ORIGINAL ARTICLE

USABILITY EVALUATION OF NEW KANSEI INTERFACE FEATURE VERSUS. EXISTING INTERFACE FEATURE IN AUTOMOTIVE NAVIGATION SYSTEM

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ABSTRACT

OBJECTIVE: *This study aims to evaluate the usability of new Kansei navigation system interface features versus. existing interface design features in automotive navigation system. The Study population consist of participants which are chosen using purposive sampling technique consist of male professional drivers (PD) and non-professional drivers (NPD) of a local University in Malaysia. A total of 60 participant ranging from 18 – 39 years old participated in this study. Participants were tested using a customized driving simulator which participant will drive according to the route shown by the GPS navigation system(GPS system based on Kansei versus existing system) drivers were tested in terms of their 1) completion time for each task given 2) the number of error produce from each task 3) the satisfaction level from each feature in the GPS system using System Usability Scale (SUS) 4) a kansei survey to measure participant understanding and perception towards usability of GPS interface designs. A Counterbalance method was used in order to eliminate order biased participant. A total of 10 minutes was taken to complete the overall task. Wilcoxon Sign Test was used to compare all objectives except for satisfaction level for NPD and Kansei survey for PD.The Result for driving completion time for both PD and NPD, shows that Kansei GPS system (PD, mean = 2.49±0.66 min, NPD, mean = 2.18±0.71 min) had significantly shorter completion time (p=0.013) compared to the existing system (PD, mean = 2.75±0.66 min, NPD, mean = 2.44±0.74 min). For the number of errors, Kansei GPS system showed a significantly lowered driving error (p <0.05) (PD, mean = 8.86±6.55, NPD, mean = 7.23±6.03) compared to existing GPS System (PD, mean = 13.7±7.94 NPD, mean =10.6±7.6). For the satisfaction level showed no significant different in satisfaction for Kansei GPS System both (PD, mean score = 61.7±19.4 NPD, mean score = 66.58±21.9) compared to existing GPS (PD, mean score = 66.58±21.9 NPD, mean score = 63.58±20.9) (p>0.05). In term of Kansei Survey, shows that there is a significantly higher scoring for Kansei GPS system for both (PD, mean score = 3.6±0.99 and NPD, mean score = 3.69±1.44) compared with existing (PD, mean score =3.15±0.88 NPD, mean score = 2.68±0.18) (p<0.05).* The conclusion of the was *the new Kansei GPS system performed better in reducing the task completion time, reducing the numbers of driving error and easily distinguish features compared to existing GPS system. However, both professional and non-professional were satisfied using Kansei and existing GPS system.*

Keywords: *Kansei, GPS, Simulator, Error, Completion time, Drivers, SUS*

INTRODUCTION

GPS navigation system in car is widely used to assist drivers to their destination of an unknown route. In 2008 and 2009, 40 million of the Portable Navigation devices (PND) are being ship yearly (Statista 2015). In 2013, it increase to 110 million and 70 million were installed straight into the car system (Statista 2015). Navigation apps are now being use increasingly by user in 2013 which was 68.6 million (Statista 2015). Increasing number of user means there is also a possibility of high accident rate that could cause by this navigation system itself. Report saying 300,000 accident that were cause by navigation system mainly causes by distraction of user from focusing on driving. This condition happened due to lack of usability features of the navigation system interphase which reduce the user experience of a product

Usability evaluation in automotive navigation system

Current automotive navigation systems are capable of providing reasonably accurate and reliable door-to-door guidance. Market predictions suggest by 2009, 25% of the vehicles produced will have navigation systems (Richardson & Green, 2000). A well-designed navigation system can prevent wrong turns, reduce travel times, and hopefully, alleviate some of the driver’s workload. However, poor usability can misdirect drivers, increase driving workload, and lead drivers to make unsafe manoeuvres.

Usability testing identifies the struggle individual use in the product and help make recommendation and improvement (Najmeh

Ghasemifard, 2015). There has been substantial human factors research on navigation systems over the past 10 to 15 years inventory of current technology (Nowakowski, Green, & Tsimhoni, 2003). Unfortunately, even with all of the research, guidelines, and feedback from several generations of products on the market, many **basic safety and usability problems still seem to re-occur, and** the need for an awareness of these problems and product usability testing is greater now than ever before.

