A Tool-based Approach for Structuring Feedback for User Interface Evaluations of Mobile Applications

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ABSTRACT
User-centered design (UCD) is a prevalent approach for developing mobile applications. It is an iterative, multi-stage design process in which prototypes are used to communicate with different stakeholders and to receive user feedback to optimize app concepts. The collection, structuring, and interpretation of user feedback in the evaluation phases is critical to the success of suchlike design processes. Although the necessity of collecting user feedback is undisputable, the UCD approach lacks some guidance on appropriate tools to efficiently manage the evaluation phase and the user feedback process in practice [1,6,7,8,11,12,15]. Against this background, the purpose of this paper is to present a tool-based approach for structuring feedback for user interface evaluation of mobile applications when using a UCD approach. The paper is work in progress. It presents the approach and some preliminary findings as well as a roadmap for further development of the tool-based concept within this project.

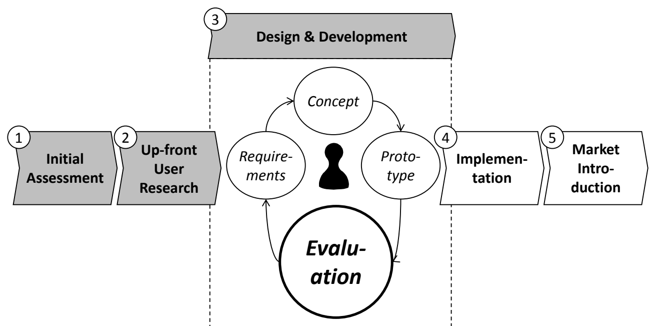
Author Keywords
Mobile applications; user feedback; evaluation tool.

ACM Classification Keywords
H.5.2. User Interfaces: Evaluation/methodology, Prototyping, User-centered design

General Terms
Human Factors; Design; Measurement.

INTRODUCTION
User-centered design (UCD) is a design approach that is based on the early integration of information on user expectations, behavior, and perceptions in the design process to develop usable products. The UCD process and methodology are described in literature and international standards (i.e. EN ISO 9241-210). The descriptions vary in detail but some elements are common to most of the approaches. Against this background a simplified UCD process is presented in figure 1. It consists of five essential elements: (1) initial assessment, (2) up-front user research, (3) design and development, (4) implementation, and (5) market introduction [3]. Evaluation of the prototype occurs in the design and development phase as indicated below.

Figure 1. Simplified User-centered Design Process



Objectives and general user requirements are identified in an initial assessment phase followed by up-front user research on usage contexts and user requirements. Based on the findings which can be documented in the form of personas and use cases/scenarios, a first visualization of the design concept can be elaborated by way of sketches, wireframes, mock-ups, and storyboards [3]. This more conceptual work is then used to develop and evaluate an interactive prototype to effectively communicate the concept to different stakeholders. Based on their feedback the prototype may be refined until an appropriate design concept is derived and the targeted mobile application is coded based on the appropriate mobile platforms, frameworks and software development tools [4]. The market introduction is the last phase in the UCD concept. It can contain additional testing for further improvements of usability, user experience and satisfaction.

During the iterative UCD process the prototype may evolve from a simple visualization of basic design characteristics (low-fidelity prototype) to a representation of the application that is rich in details and functionalities and quite close to the final product (high-fidelity prototypes) [3]. Prototypes can be evaluated to identify and resolve usability problems (formative testing) within the design process. The appropriate evaluation methods vary within the phases of the prototyping process from more exploratory formative methods in early stages to more formal summative testing in later stages while

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the prototype evolves. High-fidelity prototypes can also be used to measure the success with which the users achieve task goals and to derive metrics on the effectiveness, efficiency and satisfaction of the design (summative testing) [9]. This paper focuses on early phases of the prototyping process and the method of participatory evaluation in which users "…employ a prototype as they work through task scenarios" [9]. In contrast to automated testing as suggested here [14] the user actively participates by commenting or interpreting its user interaction or even suggests changes or improvements of the user interface. When applying this method traditionally the user comments on the walkthrough process by "thinking aloud" and this information can be recorded or captured by an observer [5]. As a result a list of problems is derived that can be used to address issues of the prototype and to refine the design concept.

