Improving Mobile Applications Usage Experience of Novice Users through User-Acclimatized Interaction: A Case Study

Abstract

The proliferation of low-cost mobile devices has allowed a large proportion of users living in emerging economies to use mobile applications. Despite the increasing number of novice users using mobile applications, researchers seldom consider usability for these users when examining performance, satisfaction and experience with usage of mobile applications. In this study, we suggest that it is not appropriate to design one interface for all users at all different literacy levels of increasingly diverse communities. We propose a user-acclimatized approach to adapting mobile applications that integrates three types of interaction elements, namely content personalization, structural navigation and representation. In an evaluation of the proposed approach on mobile devices, we conducted a field study in India to demonstrate the effect of user acclimatization on performance, satisfaction and experience for novice users. The findings provide theoretical and practical implications for the design and implementation of user interface on mobile applications.

Keywords

User Acclimatized Interaction, User Interface, Content Personalization, Structural Navigation, Representation

Introduction

The proliferation of low-cost mobile devices equipped with touch screen capabilities in the developing countries has created multifold opportunities to develop mobile application for the millions of people who are living in these underserved communities (Medhi et al. 2011). These users have limited exposure with technology and do not have the skills to use interaction elements such as menus (Medhi et al. 2009). These users are often regarded as novice users. Besides that, the users have very different levels of formal education (Medhi et al. 2010). This has posed a huge challenge to the developers to cater to these people. Developers should design interaction on mobile applications in a way that better adapts to users’ needs and expertise so as to achieve greater usability (Sears and Shneiderman 1994).

Usability is defined in International Organization for Standardization (ISO 9241-11 1997) as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”. It assesses the users’ ability to successfully accomplish tasks in an adequate time frame without frustration, and whether the user enjoys using the technology (Reinecke and Bernstein 2011). Existing adaptive systems have been shown in previous studies to improve user
performance, satisfaction and experience (Gajos et al. 2008; Findlater et al. 2009; Adipat et al. 2011). Although researchers and practitioners understand that adapting mobile applications to users' expertise is the key to implementation success, efforts in this direction are limited to geographical boundaries of regions. Mobile applications are localized such that few interface elements are modified to deploy in a region without adaptation at the interaction level (Kersten et al. 2002). For instance, existing technologies are adapted to different languages without changes in the content complexity, structure and navigation for all users (Bourges-Waldegg and Scrivener 1998).

To address the gap between the need for mobile applications that cater for individuals with limited mobile experience and the lack of interaction techniques in existing literature for diverse users, we propose an approach which is termed user acclimatization. This technique will provide personalization of content, structural navigation and representation on mobile applications adapting to the users’ needs and expertise levels. The goal is to develop mobile applications that allow the novice users to use mobile applications with minimal assistance.

The user acclimatization approach is developed with reference to the information architecture framework (Garrett 2002) where we identify the key interaction elements of mobile applications to be taken into consideration so as to increase its usability. Usability of mobile applications can be affected by the content that is delivered (i.e., personalization), the amount of content on each screen (i.e., structural navigation) and the format of the content in terms of textual, image and other visualization cues (i.e., representation). These three interaction elements in the information architecture framework have been shown to be effective in enriching user experience on mobile devices (Wodtke 2002).

This structure of this paper consists of this introduction, followed by the research objective where we have the research questions. After the research objective, we have a section on related works which consists of three sub sections that are Content, Structural Navigation and Representation. In this section, we discuss how each of the concepts is being adapted by previous literatures. Following the related works, we have the research methodology section which consists of three sub sections that are mobile prototype, task, participants and results and conclusion. In this section, we describe how the case study is being conducted. Following that, we have the implication section which consists of two subsections that are theoretical implications and practical implication. This paper ends with a section on limitations and future research.

**Research Objective**

This research aims to close the knowledge gap by conducting a case study to understand the impacts of user-acclimatized interaction (content, structural navigation and representation) on usability of mobile applications for the novice users through the following research questions:

1. What are the impacts of user-acclimatized interaction (content, structural navigation and representation) on usability of mobile applications?
2. How does expertise level of users affect the impacts of user-acclimatized interaction (content, structural navigation and representation) on usability of mobile applications?