There are 3 types of usability model developed as shown in Figure 1:

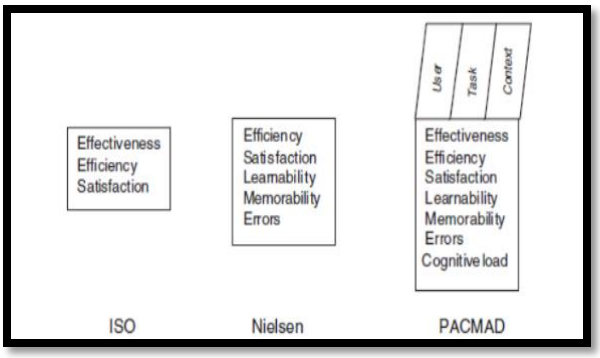

Figure 1: Usability Model

Each of this model assess specific measurable attributes. The ISO have identified 3 important factors in usability which is efficiency and satisfaction .The PACMAD and Nielsen 1993 usability model identifies 3 important factors to address which can affect the usability of a mobile application that is efficiency, errors and satisfaction. Efficiency is addressed in all three model such scenario is the task completion time (Rummel, 2014).

The PACMAD usability model extends the description of errors which first proposed by Nielsen, to include an evaluation of the errors that are made by participants. Usability in use and flexibility in use are measured by efficiency (time of completion), error and satisfaction. The relative importance of these measures depends on the purpose for which the product is being used (Bevan, 2008). For example, navigation system needs to be fast and no error in order for user to complete the journey.
Usability will ultimately contribute in the user experience of a product. User experience is defines as all aspects of the user's experience when interacting with the product, service, environment or facility (Bevan, Carter, & Harker, 2015). User experience is still a concept that is being debated, defined and explored by researchers and practitioners (Law, Roto, Vermeeren, Kort, & Hassenzahl, 2008).

However, it is clear that this concept is already an important part of the evaluation of usability and will become more important in the future. The new evolution for improving user experience is now taking place which user emotion is taken into consideration in designing a system or features
Kansei Interface versus Existing Interface

Understanding human feeling and impression on a product is important to understand what the user. Kansei Engineering which is founded by Professor Mitsuo Nagamachi of Hiroshima is a method to design and develop a way to understand this emotion of a person and incorporate into a product (Nagamachi, 1995). Kansei Engineering targets to improve human well-being by looking into physiological and psychological aspects (Lokman & Nor Laila, 2006).

Studies have shown that kansei engineering works very well in design field. Mazda Miata have been one of the earliest product which have been integrated with kansei element which have proven significantly on sale of the car which turns to be world bestselling light weight. In terms of improving usability of navigation system it is still very new. Since there is rising use of navigation system, it is important to have look into the possibilities of incorporating kansei into navigation features which would improve the usability of the system (Lee & Lin, 2014). Existing features have several problem identified in previous study for navigation system and one of it is the complexity of understanding a system (Brown & Laurier, 2012).

Problem Statement

Navigation apps are now becoming another increasingly number of user in 2013 which was 68.6 million (Statista, 2015). Increasing number of user means there is also a possibility of high accident rate that could cause by this navigation system itself. In United Kingdom, Reports of 300,000 motorist accident were cause by navigation system system mainly causes by distraction of user from focusing on driving (Mirror, 2010). Distraction while driving such as looking at navigation system screen for a long time that leads to a condition called Eye off Road (EOR). This condition happened because either the user are confused of the features of the navigation system design or any other error made which is not user friendly to user.

Problem arising with usability usually related to visual demanding interpretation of any interface. A well-designed navigation system can prevent wrong turns, reduce travel times, and might decreased some of the driver's workload. However, poor usability can misdirect drivers, increase driving workload, and lead drivers to make unsafe manoeuvres. To improve this problem, there is possibility to incorporated kansei in a navigation system to improve it effect the completion time and errors made during driving compare to the existing interface which will also improve the satisfaction and perception in usability of the new design

Objective

To evaluate the usability of new kansei navigation system interface features versus. existing navigation system interface features by determining the difference in completion time for each feature, number of error generated from testing, satisfaction level using Sytem Usability Scale, and also the kansei survey score from kansei survey.

METHODS

Subjects

This study will be conducted among individual studying and working in University Putra Malaysia, Serdang Selangor. Student and Staff/Driver from any faculty in UPM. They were selected randomly within inclusive criteria. 30 non-professional drivers consist of male only were selected and 30 male professional drivers. Age between 18 to 39 years.

Instrumentation

Driving Simulator

A basic setup for the driving simulator used to test mimic real driving condition.

