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Seyff, Norbert ; Ollmann, Gregor ; Bortenschlager, Manfred

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AppEcho: A User-Driven, In Situ Feedback Approach for Mobile Platforms and Applications

Norbert Seyff

University of Zurich
Zurich, Switzerland
seyff@ifi.uzh.ch

Gregor Ollmann

IWA Technologies Inc.
Linz, Austria
gregor@iwa-tech.com

Manfred Bortenschlager

3scale
Barcelona, Spain
manfred@3scale.net

ABSTRACT

Mobile platforms and applications are an exciting and important phenomenon in today's software and business world. They are being woven into the fabric of daily life faster than expected. Continuous collection of user feedback enabling the improvement of platforms and applications becomes critical to support the continuous evolution of mobile systems. Particularly user feedback is needed to provide systems that best fit user needs. We have designed a mobile feedback approach, which enables users to document individual feedback on mobile systems in situ. This information can then be evaluated and used as new requirements by developers. Based on this solution we have developed a feedback app for two different mobile platforms. Furthermore, we have conducted a study with smartphone users applying this approach and communicating feedback on a mobile platform and pre-installed apps. The study revealed that users were able to give individual feedback and that a large amount of this feedback was considered to be useful for mobile system improvement by a platform developer.

Categories and Subject Descriptors

D.2.m [Software Engineering]: Miscellaneous

General Terms

Design, Experimentation, Human Factors

Keywords

user involvement; feedback gathering; mobile platform improvement; user experience

1. INTRODUCTION

Mobile devices such as smartphones have advanced significantly over the last years and a variety of platforms are available. They have become an integral part of our daily lives and are available on an arm's reach. Users are familiar with smartphone features (e.g. touch screens) and the variety of applications. The demand for apps is high, as are users' expectations. However, mobile

application development represents challenges for developers. Reasons include limitations of mobile platforms and development environments. Other reasons also include short time-to-market periods and a lack of appropriate development methodologies. This increases the risk of providing apps that do not meet user expectations [10].

Furthermore, literature highlights that software must be continuously adapted and enhanced to remain satisfactory [1, 13]. User needs and expectations change depending on the actual user context; they also change over time [15, 17]. Software should provide desired new features, but also improve in quality to fulfil user needs in changing environments [7]. Furthermore, individual users might have different expectations of what kind of features a system should provide and how a system should evolve. These considerations are particularly true in the mobile system domain and highlight the need for user feedback on existing mobile platforms and apps. However, individual user feedback on mobile platforms and apps is hard to obtain. More traditional feedback approaches include interviews, surveys and workshops. These approaches often do not allow involving a high number of users and do not enable them to provide feedback in situ (e.g. when they are actually experiencing a problem). Another option for developers to gather feedback are mobile application stores (e.g. Google Play). They provide features enabling smartphone users to rate or comment on apps. Although a large amount of individual feedback could be gathered, in many cases, the feedback provided is often rather high-level and superficial. However, it also includes useful comments, bug reports, user experience, and feature requests [5, 11]. This feedback can support system evolution.

However, feedback communication via mobile application stores proves limited support for documenting feedback in situ and a more detailed description of the problem context might be missing. We therefore conclude that there is a lack of structured approaches which enable users to adequately communicate individual feedback to developers.

The goal of our research is to tackle this issue by providing mechanisms that support users in expressing feedback regarding mobile platforms and apps. Mobile devices are ubiquitous and provide an opportunity for users to provide feedback on the running platform and apps in situ. Therefore, mobile devices such as smartphones provide a possibility for active user involvement [2, 17]. Furthermore, current literature discusses the involvement of users in

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software development and reveals that it is a key aspect [3, 6] whose importance will increase in the future [2].

The work presented in this paper addresses these issues by making two main contributions: (1) We introduce a mobile feedback approach to gather individual user feedback on mobile platforms and apps; (2) We present the results of an initial evaluation of this approach, where smartphone users provided in situ feedback on a selected mobile platform and pre-installed apps. In order to approve the validity of the feedback gathered, a platform and app developer analysed its understandability and usefulness for system evolution. Results highlight that users can document and report feedback without the help of analysts. Furthermore, developers considered a large amount of this feedback useful to support mobile platform and app evolution.

2. RESEARCH GOAL AND QUESTIONS

The goal of the presented research is to realize and to initially evaluate a mobile feedback approach enabling smartphone users to give individual feedback on mobile platforms and apps in situ. We identified more specific research questions (RQ) to define the focus of our research:

RQ 1: To what extent does the mobile feedback approach support users in providing feedback on a mobile platform and applications in situ?

RQ 2: To what extent do users apply the mobile feedback approach continuously over time?

RQ 3: To what extent is the feedback gathered understandable for developers?

RQ 4: To what extent is the feedback gathered useful for mobile platform and application improvement?

In order to answer these questions we organized our research activities as follows. As a first step, we explored the state-of-the-art in mobile user feedback generation to identify and gain an overview on relevant approaches and strategies. In a next step, we conducted interviews and used online questionnaires in order to figure out user and developer needs regarding our envisioned mobile feedback approach. Based on this state-of-the-art analysis and the requirements collected, we designed a platform independent conceptual solution – a feedback approach which enables users to give individual feedback on mobile platforms and apps. In a further step we developed a mobile feedback app for two different mobile platforms. To evaluate our approach, we conducted a case study where smartphone users gathered feedback on the platform and pre-installed apps in situ. In a final step, the feedback gathered was presented to a platform developer for analysis.

