	Design 1	Design 2	Design 3
Indicator design for speedometer	Analogue	Digital	Both
Indicator design for Tachometer	Analogue	Digital	Both
Indicator design for fuel gauge	Analogue	Digital	Both
Color option for speedometer	White	Blue	Green
Color option for tachometer	White	Blue	Green
Color option for fuel gauge	White	Blue	Green
Color option for warning	No color	Same color	Different color
Center scale for speedometer	100km/h	110km/h	120km/h
Scale style for fuel gauge	Line	Bar	Dotted
Pointer design for speedometer	Long	Medium	Short
Pointer design for tachometer	Long	Medium	Short
Pointer design for fuel gauge	Long	Medium	Short
Labelling style for speedometer	10 km/h	20 km/h	30 km/h
Labelling style for fuel gauge	Alphabelt	Number	Both
State of warning indicator symbol	Light	Sound	Both
Layout design for warning	Vertical	Horizontal	Rectangular
Transparency of the display	50%	75%	100%
Shape of speedometer	Round	Half-round	Rectangular

Selection of Kansei Ergonomics concepts words for HUD control panel design
Kansei Ergonomics concept words are collective of Kansei words that describe the product, system, design, situation, and surrounding that can specifically relate with the ergonomics concepts. In Kansei Engineering, the selected words represent the consumer's feeling. However, for Kansei Ergonomics, the chosen words would specifically relate to the ergonomics principles. For instance, to describe the color of a product, the possible Kansei Engineering words that can be chosen were elegant, stylish, and beautiful. As for Kansei Ergonomics, the words that suitable to describe the color were identifiable, visible and attentional.

The method to collect the Kansei Ergonomics concept words is similar with Kansei Engineering words in which the words can come from the combination of the external sources as well as the words from the experienced people based on the existing product in the market. Some of the suitable sources are: (i) academic book; (ii) magazines; (iii) scientific publication; (iv) internet, and (v) expert's opinion. One important consideration that was taken when choosing the Kansei Ergonomics concept words for this study was to ensure the words were always in 'positive' words. This is because, if the chosen word is negative, it will affect the scoring method during the evaluation phase. For instance, if the negative word "confused" was chosen, by giving the lowest score meaning the design property was not confused (positive word) while giving the highest score meaning the design property was confused (negative word). Consequently, if the total score of the two words (negative and positive) were added up, it will be meaningless. Therefore, to avoid the word become meaningless during the evaluation phase, the negative words were changed to positive word to become "unconfused". After ensuring the chosen words were the positive words and also related to the ergonomics principles, a total of nine Kansei Ergonomics concept words were selected for the study. Table 2 lists the words with its definition.

Table 2 The nine selected Kansei Ergonomics concept words with its definition

Kansei word	Definition
Identifiable	Capable of being recognized
Interpretable	Capable to be explained
Distinguishable	Capable of being differentiate
Understandable	Capable of graps the meaning of
Visible	Capable of being seen
Attentional	State of applying mind to something
Useful	Capable of being put to use
Legible	Capable of being read
Simple	Not complex

Development of Semantic Differential Question
Semantic Differential Question is one of the tool used in Kansei Engineering to evaluate the relationship between the Kansei words and the product design properties. In this study, the evaluation was specifically focus on finding the relationship between the Kansei Ergonomics concept words against the design properties of HUD control panel design. Thus, to develop the Semantic Differential question, each design property was matched with the selected Kansei Ergonomics concept words. To evaluate the relationship, each respondent was required to give his or her score towards the Kansei Ergonomics concept words. Normally, in Kansei studies, a 5-grades and 7-grades of Semantic Differential scale was used for the scoring method. In this study, a 5-grades scale was used to develop the question form. By having a 5-grades Semantic Differential scale means that each Kansei word will consist of 5 levels of score - 1, 2, 3, 4, and 5-point scales - in which '1' is referring to the most negative judgment of the Kansei word while '5' is referring to the most positive judgment of the Kansei word.