Figure 2: Driving simulator

Tablet (Galaxy Tab 10.1)

The tablet is display the animation of navigation system for participant to navigate their way in the simulator route to complete the task. It will act as a real gps navigation device.

Figure 3 : Samsung Galaxy Tab 10.1

Software

Driving Simulation Software

1) 3D driving School software
   It simulate real life driving experience for participant to drive.

Figure 3.3: Driving simulation software

Navigation system Interface

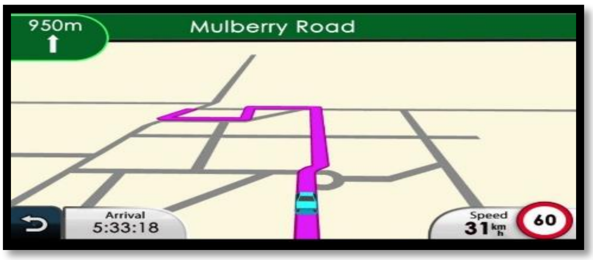

Figure 4 Existing features

Figure 5 : Kansei Feature

Driving Simulator
There are 2 variable collected using the simulator which is the completion time for each task and error made by Participant are required to evaluate 2 different types of navigation system interface features which is the kansei interface feature and also the existing interface features by using a driving simulator and also sets of questionnaires. Participant was given a chance to familiarize themselves with the driving simulation software and driving equipment for 5 minute before starting. First Phase started off by the driving simulator, participant will drive a car according to specific routes displayed by the navigation system interphase on a tablet to complete the testing. Participant need to follow direction show by navigation system until finish of the route.

Questionnaires
Participant is then required to answer 1 set of questionnaires which is the System Usability Scale (SUS) and followed by another 1 set of survey which is the Kansei Survey. First phase completed. After completed all of the above procedure, participant will start the final phase of testing which is similar to first phase but by using different navigation system interface.

Statistical analysis
Descriptive analysis was used to show the basic statistical data of information such as age, education level and type of gps used. The Wilcoxon Signed Rank analysis was used to determine whether there is a significant different in completion time, number of errors generated, satisfaction level and also the perception in usability for between designs

RESULTS

Socio-demographic

The data on age, ethnicity, marital status, income, and education level are 5 items considered for socio demographic status. The result showed that in the total sample the range of age was 19 -21 years old (33%), 22-24 years old (17%), 30-32 years old (12%), 33-35 years old (25%), 36-38 years old (12%) and 39 years old (2%). The education level was direct SPM level (50%) and Degree level (50%)

Background Information on GPS

Data on the Type of GPS used and experience using GPS were collected. According to the result, most participant used android based GPS (eg: Waze) with percentage of (57%), second is Existing design (37%) and third In-car navigation mounted type (7%). 88.3 % of participant have experience between 2-3 years of using GPS devices and remaining 11.7% had only around 1 year in using GPS

Main Findings

Difference between task completion time for professional drivers and non - professional drivers on each feature

The first objective is to determine the difference of completion time between kansei and existing features in GPS device among professional drivers and non-professional drivers. The result in table 2 showed significance different between the kansei feature and existing feature ($p<0.05$) for both professional and non – professional drivers. The completion time for kansei in both professional drivers and non-professional drivers took much lesser time to complete then the existing design. This is because of the features in kansei that was easy to understand and participant have more confident around with less confusion and doubtful which participant felt on the existing feature (Tsopra, Jais, Venot, & Duclos, 2014). Easy to identify building, junction, roundabout and road made it possible to complete the task in a short period of time as less time was taken to interpret the condition.(Quaresma & Moraes, 2010). It took longer for some participant as previous studies (Quaresma & Moraes, 2010) shown participant did unnecessary activities such as distracted by the environment.

Table 1: Result for completion time

Condition	Total (N)	Mean Difference ± SD		Z - Value	P - Value
		Existing	Kansei		
Professional Drivers	30	2.75±0.66 min	2.49±0.66 min	-2.477	0.013
Non Professional Drivers	30	2.44±0.74 min	2.18±0.71min	-2.477	0.013

Wilcoxon Signed Rank
Significant at P<0.05

Difference between number of errors made for professional drivers and non-professional Drivers on each feature

