

REVIEW OF CURRENT USABILITY MODELS FOR ASSESSING USABILITY OF MOBILE APPLICATIONS

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ABSTRACT

A number of usability models have been developed in numerous applications and mobile application is included as well. However, the existing models were not concrete due to the limitation of the user requirement. Although, a number of usability model of mobile applications have been developed, they are not focusing on user point of view. This paper reviewed the current usability models for assessing the mobile applications. As a result, the context of use, users interface, user experience, tasks to complete efficiently, users environments, security of the mobile applications, physical features of the mobile device and user background need to be considered in order to establish a concrete usability model of mobile applications.

Keywords: *Mobile Applications, Models, Usability.*

1. Introduction

In the mobile technology, the used of mobile device increases due to portability and awareness of the users used the mobile applications. Nowadays, the lower price and handheld features are the factors that increases a number of mobile applications development. However, one of the biggest issues is the satisfaction of the user in order to achieve their specified goal when they used the mobile applications. As these mobile applications are designed to enable users to use them comfortably and this is called the usability.

Many researchers have investigated the usability to a wide range of applications (Alsos, Das, & Svanaes, 2012; Biel, Grill, & Gruhn, 2010; Brown, Sharples, & Harding, 2013; Fritz, Balhorn, Riek, Breil, & Dugas, 2012; Kushniruk, Triola, Stein, Borycki, & Kannry, 2004; Lavie, Oron-Gilad, & Meyer, 2011; Roberts, Newton, Lagattolla, Hughes, & Hasler, 2013). In the mobile applications, usability particularly sensitive to assess the level of difficulty involved in using a user interface. As a result, usability in mobile applications is closely related to the user performance with the function of the mobile applications. The most critical part in identified the user performance is the way in which user used the mobile applications. By using mobile applications, the user's activities tend to be shortly and users more focus on enabling the specific features of their mobile applications due to the environment of the user.

The mobile devices are a single hand user and with a small screen, users are able to quickly channel to the mobile applications they want. The ability to quick navigate to the desire mobile applications results the degree of the users performance. Therefore, usability of the mobile application is important in order to evaluate the user satisfaction when the users used their mobile devices.

Usability model is used for assessing the usability evaluation. The measurement of the usability is the user's behavior. The user's behavior including satisfaction, the time spent in performing an action, comfortability, success rate and the user errors. This paper aims to review previous studies and current model for developing usability model through systematic literature review as mentioned by (Saleh & Ismail) and it is well supported by (Hussain & Ferneley, 2008). The analysis of current models and previous study resulted in a set of selected quantity metrics for is then used for developing usability model in a mobile application.

2. Related study

Usability can be defined as the degree of ease with which product can be used to achieve required goals effectively and efficiently. A number of related studies on usability have been done effectively. There were two categories in ISO standard of usability which are; product-oriented standard (ISO 9126,2001; ISO 14598, 2001) and process-oriented standard (ISO 9241, 1992/2001; ISO 13407, 1999) (Abran, Khelifi, Suryan, & Seffah, 2003). Usability is a part of Human Computer Interaction (HCI) and most of the usability measurement in HCI were employed was the process-oriented standard (Hussain & Kutur, 2009). In the ISO 9241-11, usability is defined as the measurement of effectiveness, efficiency and satisfaction. For ISO/IEC 9126-1, 2000, usability is the capability of the product being understandability, learnability, used and attractiveness when they used under specified conditions and ISO/IEC 9126-1, 2001 defined usability is the capability of the product being understandability, learnability, operability, attractiveness and usability compliance when they used under specified conditions.

Unlike ISO 9241-11, Nielsen (Nielsen, 1994) concluded that usability model consists of five measurable attributes namely: efficiency, satisfaction, learnability, memorability and errors. Efficiency is the accuracy and the completeness for user to achieve their goals; Satisfaction can be defined as freedom of discomfort and the positive attitudes when the product is used; Learnability is refers to the product that ease to learnt and the user can rapidly start getting work; Memorabilty meant the product is capability to remember so the user easily returns to the product and normally he product should have a low error rate. As a result, the users make a few errors when used the product. According to (Oliveira, Cherubini, & Oliver, 2013), satisfaction is a subjective and it is refer to how the product meet the user expectation.

In addition, studied by (Gafni, 2009) has developed usability model for mobile wireless information system based on network, device and mobility. The studied named the attributes as the characteristic. The usability model developed consists of four characteristics which were understandability, learnability, operability and attractiveness. The understandability consist the sub system which were the display load, clarity of operation possibility and the completeness of the operation menu. The learnability sub characteristic was similar as

understandability in terms of display load and the clarity of operation possibility. However, the learnability also covered the level of entering the input. For operability, the sub characteristics were: Ease of input entering; display self-adjustment possibilities; message conciseness; ease of output use; parameters self-adjustment possibilities; and tasks based on used location. Finally, the sub characteristics for attractiveness were: the ease of use in terms of displays per output in terms of displays per task. From this model, the metrics were then developed in order to measure the usability in mobile wireless information system. However, the findings indicate the metrics developed only useful for measuring the quality level of the mobile information system.