Data collection through Online Survey
To collect the data and information from the respondents, an online survey method was used. The HUD technology is still new in the market and most of the Malaysian citizens may not familiar with this technology. Thus, a video presentation related to HUD technology was provided to make the participant familiar with the technology. Online survey method also requires less cost and it is also convenient for the respondents to participate because they may start answering the survey questions at one time, stop, and complete it later. A simple guideline for Semantic Differential Evaluation also was given inside the online survey to help the participant in answering the questionnaire.

Procedure of the study
Participant: A total of one hundred respondents were participated in the study. The requirement that needs to be fulfilled by the respondents is only a valid competent driving license (CDL). The age factor is not under consideration of the study due to the study is not related to the driving behavior. However, to avoid potential issue that may occur – (e.g. technology acceptance among older drivers) - only respondents between 18-30 yearsof age were recruited in this study. Gender, ethnic background, and minority status were not taken into account in this study. However, the details information of the respondents were collected for record purposes.

Apparatus and stimuli: Script for recruiting using WhatsApp was prepared so that only one standard and similar format of recruitment text was sent to the potential respondents. An informed consent form was prepared as the guideline for the potential respondents to participate in the study. In general, the form addresses about the: (i) eligibility of participant; (ii) details information of the study to the extend that it will not prejudice the objectives of the study; (iii) risk and confidentially statement of the study; and (iv) voluntary statement in participating and completing the study. This form was transferred to the Google form so that the respondents can read it before answering the survey questions. The demographic information such as gender, age, and race were collected for the record purpose. Furthermore, some additional questions related to the study also were collected such as the driving experience and participant's familiarity with the HUD system. This form was attached in the Online Survey form to make it easier for the respondents to fill it out. Since the HUD system is relatively a new technology among Malaysian drivers, a video of the HUD systems was prepared by combining several videos related to the HUD systems that available in the market. This video was shown to the potential respondents (via the youtube link that was provided in the survey) in order to make them understand and have a clear idea about the HUD technology. The video was uploaded into the YouTube and the link of the video was provided inside the Online Survey form. The Semantic Differential Question Form was used for the Online Survey to evaluate the relationship between the design properties of the HUD control panel against the Kansei Ergonomics concept words. To assist the respondents, simple instruction was provided to help the respondents in answering the Semantic Differential questions.

Online survey procedure: During the Online Survey, each participant was asked to read the Informed Consent form in order to make them understand about the study in general so that he or she can make an informed decision to participate in the study. After that, at the end of the form, each participant was given an opportunity to choose either to agree or not with the terms given. If he or she agrees with the terms provided, its means that he or she is willing to participate in the study and if not agrees, he or she can stop doing the online survey immediately. After agreeing with the Inform Consent form, each participant was asked to complete the participant form. In addition, each participant was asked to watch a video presentation on head-up display technology provided in the survey. This video presentation somehow can help the respondents to make a firm decision when they were answering the survey questions. After watching the video presentation, the respondents was asked to answer the Semantic Differential questions for about twenty minutes to evaluate the relationship between the design properties of the HUD control panel against Kansei Ergonomics concept words. The feedback from each participant was recorded in the Google Form. Finally, all of the data collected from the Online Survey were transferred into Microsoft Excel for the analysis.

Development of the new HUD control panel design based on the findings: Results from the Online Survey were analyzed using SPSS software and based on the findings, a new interface design of the HUD control panel was developed. The new interface design was compared with the Ergonomics principles to ensure the design is ergonomic and satisfy the user preferences.

RESULTS

Raw data obtained from the respondents through the online survey were sorted accordingly in Microsoft Excel and the mean for each Kansei word – there are nine Kansei words in total – were calculated. After that, these data were transferred into the SPSS software. Then, the data were analyzed to obtain: (i) the mean and standard deviation that is comparing the three designs for each design property; and (ii) significant value of the comparison. In addition, the graph of the mean with its standard deviations was plotted. Lastly, the results obtained were discussed accordingly. Design property (i) which is the indicator display of the speedometer will be used to describe the details of the finding obtained.

Design Property (i) - indicator display for the speedometer: The three designs evaluated were; (1) analog display; (2) digital display; and (3) combination of analog & digital display. The result shows that the mean score for design 1, 2, and 3 are 3.93, 4.16, and 4.22 respectively (Fig. ***2***). Thus, on average, in term of the indicator display for speedometer, design 3 was preferred by the respondents. The difference between the three designs was significant [F (2,24) = 3.419, p = 0.049].

