Accessibility Metrics for Hearing-Impaired Mobile Application Usability Evaluation Model

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Abstract: This paper discusses on the metrics derived for the detecting-damaged mobile application handling model. The study on evaluation of mobile applications has been an emerging domain. However, it lacks appropriate guidelines in identifying issues since existing models or approaches and usability standards are commonly general and unable to define clearly on the measurements for the evaluation of mobile application interface usability for disable context. This has been one of the concerns in the area of mobile application usefulness which leads to more challenges in usability evaluation for the detecting-damaged mobile application. It is also possiblet that handling model that has been developed with dimension and unable to identify specific measurements in depth unable to cater the exact need of a disabled person. This complicates the usability practitioner as dimensions are not appropriately provided in detail on measurement values comprises in the model. To defeated this issue, dimension chosen for the detecting-damaged mobile has been identifies the measurement values to ensure applications are well evaluated. Measurements identified has been analyzed through expert review process and results are discussed. Finally, total of 14 metrics were gathered to support hearing-impaired dimension for usability evaluation model and presented.

Keywords: Usability, Accessibility model, Hearing-impaired, Metrics, Evaluation.

I. INTRODUCTION

Mobile application has been widely grown in recent years due to the number of outgrowing people reach towards mobile devices. Statistic shows that in 2019, the number of mobile phone users is forecast to reach 4.68 billion according to Statista in year 2018 [1].The mobile phone penetration has been forecasted to grow up to almost 67 percent by 2019 while Samsung and Apple are leading smartphone market vendor, with 18 percent of the market share each [1].

As such, the growth seen tremendous growth of application usage worldwide regardless limitation of mobile such as limited input modalities, small screen size and limited connectivity [2]. Besides that, user is another essential condition that has been overlooked [3].

Mobile application are developed not only to cater common people but as well as disabled. As such, many applications are developed widely for the ease of the disabled people [3]. However, these mobile applications have been ignored for the user requirement needs as the requirements of the disabled are lesser being given consideration. For example, a blind people need application such as Braille, while silent people would prefer an application that implement them more towards auditory perspectives and the deafened on the other hand, in need of more optical implement application to assure handling of the application according to the type of the disability [4, 5].Commonly, mobile application are being tested for usability in ensuring the usefulness of an application are protected. However, handling is not defined in a consistent way and most of the models lacks to include major usability aspects needed in any evaluation based on user needs [6]. Besides that, the usability model are not integrated with current software practice [6] and this could lead to the reason on software practitioners unable to apply any particular model appropriately for application evaluation. Few guidelines on usability dimensions and metrics provided in past studies leads to application are often abandon as the practitioner ends up in employing usability models familiar with rather than appropriate for application precisely [7]. As such, the evaluation on the usefulness of an application will be wasted as there is lesser model were focused on the disabled people perspective.

According to the literature, model for evaluating of the application are lacking for the disabled as there are many models that has been in the limelight for usability domain. Besides that, accessibility is an important dimension that has been lesser given consideration for the hearing-impaired mobile application [7]. Thus, the level of accessibility of the applications meant for the hearing-impaired are not given much importance left the application reaches smaller amount of total disabled user. These model that commonly used for evaluation purposes does not consider on the accessibility for the hearing-impaired to be important dimension to be measured [7] that complicate on the

practitioner in the evaluation of application usefulness for the disabled.

In addressing this issue, this study focuses on introducing the metrics for the accessibility dimension for the usability evaluation model for the detecting-damaged applications. This allows handling practitioner to particularly address the need of the hearing-impaired accessibility needs and ways in measuring the dimension appropriately with developed metrics to protect convenience of an operation before influence the end user. The next section of the paper discusses background investigation followed by metrics identified for the study. Section three concentrate on the analysis of expert review on selected accessibility dimension with the metrics provided and finally overall conclusion.

II. BACKGROUND STUDIES

Usability is about how easy a task is to be achieved by the user and being evaluated to endure the usefulness through models or frameworks such as Nielsen[8] and ISO standard [9]. However, these models focus on general applications and measuring hearing-impaired application might jeopardize the evaluation results towards an application. Relationship between usability and accessibility are rarely explicitly analyzed [10].