In the following sections a tool-based approach for structuring feedback while applying a method of participatory evaluation is presented. Following this introduction the concept and implementation of the tool are the subject of the second section. Thereafter the third section describes pre-testing of an early implementation of this tool in the field of mobile applications for public transportation before conclusions and implications for future work are discussed in the last section.

TOOL-BASED APPROACH

As mentioned before, user feedback within participatory evaluation can be recorded or documented by handwritten notes. However, due to the nature of "thinking aloud" the user feedback is characterized by lack of structure and –especially for audio or video recording– by the massive amount of information that needs to be processed and analyzed [3]. The design issues have to be identified based on the collected user feedback and assigned with levels of severity to prioritize the resulting design changes for the design concept and prototype. Another problem in the feedback evaluation phase is the appropriate consolidation when the prototype has been presented to multiple users.

Tool Objectives and Concept

Against this background, a tool-based approach is suggested to reduce time and effort for structuring and analyzing user feedback. This may result in lower development costs. In addition the time needed to identify required design changes and thus the development time may be reduced by the deployment of such an evaluation tool.

As mentioned above, the tool-based evaluation approach of this paper was based on the method of participatory evaluation as described in the preceding section but modified into a two-step procedure: In the first step the users try to accomplish a given task based on a mobile app prototype. The test is set up in a laboratory environment but high-fidelity prototypes and real devices are used for testing. In a second step the desktop-based evaluation tool is used to gain structured feedback from the participating users. The relevant prototype screens are presented step-by-step and the participating users are asked to identify issues for the design elements as well as to give suggestions for modification and improvement of the design concept. The presentation of the corresponding prototype screen in the evaluation tool is shown in figure 2.

Figure 2. Screenshot of the Evaluation Tool

The tool provides several functions to request feedback for the prototype that has been presented to the participating users in the first phase (numbering refers to figure 2):

(1) Each issue identified by the user needs to be located within the screen to identify the affected design elements. For this purpose the participating users need to highlight the corresponding area in a representation of the prototype screen within the evaluation tool by drawing an issue box with the mouse. Based on the retrieved coordinates of these boxes the issues can be located and assigned to the affected design elements later. This information is important for tool-based grouping and consolidation of the identified issues.

(2) In a second step the user has to select a type of issue. [10] has proposed four types of issues that have been adapted for the tool:

- *Cosmetic problems* that need not to be fixed until the required time is available.
- *Minor usability problems* that hinder the user in efficiently accomplishing the specified task and thus have low priority.
- *Major usability problems* preventing the user from completing the task and thus require high priority for refining the design process.
- *Errors or "usability catastrophes"* that result in an immediate abortion of the user interaction

when they occur and therefore must be fixed immediately before the refined prototype can be presented to the user in the next design iteration.

(3) A further step provides options to categorize the issue. The user can assign several categories (e.g. design) and subcategories (e.g. color, fonts, shape, size, position) to the corresponding issue. This information is also used to structure and consolidate multi-user feedback by the tool.

(4) The user feedback is completed by a description of the issue from the user perspective that can be entered in a text field. This information is not required for structuring or consolidation but to provide more details to the development team when addressing and fixing the issue.

(5) In addition, the tool provides options to indicate missing features, to suggest design modifications or to give positive feedback for such design elements and features that the user values and would like to be retained for the final product.

The tool can be used to collect feedback from individual users. It generates a list of issues that are structured by location (on the prototype screen), type (problem, feature request, positive feedback), severity and category.

PRE-STUDY BASED ON THE EVALUATION TOOL

A java-based, preliminary version of the tool has been implemented for a proof of concept. The solution consists of three parts: (A) a configuration section to generate the test environment, (B) a participant section to collect the user feedback as described in the preceding section, and (C) a moderator section to consolidate the participants' feedback. Due to budget and time limitations these sections were implemented as "stand-alone" isolated pieces of software. Thus the configuration and issue data has to be saved in files and manually transferred between the different software products and computer systems. The tool was used in May 2013 to evaluate prototypes of mobile applications for public transportation to conduct a pre-test.