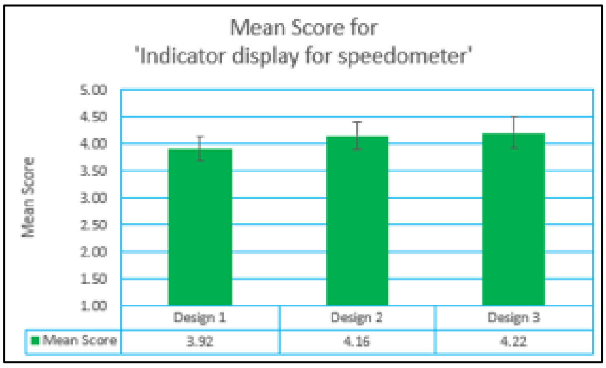

Fig. 2 Graph of the mean score and standard deviation for design property (i)

The design chosen by the respondents for this design property is the combination of analog and digital display. From the Ergonomics point of view, analog display is more preferable to be used as the indicator display. This is because a piece of additional information to the driver that is the rate of the speed change is offerred (Woodson, B. Tillman, & P. Tillman, 1992). According to Oborne (1995), the majority of the car drivers preferred to use analogue dial because of the capability for reading the fast changes of the car's speed. However, some of the car drivers might prefer to use digital speedometer due to its ability to provide the precise reading of the car's speed at any instant. According to Mitchell (2010), some advantages of using digital display are; it can provide the precise reading at any instant, and less space is needed on the control panel. In addition, digital displays perhap exist due to the current modern characteristic. But, using a digital display somehow can be poor in changing the information (Bridger, 2017). As a result, a driver might be confused and difficult to understand the information given. In this case, the reason why the majority of the respondents choose the combination of analog and digital as the indicator display for speedometer may be due to the latest technology for speedometer used to combine both analog and digital display. The details result and discussion of each design property can be found in (Amir, 2017).

Summary of the results: There are eighteen design properties that were evaluated in this study. Table 3 summarizes the findings. The highlighted color for the findings (yellow) are the designs that were chosen -the highest mean value - by the respondents. The significant values for each design property – comparison between the three designs and nine Kansei Ergonomic words - were collected by analyzing it using one-way ANOVA in SPSS. From the result, out of eighteen design properties, fifteen were significantly different. Even though the other three design properties were not significant, the pattern of the results is still consistent with the expected pattern.

Table 3 Summary of the results

No.	Design Property	Finding			Significant Value
		Design 1	Design 2	Design 3	
1	Indicator display for speedometer	3.92	4.16	4.22	0.049
2	Indicator display for tachometer	3.92	4.07	4.21	0.111
3	Indicator display for fuel gauge	4.06	4.20	4.31	0.160
4	Color of the speedometer	4.09	3.56	3.80	0.001
5	Color of the tachometer	4.17	3.94	3.57	0.000
6	Color of the fuel gauge	4.07	3.88	4.11	0.106
7	Color of the warning indicator	2.63	3.65	4.38	0.000
8	Center scale of speedometer	3.87	3.85	4.15	0.006
9	Scale style for fuel gauge	4.20	4.32	3.58	0.000
10	Pointer design of the speedometer	4.29	4.05	2.93	0.000
11	Pointer design of the tachometer	4.33	3.95	2.93	0.000
12	Pointer design of the fuel gauge	4.41	3.97	2.95	0.000
13	Labelling style for speedometer	3.93	4.28	3.67	0.000
14	Labelling style for fuel gauge	4.15	3.94	4.23	0.003
15	State of warning indicator symbol	3.83	3.79	4.44	0.000
16	Layout for warning indicator	3.72	3.92	4.15	0.000
17	Transparency of the display	4.16	3.95	3.37	0.000
18	Shape of the speedometer	4.33	4.22	3.02	0.000

DISCUSSION

Development of the new interface design for HUD control panel

The results of Semantic Differential Questions (Online Survey) from Kansei Ergonomics approach were used to develop a new interface design for the features in the HUD control panel. The new interface design was focussed on the five evaluated items of the car's control panel which are: (i) speedometer; (ii) tachometer; (iii) fuel gauge; (iv) warning indicator; and (v) transparency level of the HUD control panel on the windshield.