3. ANALYSIS AND CONCEPTUAL SOLUTION

In our previous work [17] we have developed a mobile requirements elicitation tool allowing users to in situ collect and document individual requirements regarding novel mobile and ubiquitous applications. However, little is known about how to support users in self-documenting their feedback on mobile platforms and applications. Therefore, in a first step we identified the main requirements that such an approach has to fulfil. In informal, semi-structured interviews we asked 20 smartphone users about their needs regarding the envisioned mobile feedback approach

that would allow them to give feedback in situ. We applied opportunity sampling [12], but also considered age and skills regarding smartphone usage in the selection process. After these interviews we analysed the user needs gathered and created an anonymous online questionnaire¹ (in German) to validate and prioritize them. Using snowball sampling [12] we invited participants via social networks and email to fill in the questionnaire. In total we had 66 participants in this online survey.

In addition to discussing needs of users, we also conducted informal, semi-structured interviews with five mobile platform and application developers who we asked about their opinions and requirements regarding our envisioned mobile feedback approach. Again, after the interviews, we used an anonymous online questionnaire² to validate and prioritize these requirements. Therefore we forwarded the link to our questionnaire to mobile application developers (17 developers participated in this anonymous online survey).

The online questionnaires confirmed the importance and validity of the gathered requirements. In the following we present the needs received from users and developers ordered according to their importance as found in the online questionnaires.

3.1 Needs of Smartphone Users

Easy to use: Usually, users do not have experience in feedback elicitation. To enable a wide range of users to gather feedback we have to provide an easy to use feedback approach.

Ubiquitous availability: Users need to have the possibility to give feedback on the go. For them, it should be possible to give feedback whenever and wherever they want.

Unobtrusive support: Users mentioned that they do not want to be disturbed while performing everyday activities. Therefore, what is needed is an unobtrusive feedback approach, which is woven into the fabric of everyday life.

Ad-hoc and quick support: People do not have much time to give feedback while undertaking everyday activities. As soon as they decide to provide feedback, adequate support has to be available and the documentation of feedback itself needs to be quick.

Respect privacy of users: Most of the users reported concerns about privacy and data. They want to decide which data, especially personal information, will be forwarded to application developers.

Provide guidance and support: To avoid the need for lengthy briefings and to train users in self-documenting feedback, our feedback approach should provide sufficient information and guidance.

Let users know the addressee: Users want to know who receives their feedback. Furthermore, they want to know why an addressee is interested in their feedback and what an addressee wants to achieve with their feedback.

Support different ways of feedback documentation: Users asked to exploit the features of modern mobile devices for feedback documentation. They suggested different ways of capturing

¹ <https://de.surveymonkey.com/s/Q33MH2X>

² <https://de.surveymonkey.com/s/Q33MH2X>

feedback (e.g. using text-based descriptions and audio recordings).

3.2 Needs of Mobile Developers

Receive understandable, easy to analyse feedback: Developers insisted that feedback needs to be understandable. They mentioned that they prefer clear and simple descriptions of the main issue or requirement. Feedback needs to be provided in a structured form, making it easy for them to analyse it and to draw conclusions.

Receive context information: They requested automated context-sensing and monitoring features to gather additional information. They required status information about the system (e.g. battery level, platform version), the user (e.g. profile information) and the environment (e.g. GPS status, WiFi status) to better understand the reason of the feedback submitted.

Provide the option to ask questions for clarification: Developers requested an option which would allow them to ask questions for clarification. They argued that there might be cases where essential feedback is submitted but they might not fully understand what the user was saying, so they want an opportunity to ask questions to users.

Provide a scalable approach: They requested an approach, which would allow a large number of users to provide feedback on a particular platform or apps.

Provide a platform agnostic approach: Developers requested a platform independent approach. Furthermore, they mentioned that they would like to have a “unified” feedback method which can be used for all different sorts of apps and platform features.

Get feedback from different types of users: They would wish for a feedback approach which includes people with different backgrounds. The approach should fit all user needs and should not be tailored to a particular user group.

3.3 Considerations for a Mobile Feedback Approach

In addition to the validation and prioritization of needs regarding a mobile feedback approach, we also used the questionnaires to gain more insights about current feedback mechanisms in the mobile application domain.

Over 45 % of the smartphone users indicated that they would like to have the possibility to give feedback in situ using their smartphone. Another 39 % considered the possibility of giving feedback to be important, but also highlighted that they most likely would not use such an approach themselves. Furthermore, over 75 % of the users participating in our online questionnaire stated that they would prefer to give feedback in situ; at the very time it emerges.

Developers claimed to use interviews, email but also applications stores as key channels to receive feedback. However, more than 40 % of the developers considered the feedback received via applications stores as “useful, but not detailed enough” and another 35 % indicated that the feedback from application stores “mainly addresses other users and does not support developers”. Over 80 % of the developers would like to receive more user feedback.

We considered these results to highlight the need for the envisioned mobile feedback approach. We understood that users are

familiar with the basic features and the general handling of their smartphones and mostly their smartphones are with them all the time. Therefore, our vision is to extend mobile platforms with a unified feedback approach, instead of individual feedback mechanisms for particular apps. Users would not be distracted by different feedback approaches; they could rely on a unified solution capable of gathering different types of feedback (e.g. feature requests, bug reports, positive comments).

With the help of the user and developer needs gathered, we were able to decide on the key features of a mobile feedback approach. We agreed to provide a feedback approach following the push method, meaning that it is the user who initiates the feedback documentation and communication. Therefore, we aimed to provide a user-driven mobile feedback approach and considered the needs of users to be more important for our first solution.

4. THE TOOL-SUPPORTED APPECHO APPROACH

As a result we developed a mobile tool-supported feedback approach. We focused on realizing lightweight support for mobile users that allows them to document feedback in a few, simple steps to enable quick but useful feedback documentation. This feedback is automatically forwarded to a predefined addressee (e.g. a developer). The established feedback approach can be seen as a blueprint solution that could be implemented on different mobile platforms and is presented below as implemented for a particular mobile platform.

