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Conceptualising Mobile Apps Usability Dimension: A Feasibility Assessment of Malaysian Industrial Practitioners

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Abstract: This paper proposes a usability measurement forevaluating mobile applications. The measurement incorporates usability viewpoint of both, usability specialist and non-usability expert. The resulting usability measurements were validated through a survey of 113 industrial practitioners in Malaysia. Cronbach alpha of .952 reveals that the survey response is consistent and reliable. Hypothesis testing using a Chi-square goodness of fit indicates that the usability measurements were significantly feasible for real practice with p<.000.Mobile usability studies previously conceptualised usability from HCI perspective (e.g. usability attribute and heuristics), constraints and limitations of mobile devices. On the contrary, this paper characterise usability by integrating design features of mobile application through usability features, and quality attributes through usability criteria, in conceptualising apps usability dimension.

Keywords: Usability Evaluation, Mobile Application, Mobile Usability, Evaluation Framework

I.INTRODUCTION

Usability factor is commonly conceptualised by quality attributes, heuristics or principles. However, these constructs do not reflectthe design featuresofthe intended platform in detail, which affects the usability of an application(Ham et al., 2006; Hoehle, Aljafari, & Venkatesh, 2016). Each platform has a specific user interface which does not apply to other platforms (Canelon, Losavio, & Matteo, 2007). In other areas of usability studies such as desktop and web usability, the platform design features have been acknowledged as part of features affecting usability. This is demonstrated in work by Junior, Nishida, & de Melo (2012), where Windows, Icon, Menu, and Pointers were the main evaluation basis of usability for desktop applications. Meanwhile, cross-platform, links and navigation has been demonstrated as the main concern in web usability evaluation in studies by Hasan, Morris, & Probets (2013).In addition, there isa vast collection of usability criteria available. However, it is not feasible to evaluate an application on each usability criteria, as each application has its own trade-off of usability criteria(Durães Dourado & Dias Canedo, 2019; Kainda, Fléchais, & Roscoe, 2010).

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Furthermore, mobile usability dimension is not comprehensively addressed in the literature. Gómez, Caballero, & Sevillano (2014), attempt to characterise mobile usability dimension in terms of mobile device concerns.Fatih Nayebi (2015) and Hoehle et al. (2016) attempt to demonstrate mobile usability dimension mainly in terms of usability principles. Meanwhile, A. Saleh, Ismail, & Fabil (2017), Khan, Sulaiman, Said, & Tahir (2011) and Ryu (2008) conceptualise mobile usabilitydimension in terms of usability criteria. Nevertheless, characterising mobile usability dimension by solely on usability principles or usability attributes suffers the lack of reflects on design features in details, such as notification and interaction method, which is another aspect influencing mobile usability. Dunn, Galletta, Hypolite, Puri, & Raghuwanshi (2013) and Malatini & Bogliolo (2015) emphasized the importance of conceptualising mobile usability dimension in view of design features.

On the other hand, apps development were apparently tied to short time-to-market requirement, and usability specialist; particularly usability tester, are rarely integrated into the development team. Thus, the role of evaluating the usability of an app, before its distribution, was generally occupied by non-usability experts such as software engineer or quality assurance engineer, who perceive usability in a different viewpoint; judging usability in view of their job experience. Mathur, Karre, & Reddy (2018) verified this situation in their studies among mobile apps companies and discovered that non-usability experts face challenges in conducting usability evaluation due to lack of usability skills. Consequently, having non-usability expert (e.g. software engineer and quality assurance engineer), to perform usability evaluation using core usability criteria (e.g. understand ability, learn ability, ease of use), which prone to be perceived as semantically similar by non-usability expert, risk to irrelevant usability result, due to their misinterpretation of the usability measurements. Therefore, this study attempts to address these lacking by proposing a usability measurement which integrates design features of a mobile application with quality attributes, through usability features and usability criteria for both; usability specialist and non-usability expert. The following section presents the formulated usability measurement. In Section 3, the research hypothesis, instrument development, respondent sampling and survey procedure to evaluate the framework are described. Section 4 presents and discusses thesurvey response and hypothesis testing result.

Finally, the last section draws the conclusion of this study, highlights the research contribution and future direction of the research by pointing out further work.

II. PROPOSED USABILITY MEASUREMENT FOR APPS

This paper is an extension of our previous work inRahmat, Zulzalil, Ghani, & Kamaruddin (2018). Previously, the comprehensiveness of our proposed usability measurement was assessed through a survey among academicians in Malaysia public universities. Ourproposed usability measurementsare formulated by integratingthe design features of a mobile applicationwith usability criteria. However, formulating the measurement involves the integration from a different group of usability constructs (e.g. usability features, usability criteria).