**Related Works**

Following the Information architecture framework (Garrett 2002), we introduce a technique known as user acclimatization interaction to cater for a diverse group of users. This technique will provide three concepts namely personalization of Content, Structural Navigation and Representation on mobile applications.

**Content**

The limited screen size of a mobile device is one of the challenges faced by mobile developers (Taivalsaari 1999). To overcome this problem, developers often reduce the font size so as to increase the amount of information to be displayed. Novice users have difficulties in transforming data into meaningful pieces of information (Chase and Simon 1973). Hence, the information displayed has to be carefully chosen so that the screen size can be fully utilized. Personalization of content is one of the ways to select the content to be
displayed (Bowman et al. 1994). It is the ability to provide content that are tailored to individuals based on knowledge about their preferences (Adomavicius and Tuzhilin 2005). The dimension of personalization includes location and time (Sheng et al. 2008).

Personalization of location information is the ability to provide geographical content that is tailored based on knowledge about preferences of an individual (Adomavicius and Tuzhilin 2005). For example, a mobile application [Bikely, GPS sharing and SportsDo] has enabled an individual to record their location using a GPS-enabled device while travelling around the world. Later, these individuals are able to put the information onto a Web community where they can visualize and browse their own travel/sports experiences on a Web map (Zheng et al. 2009).

On the other hand, personalization of time information is the ability to provide real-time content that is filtered based on the knowledge about preferences of an individual (Adomavicius and Tuzhilin 2005). One example of delivering real-time content via smartphone to improve user’s performance is through push notification in the mobile context. Push notifications are short textual messages that are sent to users when network is available (Pospischil et al. 2010). For example, users can receive push notifications of a restaurant that is having a promotion.

**Structural Navigation**

Information overload is one of the major problems with the limited screen size of a mobile phone. The vast amount of information to be presented often results in confusion as well as a reduction in font size (Taivalsaari 1999). Structural navigation refers to the structure an application has for the user to navigate around the system. It indicates the way the mobile application is being designed (i.e., structure), and how efficiently the procedures of mobile internet services are designed (i.e., navigation). This includes how easy it is to learn the procedure and how easy it is to move between different components in the system (Hoyoung et al. 2005).

Taivalsaari (2009) has proposed one of the approaches to resolve issues that arise from a limited screen size is to reduce the number of elements that are visible on the each screen concurrently. Using structural navigation, this can be done by creating a hierarchy of objects ensuring that the system only displays one level of hierarchy at each time (Hassanien and Head 2003).

**Representation**

Textual information requires intellectual knowledge from an individual. A user with low-literacy level will have problems understanding the information (Medhi et al. 2009). These users will require image to help them in the understanding of the information (Wiedenbeck 1999). These images are known as representation.

Representation refers to the visual presentation of information (Kamba et al. 1996). Iconic interfaces are especially important for novice users who use mobile devices on a less frequent basis (Siau 2005). Wiedenbeck (1999) argued that interfaces with images were better in comparison to texture ones. She identified that images were easier and faster to be recognized as compared to textual paragraphs (Wiedenbeck 1999).

Shepherd (1967) presented that the time required for individuals to recognize images is shorter than the time required for recognizing words or phrases. Horton (1994) has also mentioned that icons can enhance the productivity and reliability of an application as it reduces the necessity of reading. The advantage of icons is also supported by Larkin and Simon (1987) argument that "a diagram is (sometimes) worth ten thousand words". Table 1 shows a summary of the user acclimatization techniques.

<table>
<thead>
<tr>
<th>Acclimatization Technique</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalized Content</td>
<td>Content tailored based on the knowledge about the individuals’ preferences and behavior (Adomavicius and Tuzhilin 2005).</td>
</tr>
<tr>
<td>Representation</td>
<td>Visual representation of the information (Kamba et al. 1996).</td>
</tr>
</tbody>
</table>
Structural Navigation | Structure an application has for the user to navigate around the system (Hoyoung et al. 2005).