4.1 AppEcho for the bada and Android Platform

We have decided to develop mobile feedback apps – AppEcho apps for two different mobile platforms; for the Samsung bada OS and for Android OS. The bada OS was selected because Samsung granted support in terms of mobile devices and access to a platform developer. The bada platform was a relatively new platform providing similar features as other mobile platforms and thus highly appropriate for feedback gathering, although Samsung announced its discontinuation in early 2013. We also developed the AppEcho app for Android OS, as a proof-of-concept that the approach also works on a well-known mobile platform.

Both AppEcho apps apply to novel interaction techniques supported by smartphones and the user interface of the apps is optimized to be operated via touch screen. To support users in documenting feedback issues the AppEcho app provides a wizard-like interface guiding users step-by-step. The tool supports gathering essential feedback information by documenting two facets of information, the application context (information about the application in use) and the actual feedback input from the user. It was designed to make the user focus on short and simple feedback descriptions. In order to reduce the time needed for documentation, we used the built-in multimedia capabilities of mobile devices to also allow audio recording in addition to text input.

Both AppEcho apps use several services provided by the particular mobile platform libraries to access built-in smartphone features. This for example includes services to access a screenshot stored on the mobile phone, media services (e.g. audio recorder and audio listener), services for database storage, and messaging services (e.g. email client). Furthermore, AppEcho stores all the feedback information recorded in a SQLite database available on bada and Android OS. Our analysis suggests that the services used

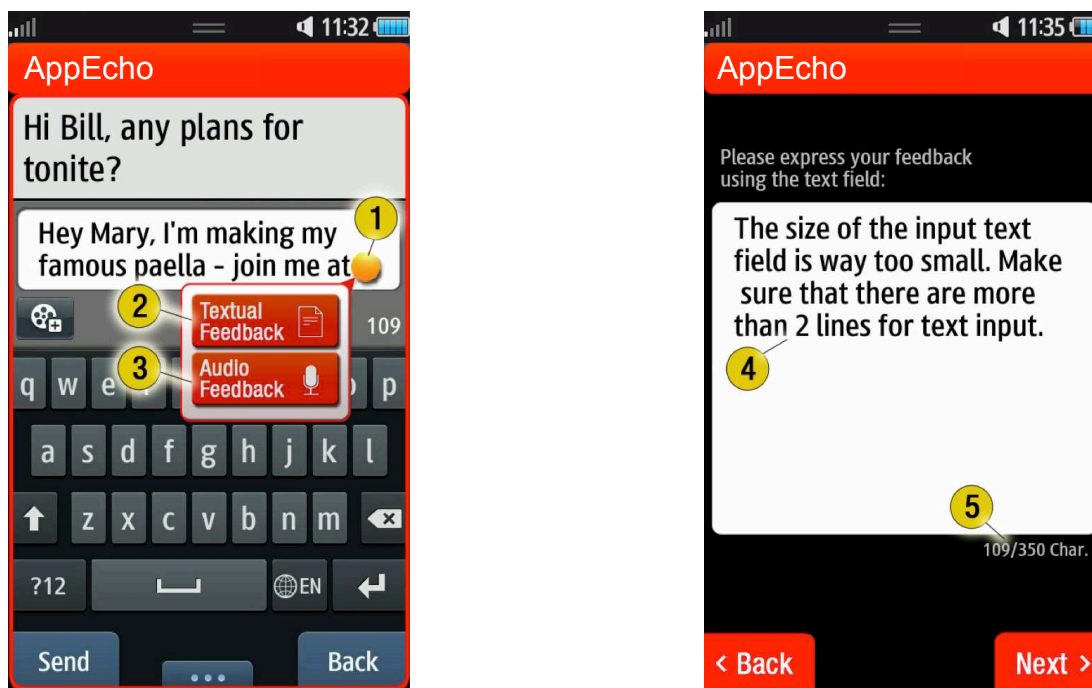


Figure 1. Selecting a relevant feedback element (left) and reporting an issue using text (right).

for the current AppEcho apps should also be available on other well-known smartphone operating systems (e.g. iOS). This means that the AppEcho feedback approach could be implemented on those platforms.

4.2 AppEcho Features

In the following we present the tool-supported AppEcho feedback approach in the form of a mobile app developed for the bada platform. We highlight the approach from the user perspective and discuss the key steps a user has to perform in order to document and communicate feedback using AppEcho:

Quickstart: We propose that starting the feedback mechanism should be easy and fast. Therefore, a mobile end-user can exploit built-in smartphone functionality to capture a screenshot of the e.g. running app, where the user would like to give feedback to. How a user can capture a screenshot depends on the particular platform. For instance, in the case of the bada platform the user has to press a predefined combination of keys at the same time. After capturing this relevant application context information the user can launch AppEcho like any other application installed.

Select Feedback Aspect: After launching AppEcho, the application highlights the screenshot captured and allows the user to select the relevant element or aspect he wants to give feedback on. Here, we refer to any GUI element or any other kind of information shown on the screen. By tapping (touching) the screen, the user can select the appropriate feedback aspect. Figure 1 shows the AppEcho app highlighting a screenshot of the bada text message app. By typing, the user selects the input text field (1) as relevant element for feedback (indicated by the yellowish circle).

Select Feedback Documentation Method: The AppEcho app provides two alternative options for documenting feedback. When

the user taps the screen to select the relevant feedback aspect, he can decide to either give feedback using text input or to audio record the issue. Figure 1 highlights this selection between Textual Feedback (2) and Audio Feedback (3).