With this intention, a content analysis was conducted on eleven relevant literature of mobile usability studies (e.g. checklist, heuristic, guideline), as provided in our previous work. The analysis reviews the literature for the corresponding quality attributeas emergent usability criteria. The usability criteria are determined based on 1) the quality attribute classificationof the reviewed item in the original literature, and 2) the quality attribute for which the item intends to evaluate. A conceptual definition of the developed usability criteria is later developed. Consequently, the usability criteria were grouped under a set of conceptual units of similar apps design pattern; usability feature.As a result, our usability measurement developed wasvalidated for its comprehensiveness in our previous study. In this paper, we have refined our usability features and usability criteria, based on the comprehensiveness survey response.It facilitates a comprehensive apps usability measurement for usability specialist while benefiting non-usability expert a reliable usability evaluation. Usability constructs in terms of evaluation basis that non-usability expert familiar with ensures a design-oriented, flexible and effective evaluation. Table 1 presents the formulated usability measurement.

Table. 1 Usability Features and their associated usabilitycriteria

Usability Features	• F01 Interaction	• F02 Notification • F03 Permission	• F04 Visual Cues • F05 Aesthetic	• F06 Presentation • F07 Navigation • F08 Information Architecture	• F09 Search • F10 Data Entry • F11 Workflow • F12 Selection
Usability	• Responsiveness (F01) • Interactivity (F01) • Playability (F01) • Ease of Use (F01) • Safety (F01) • Security (F01)	• Completeness (F02) • Promptness (F02) • Reliability (F03) • Connectivity (F03) • Flexibility (F03)	• Visibility (F04) • Discoverability (F04) • Learnability (F04) • Consistency (F05)	• Readability (F06) • Relevance (F06) • Accessibility (F06) • Credibility (F06) • Navigability (F07) • Complexity(F07) • Linkage(F07) • Understandability(F08) • Conciseness(F08) • Structuredness(F08) • Formality(F08)	• Effectiveness (F09) • Accuracy (F10) • Customisation (F10) • Operability (F11) • Efficiency (F12)

III.MATERIALS AND METHODS

The respondent sampling and procedures in administering the surveyare described in Section 3.1 and Section 3.2.

Respondent sampling

In obtaining a representative opinion from integrated viewpoint of usability specialist and non-usability expert, the prospective respondents were pooled from the search of usability specialist (e.g. usability tester, user interaction designer and user experience designer), software engineers (e.g. designer, analyst, and developer) and mobile application developers in LinkedIn. The participants are selected based on their industrial experience (i.e. previous or current job) and certification in the area of computer science such as usability, user experience, software engineering, software testing, and software quality. These industrial practitioners were selected as respondents for this study as they best represent non-usability expert which commonly play the role in evaluating apps usability in real practice.

Survey procedure

The survey intends to measure the acceptability of the proposed usability parameters in the industrial practice based on the perception of industrial practitioner's in Malaysia. The acceptability is assessed by measuring the respondent's likelihood in accepting the usability parameters.From September 2017 to June 2018, the respondents were invited to participate in the survey. The survey was conducted online using Google Docs, where the survey link was attached in an email invitation. The objective, purpose of the study, and confidentiality of the responses were also explained in the email sent to the participants.

IV.RESULT AND DISCUSSION

This section discusses the reliability assessment result, demographic distribution of therespondents and the analysis on the usability measurement acceptability.

Instrument reliability

The computed Cronbach alpha (.952) is higher than the acceptable minimum. The composite reliability of Cronbach alpha indicates a significant correlation among the usability measurement, which implies the questionnaires, is consistently reliable. The composite reliability for most of the usability features surpasses the recommended level of 0.7 as suggested by Lee J. Cronbach (1951) except for notification, signifiers, and data entry. This is explained by the small number of usability criteria dedicated to the concerned usability features. However, their alpha statistic is relatively close to the threshold and still acceptable.

Meanwhile, usability features search, workflow, and selection yield insufficient reliability to meet either recommended level of 0.70 or a typical minimum standard of 0.60 (Khan, Sulaiman, Said, & Tahir, 2012). The possible reason is that they consist of single usability criteria. However, removing these usability features would likely affect a usability evaluation result, as they are paired to a set of checklist. Thus, these usability features are retained as they were found to be significantly feasible after the data analysis as in Section 4.3. Table 2 exhibits the composite reliability for each usability features.