Sanjay Kumar Dubey and Ajay Rana (Dubey & Rana, 2012) has proposed a usability model for object-oriented system. The usability model developed was based on four attributes which were effectiveness, efficiency, satisfaction and learnability. However, the usability model was used for assessing the software system. For effectiveness, the metrics covered: the completion rate; the percentage of users who successfully complete the tasks; the amount of the tasks completed successfully; the number of errors; the percentage of relevant functions used; the percentage of task completed; and the percentage number of errors. Meanwhile, the metrics used for the efficiency were: number of goals; time taken for task completion; unproductive period; and percentage of task not completed. For satisfaction metrics were: discomfort experienced; linking for the product use; satisfaction with product use; and acceptability of the workload when carrying out the different tasks. The metric for learnability is capability of the user to learn the application.

In addition, (Hussain & Kutar, 2009) has reviewed existing metrics for desktop computing and in order to develop a conceptual model for evaluating a usability of mobile phone application. This study has proposed the guidelines to get the usability metrics. The findings indicate that the structure of new usability model of mobile application consist of measurement, goal, questions and metrics as shown in Figure 1. In this study, the usability model of (ISO, 1998) was used as the measurements. By using the Goal Question Metrics (GQM) approach, the goals for effectiveness were simplicity and accuracy; for efficiency were time taken and features; and for satisfaction were safety and attractiveness. As a result, a set of question were carried out to assess each goal of the usability model. Finally, the quantitative information was required to answer the questions. The quantitative answer was called a metric.



Figure 1: Usability Model Structure.

Other study done by (Hussain & Ferneley, 2008) also proposed the usability guideline using GQM approach. The findings prove that the usability model was structured based on the hierarchy structured started from a goal which is then refine with the main question and finally generate a metric. These findings led to define the current metrics used in order to achieve a goal of a usability model.

Moreover, there are many usability model have been developed for mobile application. Studied by (Harrison, Flood, & Duce, 2013) performed a new usability model applied to

mobile devices namely People at Center of Mobile Application Development (PACMAD). This model is the model that integrated the usability model developed by (ISO, 1998) and (Nielsen, 1994). This studied has reviewed the limitations of the mobile applications which suggested by (Zhang & Adipat, 2005). There are several factors needed to be considered in order to develop the usability model. Firstly, the context of the mobile should be considered since the user was not tied to a single location and might be interact with environmental elements such as people and object. Second is the connectivity of the mobile device because connectivity will affect the performance of the mobile application due to its often slow and unreliable on mobile device. Third is the size of the screen. The small screen size contributed to a limited of the amount of information displayed. Next is the different display resolution. Normally, the resolution of mobile device is lower compared to the desktop computers. This result the lower quality images. Limited processing capability and power also the factors that should be considered. Mobile device contain less processing capability and power. This results the limitation of the applications that suitable for mobile devices. Finally is the data entry method. The input methods required a certain level of proficiency. This result decreases in the rate of data entry.

From these factors, the PACMAD usability model was incorporated the attributes from the ISO standard and the Nielsen's model and also introduced the attribute of cognitive load. The seven attributes was then used to define metrics to measure the usability of mobile application which were: effectiveness; efficiency; satisfaction; learnability; memorability; errors; and cognitive load. Cognitive load is the amount of cognitive processing required by the user to use the applications which measured by user performance for a second action in the used of mobile applications. Meanwhile, effectiveness is a measurement whether or not the user can complete a set of specified tasks; efficiency is a measurement in a number of time to complete a given task or the number of keystrokes required to complete a given task; satisfaction is a measurement subjectively a user's attitudes towards an application; learnability is a measurement of the performance of participant during a series of tasks and measure how long it takes the user to reach proficiency; memorability is a measurement by asking users to perform a similar task after a period of inactivity; and errors is a measurement by evaluating the frequency of errors occurred.

Tepanee Treeratanapon (Treeratanapon, 2012) has studied the design of the usability measurements framework for mobile applications. The model was adopted from ISO 9241 Standard and Technology Acceptance Model (TAM). The TAM model consists of three main constructions which are perceived usefulness (PU), perceived ease of use (PEOU) and intension to use (IU). PU is referred to the user believes that using a system will enhance his job performance and (PEOU) is the effort of use of a system. IU is the strongest predictor of the user behavior. This study reported that a set of metrics are required in order to design the usability measurement framework of mobile applications. This method was also concurred with (Hussain & Ferneley, 2008).

Moreover, Fatih Nayebi et. al (Nayebi, Desharnais, & Abran, 2012) have conducted study on the state of the art of mobile application usability evaluation. The study was reported that the usability attributes were efficiency, learnability and satisfaction. In this study, efficiency meant the user took less time to complete a particular task, learnability meant users can learn the operation of the application by observing the object and satisfaction meant the users satisfied when the applications met their demand. The findings indicate that the following

measurements should take into account in order to achieve the usability of the mobile applications: Interaction with multi touch screen; displays of different resolution and dimensions; device orientation changes; gestures such as tap, flick and pinch; touch gestures; size of the icons and buttons; location of the icons and buttons; and contextual menus.