According to literature, accessibility and the relation with usability are defined in various ways. ISO/IEC define, Accessible Design as ''design focused on principles of extending standard design to people with some type of performance limitation to maximize the number of potential customers who can readily use a product, building or service'' while ISO 9241-171 [11] define accessibility as ''usability of a product, service, environment or facility by people with the widest range of capabilities'', connecting with usability. As such, to establish if an application is accessible, it is necessary to be tested as the level of accessible differs in term of usage and users. Different user having different level of accessibility, as such accessibility has to be tested based on the targeted user need and capability in handling an application.

Besides that, [12] claims that accessibility is a subset of usability that signify that accessibility problems are particular types of usability problems to be address in any application. The [11] standard compromised on a model to measure quality in use from the perspective of internal software quality attributes. While, [13] discusses that the internal quality attributes as the cause and quality in use factors as the effects. Various metrics for external quality in this standard concern effectiveness, efficiency, and user satisfaction. The hierarchical quality models described common limitations. They are all vague in their definitions of the lower-level usability metrics needed in order to obtain satisfactory measures of higher-order software quality factors. For example, there is little information are given on the method in applying specific quality metrics in usability measurements. This lack of operational definitions makes it difficult to compare results across different usability studies on different applications and identify issues related especially with disabled applications. Besides that, it is unclear in most cases on how usability factors, criteria, and

metrics defined in models are related or whether one set of metrics may be more advantageous than others.

Shneiderman on the other hand proposed on universal usability where it encompass both usability and accessibility [10] but ''access is not sufficient to ensure successful usage''. Usability cannot be considered as encompassing all the possible problems encountered by every user as such accessibility will encompass on the term in identifying accessible level of application usefulness by a user as it is the first step towards ensuring satisfactory usage which allow people with performance limitations to use interactive systems accordingly. As the people with disability are large and diverse populations, they are often overlooked and their needs are not much considered during design and development of an application. Lack of awareness [7] comprises many issues in designing an accessible software for the disabled users. As such, accessibility of an application is important as it allow equal opportunities and to enhance the user interface and ease the software use.

III. METHODOLOGY

Metrics is a function which input is data and output is the numerical value that can be interpreted as a degree to which the software process are given an attribute that affect its quality. Commonly, two types of data for metric will be collected through metrics in any usability model; namely the objective and subjective data. Objective data refers to the task performance analysis and measures the performance of usage while subjective data refers mainly to the user's feedback towards usage of the applications [2]. In many cases, researchers tend to choose a few subjective measurements such as effectiveness and presentation [14] and adapted according to the purpose of the evaluation being conducted. However, it may not be appropriate to apply on all applications due to the generalization of the available models besides their complexities and lack of descriptions in choosing suitable usability measurements. Besides that, important issues about how the system works in the hand of the user, and in determining whether the system is usable have been neglected [8] during the evaluation. This approach of adapting selected measurements is also unable to reveal usability issues related to the applications since users are not involved during the evaluation [15, [16]. The inclusion of users is believed to enable more detailed issues to be identified [17, 18]. By combining both objective and subjective measurements, reliable usability issue can be identified and evaluation of the weaknesses of the application can be conducted as well [2].

To create the metrics for the criteria that has been generated, models such as QUIM [6] and mGQM[2] were analyzed and the modified metrics from these models were employed into the proposed model according to the criteria defined and suited for the study. Reasons for accommodating these two models are due to the factor which allows freedom in selecting metrics according to the study and applied into the criteria that leave many

opportunities to thoroughly analyses suitability of the metrics [6, 19]. Besides that, both models have guidelines for selecting metrics for broader usability goals [6, 20, 21] and categorize relationship among metric and criteria appropriately [20]. These models also have independency in allowing to create usability testing plan according to the metrics derived.

The selection of the metrics for the measurement had also considered the requirements of the hearing-impaired that have been analyzed earlier and keeping in mind that the data to be collected is for mobile platform, which differs from desktop platform [12, 22]. This is matched with the criteria to be measured and finally the measurable metric is developed to gather both objective and subjective data. The accessibility dimension addresses the needs of the disabled, meeting the aim of this study which are focused on the hearing-impaired. This measures the accessible level of an application by this community with minimal effort and in accordance with the requirements fulfilled. Applications developed for mobile platform are more generalized for all users despite disabilities that leads to the reasons why many hearing-impaired or other disabilities still having difficulty in adapting to mobile application [23].These metrics were considered from the gathered requirements supported with literature that highlighted on the requirements that need to be added in an application for disabled people. However, there is none usability model in particular using metrics that were gathered in this study. This makes this dimension and the measures chosen new and address the user context, the hearing-impaired disability directly. Result of the metrics obtained has been discussed in next section.