Document Feedback Issue: Depending on the user's selection, the feedback app enables the user to document feedback information using text or audio recording. The screenshot on the right hand side of Figure 1 highlights how end-users can provide feedback using plain text (4). In order to keep users focused, both input formats are limited to a maximum number of characters (350) in the case of text input as shown in Figure 1 (5) and to a maximum recording time (30 seconds) in the case of audio recordings. In the example depicted in Figure 1, the user complains about the size of the input text field: "The size of the input text field is way too small. Make sure that there are more than 2 lines for text input."

Submit Feedback: After feedback is captured, the app summarizes the inputs documented by the user, who then has to confirm that the feedback will be sent to responsible addressees. Currently, the app uses the built-in email client of the mobile device to send the information gathered to a predefined email addresses. This also means that in case of connection problems the feedback is temporarily stored on the device. Furthermore, the feedback information gathered will still remain on the smartphone stored in the database.

The current app furthermore provides a check box which enables users to indicate if they want to submit feedback to developers anonymously. However, at the moment, this feature has no effect on the information sent. The feature was implemented to figure out if people would use such an option.

5. EVALUATION

In order to investigate how our user-driven mobile feedback approach enables smartphone users in documenting feedback and in order to provide first answers to our research questions, we conducted an initial evaluation in the form of a case study in cooperation with Samsung Electronics. In this initial study users gathered feedback on the bada platform and pre-installed apps. Therefore, we provided the AppEcho app (introduced to study participants as bada Feedback) to users, who used it over several weeks to gather their individual feedback. A bada platform and app developer analysed this feedback for understandability and usefulness.

5.1 Evaluation Method

We focused on a qualitative evaluation approach since this allows gaining in depth information and detailed insights on the usage of an approach. Applying opportunity sampling [12] we identified 14 participants who evaluated our mobile feedback approach. We solicited participants in the study with the help of social networks and word-of-mouth. Those 14 participants were of different age (24 to 43 years), gender and profession. None of these participants were professional software engineers nor had they any experience in providing feedback on software applications. The participants' knowledge of smartphones and usage patterns ranged between basic (standard users) and advanced (power users), meaning that all were familiar with smartphones but use the provided features to a different extent. Their experience regarding the use of smartphones was the only selection criterion.

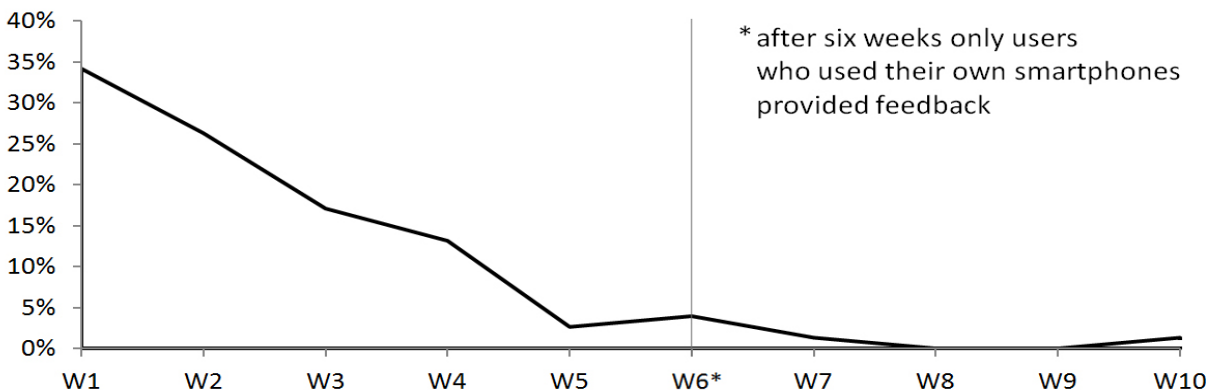


Figure 2. Percentage of Feedback issues provided over time.

Basically we had five smartphones from Samsung available for the study (Samsung Wave and Wave II devices with Samsung bada OS Version 1.2 installed). As soon as a device was returned it was given to the next participant. However, some of the participants agreed to use their own private bada smartphone to take part in the study. The motivation of people to participate was manifold. Some simply liked the idea that they would be able to communicate their thoughts about a system they use every day. Others liked the fact that they would get a high-end bada smartphone for a couple of weeks.

Regarding feedback gathering, the evaluation was split into three parts – briefing, evaluation and individual debriefing discussions. Briefings were very short, because we only told participants that the purpose of the study is to gather any kind of feedback issues

related to the Samsung bada platform and to pre-installed apps (no third-party apps were installed on the smartphones we gave to participants). We did not specify the task in more detail: we intended to investigate what kind of feedback users would provide and wanted the participants to experience by their own. We would like to highlight that we did not mention that the AppEcho feedback approach itself was also under investigation. However, as none of the participants was familiar with such a feedback app we had to give them a short introduction. This means that we showed participants how to use the tool once, maximum twice using a predefined example. Furthermore, we encouraged them to use the available privacy setting. However, we also mentioned, that we would be able to identify the submitter anyway.

During the evaluation phase, participants used the feedback approach to gather feedback on the bada platform and pre-installed apps. We decided on an evaluation period of six weeks based on initial trials conducted by two authors of the paper. We experienced that after five to six weeks the feedback generation rate had dropped significantly. During the six weeks evaluation period we had no further contact with participants. However, we were able to watch their steps from a distance as we received their feedback via email. After the six weeks period we invited the participants to individual debriefing meetings. In the debriefing meetings we mentioned that the study was not only conducted to gather feedback on the bada platform but also to evaluate the AppEcho feedback app itself. With the aid of semi-structured interviews, the participants provided feedback on the usability and utility of the method.

After all individual debriefing meeting, the feedback gathered was cleared of private information and forwarded to Samsung for further analysis. A bada platform and app developer conducted a detailed analysis of the feedback provided. Our aim was to figure out whether the user feedback gathered is understandable and provides relevant requirements for platform and app evolution.

