Development of Hearing-Impaired Evaluation Model for Mobile Phone

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***Abstract*— This paper discussed on usability evaluation model for the hearing-impaired mobile applications. Mobile applications developed for the disabled (hearing-impaired) are usually being scanted in term of usefulness and accessible for the disabled group. Evaluating the usability of such application are difficult due to the reason not many current models focus on the requirements for disabled people. Thus, this paper has proposed usability evaluation model for the hearing-impaired mobile application so that usability issue in such application could be identified and ensure applicability for daily usage. The model helps mobile developer and interface evaluator to produce better mobile applications for disabled people.**

***Index Terms*—Criteria, Dimensions, Hearing-impaired, Usability model.**

I. INTRODUCTION

Mobile phones have reached an era of usage in different environments and industries besides being used for receiving incoming and outgoing calls, messages and video calls only. Many areas have gained benefits from the utilization of mobile phones and their applications such as disaster, logistics, management and many more [1]. The use of mobile phones does not bound only for normal people, but it is accessible to disabled people as well. Compatibility of mobile phones for easy communication is being studied continuously to enhance the usability for all groups of people [2,3,4,5,6]. Thus, mobile applications have the needs to be useful and even more usable.

As for the hearing-impaired people, there are mobile applications developed to serve the community need for communication and learning [7,8,9]. However, many hearing-impaired always look forward on applications that commonly used by everyone to make their communication easier [9]. Meanwhile, mobile applications specifically for hearing-impaired plays significant roles in their daily life. In a study on German hearing-impaired usage of technology [10], found that 96% had access to mobile phones and they are using at least basic text messaging application every day. Many hearing-impaired are also drawn towards the usage of mobile phones and many applications have being developed such as sign language learning, short messaging service specifically for hearing-impaired and many more [2,11,12]. Mobile applications for hearing-impaired must be designed to use regardless of age to utilize for any needs of learning, communication or even playing games at any time and anywhere. Mobile applications developed especially for the hearing-impaired are really a must-have in enabling them to mingle around with the society regardless of the disabilities.

Hearing-impaired mobile applications are basically aimed to aid the hearing-impaired people, but in the real situation they do lack in usage of more voice rendition than video, graphics or images [13]. This makes the user feels low while using the application since they could not understand the proper utilization of the application. Though the hearing-impaired differs in term of hearing than the normal people, they nonetheless necessitate the special care for the application due to their disability as slow learner [14]. Many of the people who have the hearing impairment problems do face communication problems with the normal people that causes them to be isolated in the society and could not mix around well with others [2,3,4,6]. Through the availability of these applications, hearing-impaired do not need to be dumb whenever they met normal people and normal people on the other hand do not need to learn the specific sign language to interconnect with the hearing-impaired. Precisely through the click of a finger, they could communicate with each other well. All they need to obtain is ease of use environment with mobile smartphones which enable downloaded and installed applications that are intended for their communication and usage.

The primary problem that has been observed from past studies is that the proposed dimensions in usability studies for hearing-impaired mobile application are not clearly declared [15,16,17]. Studies previously selected few dimensions instead of adopting any model since the unavailability of specific model for the hearing-impaired mobile application evaluation. For example, [15] only used comprehensibility to evaluate the sign language animation application while [18] used user satisfaction for the audio haptic video gaming application for the hearing-impaired. These show that many studies attempt in adapting few dimensions according to their study and application since hearing-impaired specific usability evaluation model is unavailable.

Till to date, the usability evaluation model for hearing-impaired mobile application is scanted. This makes usability evaluation for the hearing-impaired is challenging, since the requirements of hearing-impaired are different from normal hearing people. Improvement of the usability model guidelines [4,19] is needed to ensure hearing-impaired necessities are not isolated, and since the available model evaluates on generic characteristic of an application and are originally developed for desktop applications. Thus, in identifying the above problems, there is a need for a new and systematic usability models that provides an appropriate and suitable metrics for development of usability evaluation model for hearing-impaired mobile application.

The next section will discuss on related literatures on the usability evaluation model and the need for the new model

for evaluating hearing-impaired mobile applications. Followed by proposed dimension and criterion derived for the proposed model. Finally, discussion on future study is also conducted in this paper.

II. Related Works

Usability determines how easy a task is achievable by the user using an application and there are several models, which are Nielsen [20], an ISO standard [21], QUIM [22] and mGQM [23]. Since these models are general and applying them directly to specific application such as hearing-impaired mobile application might not be suitable.

To measure reliability and the quality of usability, two types of measurement can be done which are empirical and analytical and since usability could not be measured with direct dimensions thus these types of measurement are needed. Usability dimensions for mobile application which can lead as guidance to determine dimensions to be considered in measuring interface usability [24]. As some of the models stated above, this is also quite general to be adopted directly for hearing-impaired mobile application though it has the capability to do so. Thus, certain dimensions can be used as guidelines for development of the model.

Evaluation for mobile applications has been growing in the domain of information technology. For many years, standard guidelines such as Nielsen [20] and ISO 9241-11 [21] have been widely used for mobile evaluation. These standard guidelines are primarily applied for general evaluation for applications that has general usability metrics. Research conducted on hearing-impaired is very limited as mentioned earlier. This is especially less for mobile application evaluations. Mostly, the studies focused on sign language interpreter using external hand gloves [24,25,27,28] which is regarded as an expensive and non-usable by many hearing-impaired people [27]. Besides that, studies are also focused on e-learning for hearing-impaired [29,30,31], which are too general in terms of application development as well as in evaluation being conducted.

Many applications that have been developed for the hearing-impaired tend to be evaluated generally rather than comprising the evaluation into more depth to test the usability [15,18,30,31]. This could be because of the aim is centered only on the development that they tend to ignore the usability importance. To fulfil the development need, the researchers evaluate the application generally whereas in the actual situation, general evaluation might not be able to produce convincing result since the requirement of the hearing-impaired are different compared with the normal people.