Demographic distribution

Although over-sampling and follow-ups have been done, only 113 of the respondents participate in the survey. Majority of the respondents are involved in the apps field for 1 to 2 years. However, they are very experienced in software engineering discipline. With 3 to 6 years of experience in software disciplines, the respondents are considered representative to the population of software engineering industrial practitioners. This qualifies them as an appropriate subject-matter expert to evaluate the apps usability evaluation framework. Table 3 exhibits the demographic data of the respondents.

Table.2 Composite reliability for each usability feature

Usability Features	Definition	Usability Criteria	Composite Reliability
Interaction	The ability to responds upon gestures, internal interruption, and media execution in effortless manner, and manage user data, access and operation	Responsiveness Interactivity Playability Ease of Use Safety	0.738
Notification	The styling of a notification and its event trigger	Completeness Promptness	0.647
Permission	The extent to which user involvement and user control are required and given in running an operation	Reliability Connectivity Flexibility Security	0.707
Signifiers	Visibility of visual response, use of recognisable indicator upon user interaction or operation and distinguishable UI component	Visibility Discoverability	0.661

Aesthetic	Consistent styling and placement of UI elements	Consistency Familiarity Appropriateness	0.731
Presentation	Structural and aesthetic content organisation	Readability Relevance Accessibility Trustworthy	0.720
Navigation	Behaviour of view control, navigation control and formatting of navigation target and interaction such as menu items organisation and placement	Navigability Complexity Linkage	0.716
Information Architecture	Content description, labelling of UI elements and organization of navigation target	Understandability Conciseness Structuredness Formality	0.769
Search	Facilities for search task and search result presentation such as input, error and query	Effectiveness	/
Workflow	Structural sequence of actions for a task	Operability	/
Data Entry	UI design of data entry and user input such as styling, organisation and use of appropriate UI element	Accuracy Customisation	0.656
Selection	Use of appropriate UI elements and features for data item selection and data table manipulation	Efficiency	/

Table. 3 Distribution of the respondent background

Age				
Range of age	**20-24**	**25-29**	**30-34**	**>34**
Number of respondents	17 (15 %)	51 (45.1 %)	21 (18.6 %)	24 (21.2 %)

Experience (Year) / Domain	Nil	≤ 3	4-6	≥ 7
Software Engineering	9 (8 %)	48 (42.5 %)	34 (30.1 %)	22 (19.5 %)
Software Quality	17 (15 %)	56 (49.6 %)	23 (20.4 %)	17 (15 %)
Software Testing	11 (9.7 %)	60 (53.1 %)	25 (22.1 %)	17 (15 %)
Human Computer Interaction	26 (23 %)	42 (37.2 %)	27 (23.9 %)	18 (15.9 %)
Usability	15 (13.3 %)	44 (38.9 %)	37 (32.7 %)	17 (15 %)

Involvement in app				
Year / Domain n (%)	**Nil**	**1-2**	**3-4**	**>4**
Apps testing	21 (18.6 %)	51 (45.1 %)	20 (17.7 %)	21 (18.6 %)
Apps evaluation	33 (29.2 %)	37 (32.7 %)	26 (23 %)	17 (15 %)
Apps development	30 (26.5 %)	37 (32.7 %)	24 (21.2 %)	22 (19.5 %)
Apps design	32 (28.3 %)	41(36.3 %)	25 (22.1 %)	15 (13.3 %)

Usability measurements feasibility

The five-point Likert scale response was combined into three different categorical variables; agree (strongly agree and agree), neutral (neither agree nor disagree), and disagree (Strongly disagree and disagree).A chi-square goodness-of-fit test were performed to test the null hypothesis, whether the proportion of the expert agreement (rating score)are equal between categorical variable; agree, neutral and disagree.Table 4 exhibits the chi-square goodness of fit test result for the feasibility of the usability feature, for real practice.