5.2 Evaluation Results

All 14 participants were able to gather feedback using the AppEcho feedback app. In total, the study participants documented 76 individual needs. This means that the 14 participants gathered on average 5.4 feedback issues.

The participants provided most of the feedback within the first two weeks (46 issues). Overall, the study shows that the percentage of feedback gathered decreases and seems to stop after about

five weeks. However, people who used their own smartphones to participate in our study continued to document feedback. Figure 2 highlights that these users even provided feedback after 10 weeks of using the tool.

To get a more detailed picture, we analysed the feedback generation rate considering different user types. We distinguished between standard users and power users by analysing their smartphone usage. We understand standard users to be people who mainly use their mobile for phone calls and text messaging. These people might also use an alarm clock, mobile Internet and built-in camera functionally but their interest in advanced smartphone features is limited. Power users are people who heavily rely on smartphone features, use several third-party apps and continuously install new apps on their smartphone. In the individual briefings we asked a few questions about the participants' mobile phone usage to assign them to the group of standard or power users.

In our study the group of power users provided 50.0 % of the feedback gathered (38 feedback issues). This contribution is even more remarkable as this group only included 4 people. The 10 other participants belonged to the group of standard users. This also includes all the participants who used their own bada smartphone to participate in this study. As a matter of fact, only the group of standard users can therefore be further divided into the group of long term bada users and users who used bada for the first time. Standard users, who used their own bada smartphone (4 participants), gathered 17 feedback issues (22.4 %). Standard users, who received a bada smartphone from us (6 participants), had the lowest generation rate and in total documented 21 feedback issues (27.6 %).

Study participants came up with a wide range of different needs related to the bada platform and pre-installed apps. We identified different categories on which feedback was given (see Figure 4). Half of the feedback was given on general platform issues (38 issues). 33 out of these 38 feedback issues on the bada platform were discussing software-related issues. This included feedback on bada's virtual keyboard, touch mechanism and menu options. However, the remaining 5 issues also include hardware-related feedback.

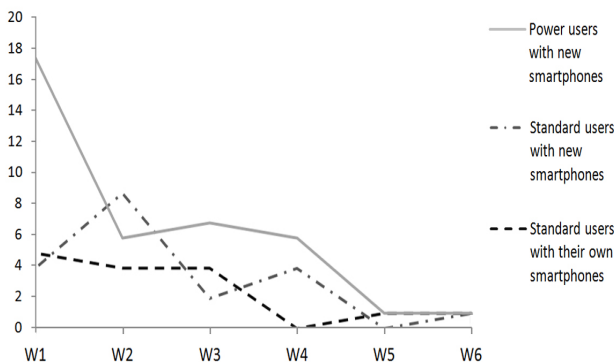


Figure 3. Number of feedback issues provided by different user groups over the period of six weeks.

For example, users complained that switching from vertical to horizontal view when rotating the device takes too much time. The second most frequent feedback, which includes 36.8 % of the

feedback issues gathered (28 issues), has been on pre-installed bada apps such as calendar, alarm clock and camera (e.g. the calendar does not support task categories).

We further received feedback concerning needs on bada widgets (5 issues), third-party apps (2 issues), and one feedback issue to the more general bada environment. Widgets are mini-applications that provide easy to access but limited functionality to users [9]. Needs regarding widgets revealed that participants basically like them but still have issues with their handling. Although we did not expect it, we also received some feedback on third-party apps as some of the participants using their own bada smartphones had also installed third-party apps and used AppEcho to communicate feedback. Furthermore, a user provided one particular feedback on the broader bada environment and noted synchronization issues with the desktop software Samsung Kies [9]. Finally, we identified two needs which we did not assign to the given categories. These needs highlighted new ideas for third-party apps.

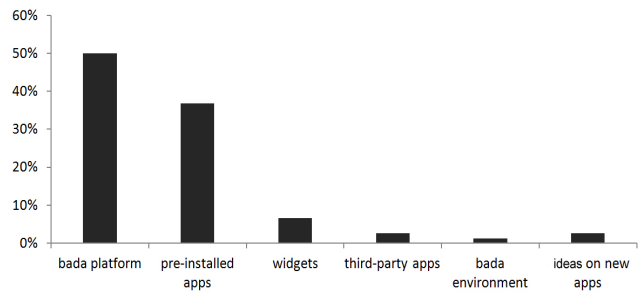


Figure 4. Categories of feedback given to platform and apps.

Having analysed the needs gathered, we decided to follow Lientz and Swanson [8] and place them in categories (see Figure 5). 52 feedback issues (68.4 %) belong to the category perfective. This describes needs triggering the improvement of already existing platform or app features. It mainly reflects non-functional requirements. A detailed analysis of the feedback in this category revealed that 45 out of the 52 feedback issues gathered addressed usability problems. Other feedback addressed operational issues (4 issues) and performance (3 issues).

Apart from the categories introduced by Lientz and Swanson [8], we defined an enhancement category. This category reflects functional requirements and discusses new ideas and needs. 15 of the feedback issues gathered (19.7 %) were assigned to this category. Thereby, 13 of these issues discussed ideas about ways to extend the functionality of existing apps. Examples include a request for an improved calculator functionality enabling scientific calculations. The remaining 2 feedback issues in this category covered ideas for new apps. For example, a user suggested a flashlight app.

The category “positive comments” reports on feedback issues mentioning something positive – things users like. This category contains 6 of the feedback issues gathered (7.9 %). For example, a user mentioned that he likes the haptic response (vibration) when pressing a key on the virtual keyboard.

We assigned 3 of the feedback issues gathered (3.9 %) to the category corrective. This category is dealing with errors that

prevent the users from achieving their goals (e.g. a user was not able to synchronize the calendar app).