The new design of the speedometer: For the speedometer, there are six design properties that were considered in order to develop a new speedometer. Based on the respondents' preferences, Table 4 lists the summary of the users' preferences for each design property for speedometer, and Figure 3 illustrates the new design of the speedometer.

Table 4 Summary of the users' preferences for each design property for speedometer

No	Design property	Preference
1	Indicator display	Combination of digital and analogue
2	Color	White
3	Center scale reference point	120 km/h
4	Pointer design	Longer (touch the scale)
5	Labelling style	Invrement by 20 km/h
6	Shape	Round

Fig. 3 The new design of the speedometer

Based on the results, all design properties were following the standard of the Ergonomic principles except for indicator display and the center scale (reference point) of the speedometer. In Ergonomics, it is recommended to use an analog display because it can be used to read the fast changes (Bridger, 2017). In addition, analog displays also can provide a piece of additional information in term of advance warning alert to the rate of change (Woodson, B. Tillman, & P. Tillman, 1992). However, incorpoarating the digital displays for the speedometer may be preferred due to the current modern design. For the center scale of the speedometer, 120 Km/h is not suitable to be used as the reference point because it is already over the speed limit. According to Angloinfo Malaysia (2017), in Malaysia, the maximum speed limit for a car at the highway road is 110 km/h and the speed limit is reduced to 90 km/h for the major urban and town road environment. Thus, it is recommended to use 110 km/h as the reference point for the speedometer (at the center) so that the driver can interpret the information easier. For instance, if the pointer on the speedometer moving over the reference point, then the driver should be aware that the car is moving over the speed limit (for the highway roads).

The new design of the tachometer: For the tachometer, there are three design properties that were considered in order to develop a new speedometer. Based on the respondents' preferences, Table 5 lists the summary of the users' preferences for each design property for tachometer, and Figure 4 illustrates the new design of the tachometer.

Table 5: Summary of the users' preferences for each design property for tachometer

No	Design property	Preference
1	Indicator display	Combination of digital and analogue
2	Color	White
3	Pointer design	Longer (touch the scale)

Fig. 4 The new design of the tachometer

Based on the result of the tachometer, all design properties were following the standard of the Ergonomic principles except for the indicator display. In ergonomics, it is recommended to use an analog display because it is capable to read the faster changes (Bridger, 2017). In addition, analog display also can providea piece of additional information in term of advance warning alert to the rate of change (Woodson, B. Tillman, & P. Tillman, 1992).

The new design of the fuel gauge: For the fuel gauge, there are five design properties that were considered in order to develop a new fuel gauge. Based on the respondents' preferences, Table 6 lists the summary of the users' preferences for each design property for fuel gauge, and Figure 5 illustrates the new design of the fuel gauge.

Table 6 Summary of the users' preferences for each design property for tachometer

No	Design property	Preference
1	Indicator display	Combination of digital and analogue
2	Color	Green
3	Scale design	Bar scale
4	Pointer design	Longer (touch the scale)
5	Labelling style	Alphanumerical

Fig. 5 The new design of the fuel gauge

Based on the results for fuel gauge, the indicator display, color, and scale style are not following the standard of the ergonomics principles. For indicator display, it is recommended to use an analog display because of its ability to read the fast changes (Bridger, 2017). In addition, analog displays also can provide a piece of additional information in the form of advance warning alert to the rate of change (Woodson, B. Tillman, & P.

Tillman, 1992). In terms of color, white is the most preferable because of its ability to provide excellent color contrast in order to give a clear display without confusing the vision of the people, (Chin Pow & Syed Mohamed, 2016). Last but not least, the scale style of the fuel gauge should be in the form of line scale. The bar scale is not appropriate to be used in the fuel gauge because there is no indication for an empty tank (Sanders & McCormick, 1993).

The new design of the warning indicator: For the warning indicator, there are three design properties that were considered in order to develop a new speedometer. Based on the respondents' preferences, Table 6 lists the summary of the users' preferences for each design property for tachometer, and Figure 5 illustrates the new design of the tachometer.