Table. 4 Feasibility of the usability features for real practice

Usability Features	Agree	Neutral	Disagree	P-value	Usability Features	Agree	Neutral	Disagree	P-value
Interaction	111 (98.2%)	1 (0.9%)	1 (0.9%)	<.000	Navigation	110 (97.3%)	3 (2.7%)	0 (0.0%)	<.000
Notification	102 (90.3%)	8 (7.1%)	3 (2.7%)	<.000	Information Architecture	102 (90.3%)	9 (8.0%)	2 (1.8%)	<.000
Permission	105 (92.9%)	3 (2.7%)	5 (4.4%)	<.000	Search	103 (91.2%)	9 (8.0%)	1 (0.9%)	<.000
Signifiers	109 (96.5%)	3 (2.7%)	1 (0.9%)	<.000	Workflow	108 (95.6%)	4 (3.5%)	1 (0.9%)	<.000
Aesthetics	106 (93.8%)	6 (5.3%)	1 (0.9%)	<.000	Data Entry	105 (92.9%)	8 (7.1%)	0 (0.0%)	<.000
Presentation	109 (96.5%)	1 (0.9%)	3 (2.7%)	<.000	Selection	104 (92.0%)	8 (7.1%)	1 (0.9%)	<.000

It is observed that the experts agree that the twelve usability features were significantly acceptable in real practice ($p<.005$). The number of experts who agree on the usability features is higher than the other two categories (Neutral and disagree). Meanwhile, Table 5 exhibits the chi-square goodness of fit test result for the feasibility of the usability criteria, for real practice. All of the usability criteria were also found to be significantly feasible ($p<.000$). Hence, there is enough evidence to reject the null hypothesis. Majority of the expert agreed that the proposed usability features and usability criteria were highly acceptable to be used for usability evaluation in industrial practice.

Table. 5 Feasibility of the usability criteria for real practice

Usability Criteria	Agree	Neutral	Disagree	Usability Criteria	Agree	Neutral	Disagree
Responsiveness	111 (98.2%)	2 (1.8 %)	0 (0.0 %)	Readability	109 (96.5%)	4 (3.5 %)	0 (0.0 %)
Interactivity	109 (96.5%)	3 (2.7 %)	1 (0.9 %)	Relevance	108 (95.6%)	5 (4.4 %)	0 (0.0 %)
Playability	101 (89.4%)	9 (8.0 %)	3 (2.7 %)	Accessibility	104 (92.0%)	6 (5.3 %)	3 (2.7 %)
Ease of Use	107 (94.7%)	4 (3.5 %)	2 (1.8 %)	Trustworthy	96 (85.0%)	14 (12.4 %)	3 (2.7 %)
Safety	101 (89.4%)	7 (6.2 %)	5 (4.4 %)	Complexity	100 (88.5%)	10 (8.8 %)	3 (2.7 %)
Completeness	97 (85.8%)	11 (9.7 %)	5 (4.4 %)	Navigability	105 (92.9%)	6 (5.3 %)	2 (1.8 %)
Promptness	101 (89.4%)	9 (8.0 %)	3 (2.7 %)	Linkage	98 (86.7)	12 (10.6%)	3 (2.7 %)
Reliability	110 (97.3%)	3 (2.7 %)	0 (0.0 %)	Understand ability	107 (94.7%)	6 (5.3 %)	0 (0.0 %)
Connectivity	98 (86.7%)	13 (11.5 %)	2 (1.8 %)	Conciseness	104 (92.0%)	8 (7.1 %)	1 (0.9 %)
Flexibility	107 (94.7%)	6 (5.3 %)	0 (0.0 %)	Structuredness	105 (92.9%)	8 (7.1 %)	0 (0.0 %)
Security	102 (90.3%)	6 (5.3 %)	5 (4.4 %)	Formality	97 (85.8%)	15 (13.3 %)	1 (0.9 %)
Visibility	110 (97.3%)	3 (2.7 %)	0 (0.0 %)	Effectiveness	107 (94.7%)	4 (3.5 %)	2 (1.8 %)
Discoverability	102 (90.3%)	8 (7.1 %)	3 (2.7 %)	Operability	101 (89.4%)	8 (7.1 %)	4 (3.5 %)
Consistency	101 (89.4%)	11 (9.7 %)	1 (0.9 %)	Accuracy	107 (94.7%)	5 (4.4 %)	1 (0.9 %)
Familiarity	98 (86.7%)	13 (11.5 %)	2 (1.8 %)	Customisation	95 (84.1%)	15 (13.3 %)	3 (2.7 %)
Appropriateness	96 (85.0%)	17 (15.0 %)	0 (0.0 %)	Efficiency	106 (93.8%)	7 (6.2 %)	0 (0.0 %)

V.CONCLUSION

This paper comprehensively conceptualises apps usability dimension solely on mobile usability literature, thus suggesting for reliable measurement.Emergent usability features and usability criteria for apps were reviewed through content analysis. Subsequently, the usability measurement is validated through an online survey among industrial practitioners in Malaysia.In order for the usability measurement to remain useful, continuous update on the paired checklist and usability measurement is recommended, considering that apps versions and mobile OS is rapidly updated in common.

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