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Usability Evaluation Checklist for Smartphone App

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Abstract: This study proposed a model for usability evaluation in view of smartphone characteristic, user interface design and context of use approach. A set of mobile related bibliographic has been reviewed. In addition, 3 usability features, 11 usability criteria and 33 UI elements have been identified. Finally, a set of 84 checklist items has resulted and paired to the identified UI elements. In this research, it has been found that nteraction and notification are the main emphasis aspect of app usability. This has been supported by the large distribution of the checklist on usability criteria such as promptness, ease of use and interactivity which govern by the highlighted usability features. The UI elements distribution also conformsto these results. It is shown that besides text, UI element such as dialogue, button and navigation drawer has been the main building blocks in designing an App. While previous studies evaluate appbased on either by traditional computing design elements, ergonomics or HCI perspectives this study address usability of App by incorporating measurement from previous studies in user interface elements of App adopted in the industry while at the same time, acknowledging the different set of evaluator skill.

Key words: Mobile usability, smartphone App, usability model, usability checklist, building, ergonomics

INTRODUCTION

The emergence of smartphones has introduced a platform with unique characteristics compared to well-known desktop computing such as software and the web. Physical constraints such as small screen size and virtual keyboard as well as its limited capabilities on connectivity, processing and battery life create challenges in designing smartphone App which usually operates in a dynamic environment and context of use. A lot of early and ongoing usability evaluation research regarding smartphones such as Kjeldskov and Stage (2004), Zhang and Adipat (2005) focuses heavily on the aforementioned characteristics from Human Computer Interface (HCI) perspective such as mobile phone constraints, limitations and mobility conditions. Whereas, limited usability research areavailable on the user interface aspect evaluation for a smartphone App.

The main problem roots from the user interface element. While the web is mainly built of components such as menus, links and navigation, App composed of user interface elements such as spinner, toast, action bar and navigation drawer which behave in a completely different manner compared to desktop computing. In addition, interaction paradigm such as pinch, flick, swipe as well as user interface elements in an App such as Snackbars, Action bars and Spinners are absent in traditional computing. This has issued mobile-specific usability problem which does not occur in desktop computing. Thus, evaluating App's usability without addressing these characteristics, paradigm and elements will certainly overlook mobile-specific usability problem thus mislead to an irrelevant conclusion.

Another important issue has to do with the usability checklist. As the usability of software and web applications are measured in terms of its user interface elements such as menus, link and navigations, it is inappropriate for current mobile UEMs to evaluate the usability of mobile applications in terms of mobile context instead of measuring its user interface element such as dialogs and icon, since, it will tend to fail in capturing the usability problem in the application interface it self. Hence, usability evaluation of mobile App by means of available guidelines is inappropriate and may not be directly applicable to mobile applications (Zhang and Adipat, 2005) thus, concluding to irrelevant evaluation results (Lee and Grice, 2004).

Various related works have been done to overcome these issues in the mobile App. Model (Zhang and Adipat, 2005; Hussain and Kutar, 2012),

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guideline (Khan *et al*., 2013), evaluation methods (Gunduz and Pathan, 2012; Jadhav *et al*., 2013; Lehutjo, 2014) and usability framework (Zhang and Adipat, 2005; Hussain and Kutar, 2012) for a mobile App has been formulated in previous studies. However, these studies focus on the HCI perspective, constraints and limitations of mobile devices, feature phone functionalities or aesthetics and performance-based measures instead of the user interface design for the App. In addition, the evaluation focus either on usability attributes which are, measured in terms of criteria based combinations of mobile characteristics, graphical controls, usability pattern or single usability index which is more appropriate for benchmarking usability level instead of measuring the extent of usability level on App.

Since, inspection is the most adopted usability evaluation method especially in the industrial computing and usability experts rarely included in a development team, this study propose a design oriented usability evaluation model by means of usability features which connects usability attributes and user interface elements of smartphone App through usability checklist. In order to establish the model, we propose a methodological approach which reviews a set of mobile related bibliographic by identify criteria and measurements denoting usability of an App.

The contribution of this research is to propose a methodological approach in establishing a usability checklist for an App. The resulting checklist can contribute to the implementation of a lab experiment or usability inspection. The intention is to capture mobile-specific usability problem through mobile oriented usability checklist. The checklist focuses on smartphone features, its dynamic environment and context of use. In addition, the established checklist is based on constructed model which perceive App usability evaluation in view of usability features and criteria. The rationale is to facilitate non-usability expert evaluators such as analyst and designer whom usually not familiar with certain usability jargon compared to usability and HCI experts.

Characteristics of smartphone: Smartphones relies on touchscreens for the primary interaction with users (Homann *et al*., 2013). It takes input via touch, stylus, miniature keyboard or some combination of these methods (Martin *et al*., 2011). In addition, its capacitative technology responds to multi-touch gestures such as tap, flick and pinch as input.