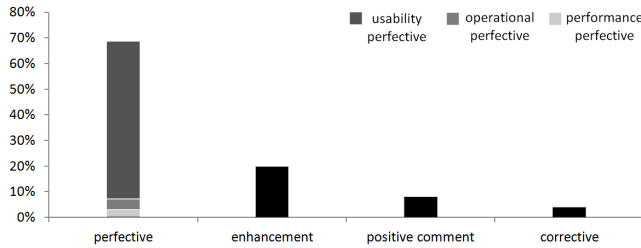


Figure 5. Classification of feedback issues.

The feedback gathered was given to Samsung in the form of a Word document showing the screenshot with the selected aspect and the textual feedback given for each individual feedback. In order to do so, the 5 audio feedback issues received (10.9 %) were transcribed into text by one of the authors. Participants used the anonymous feedback option in 48.0 % of the cases. However, no personal information was forwarded to Samsung.

The feedback was analysed by a Samsung bada platform and app developer (see Figure 6). The analysis of all the feedback issues took two hours. In total, 64 out of 76 feedback issues (84.2 %) were understandable.

More importantly, the bada platform developer also answered the question: does the feedback given provide useful information to support Samsung in improving the bada platform and pre-installed apps? Results highlight that out of the 76 feedback issues gathered, 61 issues (80.3 %) provided useful information relevant to improve the bada platform and pre-installed apps.

However, the analysis of feedback issues also revealed that there was a minor overlap between the user feedback gathered in terms of duplicates. For example, the issue that the smartphone’s pre-installed FM radio app only works when ear plugs are connected was mentioned three times. If we discount duplicates, 71 different issues were gathered instead of 76. However, these duplicates were considered useful for feedback prioritization by the developer.

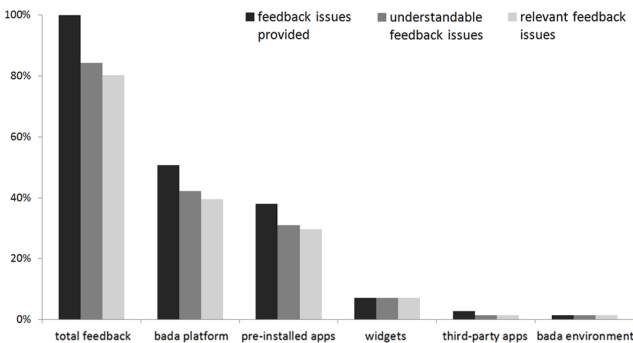


Figure 6. Feedback analysis results by developer.

5.3 Further Findings

In this sub-section we present findings and observations that primarily stem from the individual debriefing meetings we held with the participants of our study.

All participants revealed that the AppEcho approach supported them in documenting feedback in situ. They claimed that about 80 % of the feedback they captured was gathered directly in the situation when they discovered an issue for the first time. However, they also mentioned that there are situations when there is no time to document an issue. Users highlighted the lack of time to give feedback, is particularly true during daily work activities that cause a higher level of stress. Most of them used their free time to explore new functions and ways of using the smartphone. They claimed that this is the time when they found most issues. An analysis of the time when feedback was documented revealed that most of the feedback was gathered in the evening between 4.00 pm and 8.00 pm (36.8 %).

Participants claimed that the use of AppEcho did not affect their daily activities in a significant way; they think that the approach is well-woven into the fabric of everyday life. In debriefing meetings, they mentioned that the documentation of a particular feedback took about two minutes using text-based input. A more detailed analysis based on the feedback data received, revealed that on average users needed about 2.5 minutes to document a feedback using text. Debriefing results show that participants felt more comfortable using text-based input as the virtual keyboard is used as main input mechanism when working with smartphones. Only five feedback issues were documented using audio. However, end-users mentioned that in some situations audio recording is a helpful alternative to gather feedback (e.g. when there is limited time, or while physically moving).

Furthermore, we tried to see if a developer, knowing the system under investigation, is able to understand user feedback and if this feedback provides useful information for system evolution. The bada platform and app developer who analysed the feedback gathered, claimed that the information provided allowed a quick analysis. On average, the developer involved in our study needed less than two minutes to analyse a particular feedback issue. The feedback which was considered to provide useful information for system improvement was communicated to the greater bada developer team. However, we are unaware if and to what extent this feedback was actually considered. The developer also mentioned that it was interesting to receive a few positive feedback issues. These were considered to be important, as they show where the system has already reached a level of quality which satisfies user needs and where no changes should be made.

5.4 Threats to Validity

We did not compute statistical significance when analysing the results of our study which is a threat to conclusion validity. Considering the number of bada smartphone users worldwide, our random sample of 14 does not allow any statistically relevant conclusions. However, our aim was to basically explore the feasibility of in situ user feedback generation and the relevance of the feedback gathered.

To keep the use of smartphones as natural as possible, we did not conduct our study in a controlled environment which possibly affects its internal validity. Our aim was to enable users to provide feedback in naturalistic settings. This means that environmental effects might have had an influence on the results. As reported by participants, their stress level influenced feedback generation. Furthermore, being part of a study might have had an effect on users’ motivation towards feedback generation. Providing a smartphone and obviously expecting their feedback might have

also influenced how and how often people documented feedback. However, we did not put any pressure on participants and conducted a long-term study where users were able to document feedback for six weeks without any intervention from our side.

We asked participants to give feedback on the bada platform and pre-installed apps. Our study did not cover the large number of available third-party apps and the continuous updates provided. Although initial feedback was gathered on two third-party apps we consider this lack as a threat to construct validity, but also allowed us to focus on particular aspects of the bada environment.