Background

Mobile apps can be used in public transportation in many ways (e.g. to schedule trips, get directions, buy tickets). The features and functionalities of such mobile apps may also vary significantly between public transportation systems and operators. In this context the research project "Success Factors of Mobile Application Design for Public Transportation (SMAT)" was initiated at RheinMain University of Applied Sciences in Wiesbaden, Germany, to gain insights into user expectations and preferences for the development of such mobile applications. A user-centered design approach was chosen and a prototyping platform was developed to be able to simulate different backend systems and to allow flexible configuration of mobile app features. Based on this platform a high-fidelity prototype was developed. The prototype presented in the pre-study focused on trip scheduling functionalities (based on text input or GPS-based positioning).

Study Design

The preliminary implementation of the evaluation tool was tested in evaluation workshops in a laboratory environment. Three prototype iterations with integrated evaluation phases were planned to be conducted with a consistent panel of participating test users within the SMAT project. In the first iteration feedback was collected from three user groups that consisted of 18 participants (7/5/6) in total. All participants were students of different programs at RheinMain University of Applied Sciences. The age of the participants ranged from 19 to 30. In the workshops the users received a short introduction to the evaluation tool and were then asked to conduct a trip scheduling task with the prototype. For that purpose the mobile app prototype was installed on a mobile device with an Android OS (HTC Desire). The walkthrough on the mobile devices consisted of five prototyping screens. In the second phase of the workshop the participating users reported design issues with the help of a desktop-based installation of the evaluation tool. The user feedback was consolidated and provided to the development team for the refinement of the prototype and the design concept. The evaluation tool was fully functional even if some of the functions of the evaluation tool were not implemented for the pre-study yet and had to be realized manually (e.g. assignment of the issues to design elements of the user interface).

The proof of concept of the tool was successfully applied during the pre-study. In total 152 issues were identified for the five prototyping screens by the 18 users. The types of issues were assigned by the users as intended but were additionally independently assigned by four members of the project team (from the designer and developer perspective) to check for semantic problems due to varying interpretations of the problem types [2]. The project team assigned the issue types based on the users' issue descriptions with a degree of conformity of 86 percent (among the four reviewers). However, based on this expert assignment 48 percent of the issue types assigned by the users had to be adjusted.

Table 1 presents the identified problems derived from the consolidated results. In total 82 problems were identified. The number of problems varies between the screens but cannot be attributed to the different numbers of design elements on the presented screens alone.

Screen ID (Elements)	Error	Major	Minor	Cosm.	Total
1 (5)	0	0	2	6	8
2 (9)	0	4	18	3	25
3 (4)	0	11	7	7	25
4 (3)	0	0	5	13	18
5 (6)	0	0	3	3	6
Total	0	15	35	32	82

Table 1. Problems Identified by the Evaluation Tool.

CONCLUSIONS AND FUTURE WORK

The concept for an evaluation tool presented in the second section of this paper was successfully applied for structuring and consolidating the feedback derived from multiple users. The results of the pre-test indicate that the tool is a promising approach for collecting and consolidating user feedback in the evaluation phase of a prototyping process. However, more comprehensive analyses are required to assess the effectiveness and the efficiency of the tool. The following topics need to be addressed and analyzed as next steps in the project when working with the evaluation tool:

- Effectiveness of grouping the issues based on their assignment to affected design elements by using the screen coordinates of the issue box.
- Improve semantic consistency i.e. better communication of issue types to reduce the variations and required adjustments of the users' assignments.
- Usefulness and handiness of the issue information reported by the tool from the developer perspective (based on a tool-generated issue report).
- Impact of the issue fixing/refinement of the design concept on the number of identified issues in the next iteration phase of the design process.

Future work also needs to elaborate on the architecture of the evaluation tool and the high level of abstraction from the real mobile user context due to the laboratory environment and the use of a desktop-based evaluation tool [13]. Therefore a roadmap of the tool development has been defined:

- *Phase 1:* The current solution with three isolated software sections will be migrated into a client-server architecture. Access to the evaluation tool will be provided to the participating users by a web-based frontend. Moderators will be able to access the tool, configure the test environment and analyze the collected user feedback data based on a browser-based backend. All related data is stored and distributed to the web-clients by the server to render the manual and file-based transfer of this information obsolete.
- *Phase 2:* The client-server solution will be extended to collect data directly via the mobile devices. The participating users can provide their feedback directly during the walkthrough and do not need to switch to the desktop environment afterwards. The solution will be integrated into the SMAT prototyping environment and provide further features for non-intrusive usability testing.

The implementation of these phases is not within the scope of the SMAT project and will be addressed as future work if required funding can be retrieved.

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