There is less research conducted in terms of mobile application usability specifically that aimed for hearing-impaired which leads to challenging task in developing usable application for this community in future. There is also lack of reflection and subsequent methods and models being used for the evaluation process. Application should be ease of use and straightforward, especially if a user is novice or disabled [32]. Thus, mobile application with flexibility in terms of accessible should be invaluable assets for impairment people. This will be one of the motivations for this study in determining applications evaluated to ensure usability for the hearing-impaired.

III. Proposed Dimensions and Criteria for the Usability Evaluation Model

Literatures analysis conducted to identify dimensions that constantly being used in usability measurement of an application. In Human Computer Interaction (HCI), usability needs to consider on human ways of interacting with objects. Total of 25 dimensions were collected from 45 selected papers through Systematic Literature Review (SLR). However, only 15 dimensions were chosen based on the frequency being mentioned and used in literature for usability evaluation in general, mobile platform as well as for hearing-impaired or disability concerned. In this study, dimensions are chosen based on the number of count its appearance in literature. Count that is more than 3 is considered into the dimension list which is using the same way of identification of dimension [24].

All the 15 dimensions were later simplified into 6 measurable dimensions as shown in Figure 1. Total of 15 are considered as too many to ensure practicality of usability evaluation to be conducted and taking into consideration that complexity will encounter more complicated evaluation, therefore, adoption of ISO strategy which is simplification to utmost [21] has been conducted and finally scrutinized into 6 dimensions. Selection of 6 dimensions are based on the frequency of appearance in previous studies and mostly discussed in term of HCI and usability. At the same time, the dimensions are also carefully selected in term of user, technology, task and environmental contexts which support the contextual factors as agreed by previous studies [24,33,34].

However, a total of 15 dimensions to be used in an application evaluation for the disabled are considered too many and simplicity should be insisted in any model development [21,34]. Thus, the most appropriate dimensions are carefully chosen while some are omitted to ensure the essential element for the study which is ensuring reliable mobile applications for the hearing-impaired. This is also to ensure the selected dimension align with the four contextual elements in usability which are user, task, environment and content [33].

This shows that, all the dimension chosen for this study are ensured on the usage is justifiable according to the need of the study besides considering the four components of usability and the requirement needed by the hearing-impaired. Through this, the proposed dimension for the model is considered to be appropriate and sufficient in evaluation for the hearing-impaired application. Proposed dimensions are also presented with percentage of studies that have been used by the dimensions in SLR. For example, there was total of 42 studies mentioned efficiency, ease of use, usefulness and accuracy dimensions to be used in measuring efficiency of an application.

As stated earlier, the dimensions chosen by keeping in mind the proposed model are addressed for the specific disabled group of users leads towards scrutinized dimensions to ensure applicable measurement are done on these applications. Next section will be discussing on criteria selected for the dimensions derived earlier for model measurement according to the objective of this study. Figure 1 below shows the proposed usability dimension for this study.

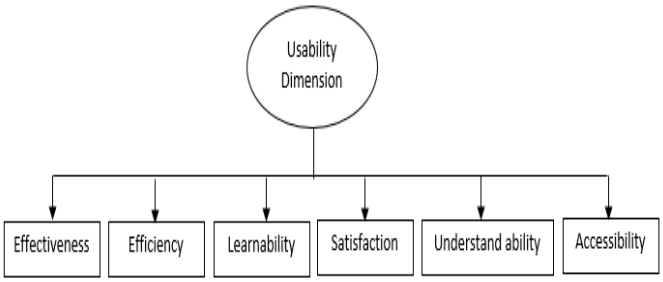

Figure 1: Usability Dimensions

However, since the proposed model is focused on special user, thus through the analysis done, gathered criteria are reduced to a total of 15 criteria (Refer to Table 1) by ensuring the consistency and effective measurement are done, as well as by avoiding duplication in the selected criteria. Hearing-impaired requirements on mobile applications are given consideration since accessibility has been highlighted to be an important dimension which differ from previously established usability evaluation model which are too general in terms of users and application platform which are focused on desktop instead of mobile application which is being used widely nowadays [4].

Each criterion described above is matched with the dimensions derived earlier. Loading time and compatibility are placed under efficiency [22,23] while accuracy and fault tolerance are placed under effectiveness [22,23,33]. While under satisfaction dimension, user guide, content and aesthetic was placed [22,24]. As for learnability dimension, consistency and familiarity criteria will be measured[22] while understand ability will measure simplicity and presentation criteria [22,24]. Finally, the important dimension in the proposed model, accessibility would measure perceivable, assistive and operable criteria [22]. The matched criteria with the dimensions are shown in simplified form of table below.

Table 1
Proposed Dimension and Criteria

Dimensions	Criteria
Effectiveness	Accuracy
	Completeness
	Fault Tolerance
Efficiency	Loading Time
	Compatibility
Satisfaction	Self-Descriptive
	Content
	Aesthetic
Learnability	Consistency
	Familiarity
Understandable	Simplicity
	Presentation
Accessibility	Perceivable
	Assistive
	Operable

Thus, the above table shows the dimension and criteria that has been matched as literature supports. Studies in future will focus on determining the metrics to be measured for the proposed model. The metrics derived uses requirements obtained in earlier phase alongside with QUIM and mGQM as guidance. Thereafter, the proposed model will be presented as a whole.

IV. CONCLUSION

The main aim of this paper is to propose usability evaluation model that was derived from SLR and requirements from the hearing-impaired users. This proposed model contains 6 dimensions and 15 criteria which later will be used to derived appropriate metric for evaluation process to be conducted.

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