Table 5 Summary of the users' preferences for each design property for tachometer

No	Design property	Preference
1	Color	Different color
2	State of warning	Combination of light and sound
3	Layout	Horizontally

Fig. 6 The new design of the warning indicator

Based on the results for warning indicator, all design properties were following the standard of the ergonomics principles except for the state of warning indicator symbol. In ergonomics, the standard design for warning indicator is presented in the form of light either flashing or in a steady state. The additional sound warning somehow can make the driver feel annoyed because the sound keeps on repeating (Sanders & McCormick, 1993). As a result, it will distract the focus of the drivers while driving.

The transparency level of the HUD control panel on the windshield : Based on the respondents' preferences, 50% transparency level was preferred. This is allign with the ergonomic principle, because the lower level of transparency with result a better color contrast between the information being displays with the clear background of the windshield. Thus, it will optimise drivers' performance in receiving the information being displayed (Sanders & McCormick, 1993).

CONCLUSION

The primary objectives of the study is to develop a new interface design for Head-Up Display control panel based on the user preferences by evaluating the relationship between the design properties of the HUD control panel with the Kansei Ergonomics concept words. A total of eighteen design properties and nine Kansei Ergonomics concept words were identified for the study. From these, three designs options for each design property were designed to be avaluated. Out of the eighteen design properties being evaluated, fifteen were found to be significant difference. Even though most of the design properties preferred by the users were alligned with the ergonomic principles, some differences do occured. This is perhap due to lack of understanding of ergonomic principles among the respondents. Looking at the development of the ergonomic concern in Malaysia context (which is still in introductory phase), the results shows a promising development of the understanding of ergonomic among Malaysian.

Contribution: The result obtained from this study can be used as a guideline or additional information about the HUD control panel design in general, more specifically, will provide the improvement of the design properties of the HUD control panel. In addition, the results from this study also proved that the knowledge from Kansei Engineering and Ergonomics are interrelated and can be used together to develop a new product that follows the user preferences. Last but not least, the finding from this study also capable to lead the other similar research studies but in more deeper approaches.

ACKNOWLEDGMENTS

The research was supported by the Malaysian Ministry of Higher Education through the RAGS15-066-0129 grant to International Islamic University Malaysia (Malek Hamid, PI). This study was also supported by the Department of Manufacturing and Materials Engineering, International Islamic University Malaysia, Malaysia.

REFERENCES

Amir, S. A. (2017). *Kansei Ergonomics Approach Towards Automotive Head-Up Display Control Panel Design*. Gombak: Department of Manufacturing and Materials, Kulliyah Engineering IIUM.

Angloinfo Malaysia. (15 12, 2017). Retrieved from Types of roads and speed limit: https://www.angloinfo.com/how-to/malaysia/transport/driving/on-the-road

Bridger, R. (2017). *Introduction to Ergonomics*. London and New York: Taylor & Francis.

Chin Pow, & Syed Mohamed, M. S. (2016). Kansei Engineering Approach Towards Automotive Heads Up Display (HUD)

Interface Design. *Malaysian Journal of Human Factors and Ergonomics*, *1*(1), 22.
Mitchell, M. (2010). The Development of Automobile Speedometer Dials. *Visible language 44.3*, 331-366.
Naeini, S. H., & Heidaripour, M. (2011). Kansei Engineering and Ergonomic Design of Products. *International Journal of Occupational Hygiene*, 81.
Nagamachi, M. (2008). Perspectives and new trend of Kansei/Affective Engineering. *TQM Journal*, 4.
Oborne, D. J. (1995). *Ergonomic at work, Human factor in design and development*. West Sussex,UK: John Wiley & Son Ltd.
Sanders, M. S., & McCormick, E. J. (1993). *Human Factor in Engineering and Design*. New York: McMraw-Hili.
Tufano, D. (1997). Automotive HUDs: The overlooked safety issues. In *Human Factors : The Journal of the Human Factors and Ergonomics Society*, 303-311.
Woodson, W. E., B. Tillman, & P. Tillman. (1992). *Human factors design handbook*. New York, US: McGraw-Hill.