The bada platform was introduced in 2010 and is still young compared to other mobile platforms. This could mean that our study underrepresents external validity as the likelihood of issues in a young platform might be higher. Only smartphone users who reported an interest in our study could participate. Long-term bada users who considered themselves to be smartphone power users were not included and furthermore, we only had two female participants in our study. However, we were able to focus on mobile end-users aged 24 to 43 which is the typical age of smartphone users [14]. The small number of participants in our study can be seen as a major threat to our results. Different results might arise for different types of mobile feedback approaches. Only one bada platform and app developer analysed the feedback issues gathered. Evaluation results might vary depending on the developer's background and experience. However, an analysis of the feedback issues gathered by the authors confirmed the developer's results.

6. RESEARCH QUESTIONS REVISITED

We sought to provide first answers to the four research questions based on the results of the study. As the size of our sample does not allow formal hypothesis testing, we cannot give any statistically significant results.

RQ1: To what extent does the mobile feedback approach support users in providing feedback on a mobile platform and applications in situ?

To explore this question, we gathered detailed user and developer needs in order to develop a mobile feedback approach. This served as blueprint solution for developing dedicated AppEcho apps for the bada and Android platform. The AppEcho app for bada was used by 14 participants over six weeks within a case study. The participants documented an average of 5.4 feedback issues. However, power users on the average documented 9.8 feedback issues while standard smartphone users documented 3.8 issues. In debriefing meetings, both user groups claimed that they were able to give feedback with the help of AppEcho. Furthermore, it became clear that power users investigated the bada platform and pre-installed apps in much more detail. We consider this to be a reason for the higher generation rate found with power users. We conclude that different smartphone usage patterns might influence feedback generation.

In debriefing meetings participants highlighted that about 80 % of the feedback issues gathered were documented in situ. However, they also highlighted that there are situations where this is not possible. For instance, participants mentioned that stressful tasks at work or driving a car prevented them to give feedback in situ. We therefore conclude that the tool-supported AppEcho approach in general supports users to document feedback in situ.

The time needed to document a feedback issue using text was considered to be appropriate by participants (2.5 minutes on the

average). Although participants mentioned that they consider audio recording to be even quicker, they highlighted that they are used to the virtual keyboard and in general do not often use audio recording. This might explain the low number of audio feedback received (10.9 %). We conclude that text input is more natural and preferred by users in order to document their individual feedback.

RQ 2: To what extent do users apply the mobile feedback approach continuously over time?

In our study, the participants provided the majority of the feedback (60.5 %) in the first two weeks. Furthermore, the study revealed that the percentage of feedback gathered decreases rapidly during the first four weeks. As a stable environment was provided where no changes were made (e.g. in terms of software updates) these results conform with our expectations. In debriefing meetings users mentioned that after some time they simply had documented their individual feedback issues. As mobile platforms and apps change continuously, we clearly see a need for continuous feedback communication. Mobile platforms are dynamic and we expect that, due to the installation of new apps and updates, a continuous feedback stream could be established. However, during our study we did not provide platform and application updates. We therefore conclude that the feedback generation rate in stable environments will decrease over time. Further studies are needed to investigate the effect of software changes and updates with respect to feedback generation.

However, a small amount of feedback was communicated continuously. Although we clearly communicated that we kindly invite participants to document feedback for a period of six weeks, participants who used their own bada smartphones did not stop providing feedback after this period. We even received some feedback after 10 weeks. In debriefing meetings, users mentioned that they would be willing to continuously provide feedback. We therefore conclude that we could not identify any reasons in our study why end-users would stop providing feedback. However, long-term studies focusing on users' motivation regarding feedback documentation are needed.

RQ 3: To what extent is the feedback gathered understandable for developers?

The Samsung bada platform and app developer classified 84.2 % of the feedback provided as understandable. The developer highlighted that the screenshots captured provided valuable information and supported analysis. However, in the cases where he could not understand the user feedback, the developer would have wished for more information provided. In particular, the developer mentioned capturing more information with the help of automated context-sensing and the option to ask questions for clarification to users. These developer needs are neglected by the current AppEcho approach as it would have affected user privacy needs. Apart from the bada platform and app developer, the authors also analysed the feedback gathered, which revealed that a high percentage of feedback is clearly understandable. We therefore conclude that within our study, a high number of feedback issues were understandable for a developer, although user privacy needs were respected.

RQ 4: To what extent is the feedback gathered useful for mobile platform and application improvement?

The bada platform and app developer considered 80.3 % of the total feedback issues gathered to be useful for mobile system

improvement. Considering that 84.2 % of the feedback was understandable for the app developer, this means that 95.3 % of the understandable feedback issues were relevant and provided valuable information for bada system evolution. In the debriefing meeting, the developer mentioned that as soon as he understood the feedback it was easy for him to decide whether it reveals relevant requirements. In addition to the bada platform and app developer, the authors analysed the feedback gathered, which confirmed the developer's analysis. We conclude that in our study a high amount of the feedback which was understandable also provided useful information regarding mobile platform and application improvement.

Our study highlights that the main issues which could be addressed in future releases of the bada platform and pre-installed apps are related to usability issues (59 % of the total feedback issues received). This means that with the help of our study we have identified the main subject for improvements. However, although the relevant feedback issues were communicated to the bada development team, we do not know how they influenced further platform improvements. We conclude that further studies are needed to investigate the actual impact of user feedback on platform and app evolution.

7. RELATED WORK

In the following we discuss research which introduces feedback approaches enabling users to actively participate in mobile system development and evolution by providing individual feedback and communicating needs. Although targeting at mobile systems, we also discuss approaches which go beyond mobile platforms and apps; they allow users to participate in the development and evolution of ubiquitous systems. We focus on existing approaches which enable users to give feedback in situ. Furthermore, we only discuss approaches where mobile devices are used as means of feedback generation. In the following we describe the approaches identified and discuss them in more detail:

MyExperience: In their work, Froehlich et al. [4] describe a logging and feedback tool for Windows Mobile. MyExperience is designed to support research on the usage and handling of mobile devices. The authors explain that researchers are supposed to customize the tool and end-users will run the tool on their mobile devices. Based on excessive context-logging, the tool is able to identify up to 140 event types. Events are used to pull feedback from users. This, for example, can be done in the form of questions on the quality of service (e.g. a phone call). The feedback gathered is sent to researchers.