IV. RESULTS AND DISCUSSION

The metrics developed for the accessibility dimension in any usability model for evaluation related applications [21]. According to the criteria, perceivable is the information and user interface components that should be presented to users in the way it can be perceived appropriately. In this case, the detecting-damaged user should be capable to perceive the component layout in terms of presentation [24]. The layout of the application should be satisfying for them in order to allow them to understand multimedia content and use the application without hindrance. As such, these metrics are

identified such as time taken to select a task, time taken to complete a task, satisfaction with virtual keyboard accessible, satisfaction with menu and number of error during navigation.

Operable is considered another important aspect to be measured in hearing-impaired application due to limitation in understanding and learning compared to other disabled people [24, 25]. Operable is commonly used in measuring the level or amount of effort used by a user without difficulty. As for the detecting-damaged, they must be capable to understand the flow of the application easily and able to complete task in lesser time. This will also ensure complicated applications are not abandoned after development as they are capable of handling the applications. This will also measure the level of presentation as structured in the application and allow users to move around easily in the application. The feeling of being a knowledgeable user in using an application must be simple [6] in inputting data without much hassle especially when using virtual keyboard which is smaller than desktop application keyboard. As such, satisfaction with text, video and captioning presentation is important metric to be evaluated.

While assistive basically focuses on the assistance provided to the user in completing a task or using the application. Animation, multimedia and more content values should be included in the application for the detecting-damaged to ensure the operation is able to be used easily [22]. Alerting, such as flash lights and vibration that can be recognized easily, should also be considered to provide alerts for the hearing-impaired users since they are unable to hear audio outputs. This was also part of the information gathered in the earlier phase which needs consideration in order to achieve full satisfaction towards the application. Incorporating this into the measurement of accessibility helps to identify the level of assistive being provided in an application for the hearing-impaired. Thus, the metrics considered for this criteria are such as satisfaction with alerting, number of error, in recognizing incoming alert in device, number of error using text to sign language or translator, satisfaction with video provided, sign language used proper for different culture and translator for sign language and text satisfaction. Objective and subjective metrics that have been chosen are listed in Table 1 below.

Table. 1 Objective and subjective metrics for accessibility dimension

Objective Metrics	Subjective Metrics
Time Taken To Select A Task	Satisfaction With Virtual Keyboard Accessible
Time Taken To Complete A Task	Satisfaction With Menu
Number Of Error During Navigation.	Satisfaction With Text Presentation
Number Of Error In Recognizing Incoming Alert In Device	Satisfaction With Video Presentation
Number Of Error Using Text To Sign Language Or Translator	Satisfaction With Captioning Presentation
	Satisfaction With Alerting
	Satisfaction With Video Provided
	Sign Language Used Proper For Different Culture
	Translator For Sign Language And Text Satisfaction

Total of 14 metrics consists of 5 objective metrics and 9 subjective metrics identified for the accessibility measurement. The objective metrics are those measured through tasks carried out by participants with the inclusion of the application performance during the task being conducted. While, subjective data will be collected through post usability test questionnaires after task being conducted. Selected participants can also be included in the interview session in order to support data collected in post usability test questionnaire. This, however, depends on the objective of the usability evaluation to be conducted. Through this, the proposed accessibility related metrics is considered to be appropriate and sufficient in evaluation for the detecting-damaged 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 application.

V. CONCLUSION

As to conclude, this paper main aim is to proposed metric for accessibility dimension for the handling assessment model. The proposed metrics consists of 5 objective metrics and 9 subjective metrics which later will be used to conduct handling assessment for the hearing-impaired mobile application. As for the next step of the study, the metrics will be send for validation to the experts and results will be analyzed in ensuring the derived metrics are appropriate for the detecting-damaged mobile operation handling evaluation.

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