The second objective is to determine the difference of the number of errors made by professional drivers and non-professional drivers between kansei and existing features in GPS device. Error are measure by using point as high point is due high error and vice versa .The result showed that kansei scored a significant lower point for error for both the professional drivers and non-professional drivers. Both showed significant difference in kansei and existing features. Outcome for low error in kansei is obtained because of it feature focused on reducing the error by having and a visually recognized and easy to identify sub features (eg: 3d building). Participant said "This kansei features is easily recognizable and also very responsive." The error which was mostly could be that the user did not feel confident and were disturbed when the gps navigation system device would give no indication whether they were going on the right way towards their destination (Al Mahmud, Mubin, & Shahid, 2009). The existing features does not display enough information for the participant to make a decision which resulted in more error due to its complexity.((Brown & Laurier, 2012)

Table 2 Result of number of errors made in each task

Condition	Total (N)	Mean Difference ± SD		Z - Value	P - Value
		Existing	Kansei		
Professional Drivers	30	13.7±7.94	8.86±6.55	-3.381	0.001
Non Professional Drivers	30	10.6±7.6	7.23±6.03	-3.381	0.001

Wilcoxon Signed Rank
Significant at P<0.05

Difference between satisfaction level of professional drivers and non- professional drivers on each feature

The third objective is to find the differences in satisfaction level each of the features for professional and non-professional drivers. A System Usability Scale (SUS) is used to gather data based on 10 question that describe a satisfaction for usability of user. The result showed no significant difference between the satisfaction level scores between two groups. Higher core mean high satisfaction on the usability of the features where low score mean low satisfaction level .Scores of kansei features for professional drivers showed a lower score compare to the existing which could be because of certain parts of the feature are not as what they prefer in a gps navigation system such as the there were no indication of traffic light in junctions. The Non – professional drivers on the other hand felt this kansei feature is very interesting which give more information for them to interpret for a much reliable drive on the road. However, both features have areas which influenced the satisfaction because different part if the interface maybe judge differently (Bangor, Staff, Kortum, Miller, & Staff, 2009). In term of the measurement of satisfaction of usability, SUS questionnaire still is a top choice compare to others (Jarrett, 2015)

Table 3: Result of System Usability Scale (SUS)

Condition	Total (N)	Mean Difference ± SD		Z - Value	P - Value
		Existing	Kansei		
Professional Drivers	30	66.58±21.9	61.7±19.4	-0.985	0.324
Non Professional Drivers	30	63.58±20.9	66.58±21.9	-0.514	0.611

Wilcoxon Signed Rank
Significant at P<0.05

Difference between kansei survey of professional drivers and non- professional drivers on each feature.

The fourth Objective is to find difference between kansei survey of professional drivers and non- professional drivers on each feature. The kansei survey was develop to based on salient variable to integrate the concept of usability using kansei engineering in automotive navigation interface which is used to measure the how user perceive usability for automotive navigation user interface. The result showed that both professional and non – professional drivers have a significant difference in term of how user perceive the system respectively. The kansei showed higher scoring than the existing features .This mean the kansei feature is more findable, noticeable, useful, recognizable, interpretable, understandable, distinguishable, readable and etc based on the salient variable study to compute those words to shows that how kansei feature perceive the system as it was much easily interpreted by participant. (Mohamed et al.,2015).

Table 4: Result of Kansei Survey

Condition	Total (N)	Mean Difference ± SD		Z - Value	P - Value
		Existing	Kansei		
Professional Drivers	30	3.15±0.88	3.6±0.993	-0.985	0.001
Non Professional Drivers	30	2.68±0.18	3.69±1.44	-0.514	0.002

Wilcoxon Signed Rank
Significant at P<0.05

Conclusion

In conclusion, the new Kansei GPS navigation system performed better in reducing the task completion time, reducing the numbers of driving error and easily distinguish features compared to existing GPS navigation system. However, both professional and non-professional showed no different in satisfaction level between features.

Recommendations

Some part of this existing feature can be improve. Usability evaluation enable to detect what we could add to improve or solve problem of the feature. In terms of the features itself, several thing can be added to the system based on participant preference such as traffic light indicator, voice guidance, incoming traffic indicator, a more accurate building structure, pathway of road much more visible. These are overall comments that were received from the participants during testing.

In terms of the material of study, a better setup of the simulator and software was highly recommended to create a much real like driving experience with up to date hardware and equipment. The animation duration for navigation system can be lengthened for a better experience for participant for them to judge it more accurately. Besides, methods to assess the usability should cover more parameter such as memorability, and learnability.

Limitation of Study

The limitations of this study is because we are comparing the newly develop kansei and the existing design which does not have much reference or previous study to support outcome. However, this study could be uplift by upcoming research on this topic which will enlighten the subject itself and also improve the finding.

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