The MyExperience approach particularly focuses on generating feedback on mobile platforms and apps. In contrast to the AppEcho approach it uses a pull feedback generation method, which contradicts with the needs of users as identified in our research. Furthermore, the approach uses monitoring and context-sensing which might affect user privacy needs.

play.tools feedback: The play.tools framework is an environment for providing prototype applications to mobile end-users [16]. The play.tools feedback add-on enables users to give feedback to play.tools prototypes installed. Play.tools feedback focuses on usability and user experience. Similar to MyExperience, play.tools uses context-logging to identify events to pull feedback from users. This is done through questionnaires which detect intentions and feelings of users. Feedback is sent to developers who can use play.tools analysis support for prototype evaluations.

The play.tools feedback approach suffers from difficulties similar of those of MyExperience. In addition to the problems mentioned – such as using a pull feedback method and privacy issues – it is limited to the play.tool prototype applications.

iRequire: In contrast to previous approaches, iRequire follows a push approach [17]; i.e. it is the user who decides when to document needs. However, iRequire focuses on gathering user needs instead of feedback issues. In a first step, the tool requests the user to take a picture of a relevant environmental object. Furthermore, iRequire uses limited context-sensing (e.g. GPS location detection) in order to provide additional context information. In a second step, the user documents a need using an audio or text description.

The iRequire approach was not designed to give feedback on existing mobile platforms and applications; it focuses on gathering requirements for new mobile and ubiquitous systems. Again, the use of context-sensing to gather information on the user environment might affect privacy needs.

ConTexter: The work of Schneider et al. [15] focuses on the mobile ConTexter feedback tool, which enables end-users to give feedback on context-aware and ubiquitous systems. In contrast to iRequire, the ConTexter uses context information to automatically identify relevant entities. Users select the entity of concern (e.g. an info display) and provide feedback based on predefined feedback categories (e.g. complaint). Furthermore, the tool already presents available feedback on the selected entity, so that, in an ideal case, users just have to select the feedback they want to give.

The ConTexter is a feedback tool for context-aware and ubiquitous systems and relies on already existing ubiquitous environments to allow feedback generation. The use of heavy context-sensing to detect relevant entities might affect user privacy needs.

The issues discussed might limit the application of these approaches in today's real-world scenarios and therefore might not support continuous evolution of mobile platform and applications. The pull strategy applied by MyExperience and play.tools might not fulfil end-user expectations as it can disturb and disrupt their daily life. Although, iRequire and the ConTexter, in general, allow end-users to provide needs and feedback, both tools have limited capabilities regarding feedback generation on mobile platforms and apps. Current literature does not provide detailed information on the evaluation and success of the presented methods.

8. CONTRIBUTION AND FUTURE WORK

In this paper we describe the AppEcho feedback approach that enables users to give feedback on mobile platforms and apps in situ. The approach is presented in form of the AppEcho app, which we developed for the bada and Android platform. Furthermore, the feedback approach was initially evaluated in form of a case study which was conducted in cooperation with a mobile platform provider. We foresee that this approach will enable smartphone users to actively participate in continuous mobile system evolution and improvement by providing individual feedback to developers. We claim two contributions to requirements and software engineering knowledge:

- A mobile feedback approach developed based on user-needs, which enables users to provide feedback on mobile platforms and apps in situ;

- A study revealing that users can document individual feedback, which is understandable for developers and provides relevant input for mobile system evolution.

The work we presented is a first, but essential step towards our vision of strengthening user feedback in the mobile software domain. We foresee that the user feedback gathered will be (automatically) forwarded to responsible developers where it will be analysed and processed. Following such an approach both users and developers will benefit. Users get the chance to communicate feedback, which can be considered in further system evolution, in a fast and simple way. Developers benefit as they gain certainty and can provide high quality software based on concrete user needs.

We foresee that the feedback approach presented will complement existing feedback approaches such as gathering feedback via interviews. Furthermore, it offers new insights and shows new research and application opportunities. Our future research will focus on the following issues:

Advanced tool-support: Our study has revealed usability and utility issues which we will address in future (publicly available) AppEcho versions. In particular, we will work on a solution which does not require manually taking a screenshot before launching AppEcho. Furthermore, we will provide improved privacy features, and advanced guidance and support options. In our opinion, these are the most important improvements that are needed before AppEcho can be initially used by industry. However, we also will focus on automated distribution mechanism regarding user feedback. Therefore advanced monitoring and context-sensing features will be needed. Another goal is to provide the AppEcho app for all well-known mobile platforms.

Long-term evaluation studies: Our initial study focuses on AppEcho provided for the bada platform. However, we have also developed AppEcho for Android, which we plan to use in long-term evolution studies involving a larger number of participants. These studies will focus on exploring the quantity and quality of the feedback gathered in more detail. Furthermore, we would like to better understand the motivations of users contributing to mobile software development. Ideally, these studies will also allow us to investigate the actual impact of user feedback on platform and app evolution.

(Semi-)automatic feedback analysis: We plan research on the (semi-)automatic analysis of feedback. This could include automated grouping of similar feedback issues and automated prioritization (e.g. using duplicates). This analysis could also involve users who could for example comment or rate feedback of other users before it is communicated to developers. Such mechanisms would support developers in real-world settings, where we expect a high number of feedback issues to be communicated by mobile system end-users.

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