The graphical display of smartphones is restricted with small screen size (Jadhav *et al*., 2013; Martin *et al*., 2011; Flood *et al*., 2012; Adipat and Zhang, 2005) and display resolution (Martin *et al*., 2011; Adipat and Zhang, 2005). Hence, the interface layout for content presentation limited. Smartphones are designed with limited memory size (Hussain and Kutar, 2009) and it has limited processing power (Martin *et al*., 2011; Flood *et al*., 2012; Adipat and Zhang, 2005) compared to desktop and laptop.

However, with the variety of integrated sensors such as accelerometer, Global Positioning System (GPS) and camera (Homann *et al*., 2013), smartphones are equipped with responsive capabilities such as location awareness (Nayebi *et al*., 2012) and context aware (Flood *et al*., 2012; Adipat and Zhang, 2005). Nevertheless, smartphone usually has connectivity drawbacks such as limited bandwidth and unreliable wireless network (Adipat and Zhang, 2005) for internet connection.

These characteristicscreate task workflow which shaped App user interface design profoundly different compared to desktop computing in terms of the UI elements used, content organization approach, user interaction paradigm and response. Gestures such as tap, pinch and swipe have become the main data entry model. In addition, dialog and alert are extensively used to provide responsive feedback. Consequently, content sharing and update are made possible thus requires security issues preventive action. Hence, user permission and access control are promptly verified to avoid a data breach.

These features have characterized smartphone App and create mobile-specific usability problems which are absent in desktop computing. Hence, the dimension of usability evaluation for App involves different usability criteria and measurements of interest compared to desktop computing.

While previous studies are subjected to the feature phone, PDA and tablet mobility issues and constraints, this study focuses on App UI design for smartphones such a phablet and touch phone particularly on general purpose App such as communication, banking and utilities. The following study describes the methodological approach performed in defining the set of usability features and criteria depicting App usability. Altogether, the features and criteria form model and checklist to serve for App usability evaluation.

MATERIALS AND METHODS

We defined three properties as a basis for developin the usability evaluation model as follows:

Design-oriented: Different level of evaluator skill should be considered. Usability evaluation basis such as design

pattern, quality attributes and UI elements are more familiar compared to usability heuristics or principles for those from software design and engineering field.

Hierarchically structured: A model should reflect the governance between evaluation basis which consist of different abstraction level.

Analytical approach: Compared to lab experiment and field studies, analytical approach outweighs and widely used in mobile phone industry (Heo *et al*., 2009). Based on the established properties, 4 activities are carried out.

Review of mobile usability checklist: Usability evaluation is a part of development life cycle which interrelated with other life cycle phases such as requirement and design. Hence, this activity reviews sets of usability requirement, heuristics, checklist, guideline, recommendation and usability problems. The review process ranges from the requirement up to evaluation life cycle. The rationale is to obtain a comprehensive depiction of App usability. This process is restricted to mobile and App related sources. In addition, the reviewed items are taken as measurements candidates and recorded into a corpus. Finally, the candidate measures are redacted based on predefined criteria. Items referring to desktop based input devices such as mouse and keyboard; web-related user interfaces such as link to related content, breadcrumb and splash screen; physical user interface such as screen densities; soft key and shared devices concern; performance-based measure such as task completion time, loading time, download speed and installation are removed from the collection. In addition, cross domain concern such as user experience and interaction design are excluded from the collection of candidate measures.

Determination of model structure: The model aims to support non-usability expert such as analyst, designer and developer to evaluate App accordingly. Hence, determining evaluation item realized in terms of perspective they are familiar with are essential to ensure design-oriented, flexible and effective evaluation. Therefore, the candidate measures are abstracted and rearrange into hierarchy namelyusability featuresand usability criteria. However, these hierarchical components differ in terms of their abstraction level. Therefore, a tree-like model is appropriate to depict the governance between these components.

Classification of reviewed items: This classification process adopts bottom-up approach by firstly identifying corresponding usability attributes for each candidate measure. The usability attributes are determined by an appropriate value which fit them most based on the candidate measure and their description in their original source. The identified parameters for usability attributes correspond to the usability criteria hierarchical level. The identified parameters of usability criteria are then classified into corresponding usability features and UI elements. Likewise, the parameters for usability features are determined by clustering the parameters of usability criteria into groups of similar smartphone characteristics reflected by the candidate measure. Additionally, corresponding UI elements is assigned based on the UI elements defined by google android. As discussed in the earlier study, academic research findings regarding UI elements of App mostly addressed the elements as their term in web and software domain. In addition, most of UI elements used in the App are not addressed in their studies. Therefore, this study attempts to bridge the findings from academia and industry through the use of UI elements defined by google android. The UI elements are enhanced with additional elements from academia for a holistic view in classifying candidate measure reviewed from previous studies.

Transformation into checklist items: After that items referring to the same measurement are grouped and rephrased to homogenize the resulting usability checklist. The checklist items are then recoded towards adherence of usability guidelines for ensuring its reliability before it can be used for usability evaluation.