3. Limitation of the existing model

From the above existing models, the findings concurred that usability could be measured by the metrics developed with their attributes. However, there are no specific usability models for measuring usability in mobile application. The existing model mainly focuses on usability in software application, wireless information system and desktop application. Wixon and Wilson (Wixon & Wilson, 1997) stated that in order to develop usability model, the user profile and the task analysis should be considered. The user profile such as behaviorness, effortlessness, timeliness and steadiness should be added in a new model of the usability in mobile application. This findings also agreed well with (Fadzlah & Deraman, 2007) which reported that behaviorness, timeliness (Fadzlah, 2012) and accurateness (Fadzlah, 2014) played an important role for measuring usability.

According to Gafni (Gafni, 2009), usability model is associated with attractiveness. From the measurement of attractiveness, the degree of usability which affected due to the size of the mobile screens, the difficulty to operate and the used during mobility should be determined. This was also agreed with (Nayebi et al., 2012) and (Hussain & Kutar, 2009). In the case of completely new usability model, attractiveness should be taken into the account.

Rachel Harrison et al. (Harrison et al., 2013) described that there are three factors affected the overall usability of mobile application which are user, task and context of use. Although these factors were also agreed with (ISO, 1998) and (Nielsen, 1994), but the most critical factor is context of use. The context of use referred to the environment of the user used the application including the interaction between the users with other people or object. Therefore, the adaptiveness which the ability of the users interact with the surrounding objects is important to be considered.

Other research by (Jokela, Koivumaa, Pirkola, Salminen, & Kantola, 2006), stated that the quantitative measurement of usability was required in terms of user interface of a mobile application. One of the quantitative measurements of user interface on mobile applications was the time to complete the entire critical task efficiently. Thus, efficiency should be maintained as the main goal of the usability model. As discussed by (Treeratanapon, 2012), there are four factors measuring usability in terms of context of use which are users, tasks, equipment and environment. The factor of users referred to the user's experience with the mobile applications such as experience, expert and novice users. For the factor of tasks, it is important to define a set of task of users to perform and equipment was referred to how the input mode applied by the users which are pen, stylus, keypad and button. In addition, the processing power battery life, screen size, resolution and color depth were also strongly affected usability of the mobile application. Therefore, these factors were strongly highlighted for new usability model. The findings also indicates, the environment factor such as light, location and user motion either sitting or walking affected the usability of the mobile application.

Alain Abran et al. (Abran et al., 2003) stated that the currently usability model proposed to the industry were not matured. As a result, a new usability model was required by integrating the existing models in order to develop a comprehensive usability model. The study was enhanced the ISO9241-11 model by adding two characteristics which are learnability and security. The characteristics of learnability was also agreed by (Dubey & Rana, 2012). In addition, the finding indicates that security which defined as an ability to prevent unauthorized access and data corruption were needed to be considered.

Folstad et al. (Følstad, Law, & Hornbæk, 2012) have done usability surveys for determining usability attribute. The results showed the most frequently used to measure usability was the tasks completion, followed by satisfaction, error rate and task time. From this result, it is noted that the task completion was the main factor in usability model. However, Shamsudeen et al. (Rabi'u, Ayobami, & Hector, 2012) have revealed the usability characteristics of mobile applications. The first characteristic is the screen size and the resolution. This characteristic contributed to the speed friendliness and vision friendly display. Second, the color rendering and text source were affects the needs of targeted users. The display capability must be on fast and speedy display capability. Meanwhile, the weight of the device, screen dimension and the type of the device were also important due to the user interface interruption.

One of the important thing to be highlighted is the mobile phones were not only designed for young users, but also for all users. Furthermore, S. T. Raza and F. Sahar (Raza & Sahar, 2013) investigated the perspective of usability of mobile phones for elder persons with minimum complexities. The study was based on the literature review with focusing on usability and functionality. The results indicate that the main attribute to be considered in usability due to the increasing of users aging was the interaction of the users with the screen and the keypad including too many and complex functions of the mobile device, small button and displays and difficult keypad to used . This finding were contributed to the context of use which also agreed well by (Harrison et al., 2013). Therefore, the enhancement of existing usability model is needed as well as expanding the applicability of the model for mobile applications in others domain.

4. Conclusion

The current models of usability in wide range applications have been conducted. With the increased of mobile devices users, the range and availability of mobile application were also increased. For instance, the usability models of mobile applications were developed from the various points of view. However, from the strength and weakness analysis of other models proposed by various authors, the new usability model is required due to the limitation of each model presented. Issues such as context of use, users interface, user experience, task to complete efficiently, users environments, security of the mobile applications, physical features of the mobile device and user background have affected on the usability of mobile applications. In the future, it is recommended that these findings are used to develop a complexity usability models in mobile applications.

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