RESULTS AND DISCUSSION

Proposed App usability evaluation model

Model abstraction level: The model is organized into two abstraction levels; usability features level and usability criteria level. Each of these hierarchical components is directly paired withthe usability checklist. Thus, usability evaluation is flexible to be conducted either from the usability features or usability criteria level. Figure 1 depicts the proposed model.

Usability features level: This level consists of usability features addressing smartphone characteristic. These features are characterized by the attributes in the usability criteria level. It facilitates usability evaluation by non usability expert such as developer and designer. Table 1 and 2 show the checklist for few of the identified usability features.

Usability criteria level: This level consists of a collection of usability attributes addressing the corresponding usability feature in the lower tier. It aims to facilitate

Table 1: Measurement tied to the usability feature level

Usability feature	Measurement
Interaction	The long press gesture is reserved for multi-select
	There are no new, redefining gestures that might cause confusion
	Purpose of swipe is consistent across different areas of the same screen
Permission	User is asked for permission before making connection
	There is an option to leave unwanted state
	The App allows reverting accidental activation
Notification	Pop-up notification is reserved for occasions where a timely response is required
	User is notified when changing orientation is not supported
	Notification is not created if it is possible for the App to recover from the error without user action

Table 2: Measurement tied to the usability criteria level

Usability criteria	Measurement
Promptness	User is affirmed upon completion of an action
Completeness	New notification is combined as a summary notification if the same type of another notification is already pending
Flexibility	User is not forced to download software that is inappropriate for their phone
Connectivity	The App connect to other devices (e.g., via Bluetooth)

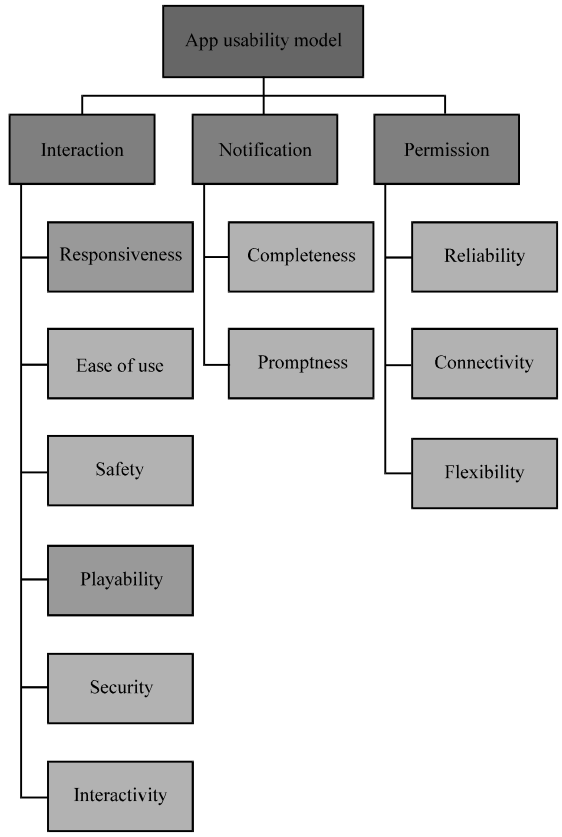

Fig. 1: The model hierarchical structure

usability evaluation in view of software engineering perspectives. Table 2 and 3 show the checklist for few of the identified usability criteria.

Table 3: Measurement tied to the usability criteria level

Usability criteria	Measurement
Reliability	User is asked for confirmation before deletion
Interactivity	Dependency is used for setting options which availability based on value of another setting
Responsiveness	Grid item is cut off indicating scrolling orientation
Ease of use	Data entry does not require the use of both hand
Playability	The media controls are simple enough to effortlessly allow control of media content
Safety	The App is secure to use while driving
Security	Graphical password is used in login

Table 4: Measurement tied to the UI elements

UI elements	Measurement
Swipe	Swipe gestures is used to navigate between detail view
Text fields	Text-area respond visually indicating wheter it's active or not
Dialogue	There is reconfirmation when something edited by the user
	There are at most 3 possible actions in a notification
Counter	UI of the App are used for notification when the relevant new information is currently on screen
Access method	The user interface take into consideration of right handed usage
Navigation	Changed state of data is indicated by counters in the drawer navigation target
Menus	The navigation menu UI component response in a respectable time to user inputs
Button	The media control component response in a respectable time to user inputs

UI elements mapped to the checklist: Indirectly, the checklist also tied to the identified UI elements. Table 4 shows some of the identified UI elements and the respective checklist.

CONCLUSION

This research presented a methodological approach to develop a model for usability evaluation of smartphone App. The model is structured into two abstraction levels; usability features and usability criteria. The abstraction levels are directly tied to the usability checklist.

The proposal mainly contributes to smartphone App usability evaluation by translating usability measures in view of non-usability expert evaluator. In addition, this study also formulates a knowledge base that allows dynamic manipulation of the measurement for different evaluator's skill.

For future research, there is an intention to incorporate the model in a framework that permit the aggregation of more than single evaluator. Other studies will be published to present the result of currently progressing content validity test and the proposed framework.

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