Table 1. Summary of User Acclimatization Techniques

In this research we propose a hybrid user acclimatization approach that incorporates the personalization of content with structural navigation as well as visual representation of information. Our approach is unique in numerous aspects. First, personalization of location and time information allows users to perform a task with minimal effort (Liang et al. 2007). This will also increase the performance and quality of the application (Adipat et al. 2011). Personalization will enable an individual to gain personal experience with the application as it contains information that is custom-made to their needs (Adomavicius and Tuzhilin 2005). Second, we enhance the personalization of content with visual images which will serve as cues to help users to recall the information (Pirolli 2007). These images will also increase the productivity of user (Wiedenbeek 1999). Third, to help the novice user in gaining proficiency, we have included the tree-view structural navigation. Tree-view structural navigation will allow users to increase its learnability as it only requires one action to be performed on a screen (Taivalsaari 1999).

Research Methodology

We conducted a case study in Pune and Nasik, India and interviewed 100 participants to understand whether our application design following the user-acclimatized approach helps them in using mobile application. The interview was one-on-one, open-ended conversation that lasted at least an hour. During the hour, the participants were also required to complete tasks on a smartphone as well as via (Short Messaging Service) SMS with the feature phone. More details will be described in the task section.

The two types of phones, smartphone and feature phone were chosen for conducting the experiment based on their interactivity characteristics.

Participants

There were 100 participants participated in this case study. These participants had 3 common backgrounds traits: (1) they are farmers; (2) they have education level no higher than a local high school; (3) they earn about US$6 a day. Apart from the commonalities, the interviewees have varying degree of experience with using mobile phones: (a) those who use mobile phones merely for synchronous voice communications; (b) those who use features such as short messaging services and camera. In Indian culture, farming decisions are made by male members in family. Hence only male farmers were recruited. The demographics of the participants were shown in Table 2.

In this case study, the participants with more than 5 years of experience in total with both the smartphones and feature phones were regarded as participants with a higher of mobile experience. On the other hand, participants with less than 5 year of experience in total with both smartphones and feature phones were regarded as participants with a lower degree of mobile experience.
Improving Mobile Application Usage Experience through User-Acclimatized Interaction

Twentieth Americas Conference on Information Systems, Savannah, 2014

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-24</td>
<td>12</td>
</tr>
<tr>
<td>25-29</td>
<td>20</td>
</tr>
<tr>
<td>30-34</td>
<td>23</td>
</tr>
<tr>
<td>35-39</td>
<td>31</td>
</tr>
<tr>
<td>40-44</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest Education</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>64</td>
</tr>
<tr>
<td>High school</td>
<td>36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prior mobile experience</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 year</td>
<td>13</td>
</tr>
<tr>
<td>1-2 years</td>
<td>17</td>
</tr>
<tr>
<td>3-4 years</td>
<td>20</td>
</tr>
<tr>
<td>5-6 years</td>
<td>25</td>
</tr>
<tr>
<td>7-8 years</td>
<td>18</td>
</tr>
<tr>
<td>9-10 years</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 2. Demographic Information of Subjects

**Task**

Before completing the tasks on the smartphone and feature phone, the participants were asked to complete a survey which consists of demographic questions as well as question related to their experience with smartphones and feature phones. We provided a smartphone (Android) with a SIM card installed with an agriculture application to every participant. The main task assigned to the participants is to make a pest observation report. First, the participants were asked to select the “आलू” crop and the “Armyworm” pest as shown in Figure 1.

![Crop Selection and Pest Selection Screen in Smartphone(Android) Application](image)

Figure 1. Crop Selection and Pest Selection Screen in Smartphone(Android) Application

Apart from making pest report with the Android smartphone version, the participants were also provided with a feature phone that has a SIM card installed. The participants were required to make a pest observation report by sending a text message. An example of such message is “Cosmic p f1234 c01 p12” with the format as “COSMIC P f<Plot Number> c<Crop ID> p<Pest ID>”. Each of the participants was given a copy of an instructional material which would indicate the crop and pest identification number as seen is Figure 2. Refer to the Appendix for the instructional material.
Results

The participants with a higher degree of mobile experience were able to complete the task on the Android application within 20 – 40 seconds. Those with lower degree took about 60 seconds to complete the task. The average time taken was 35 seconds. 10% of these participants made mistakes while making the pest observation. For example, one tapped on wheat image instead of the rice image. Even though the participants made mistakes, they could restart the tasks independently as the images made it easy to click and the process of making the pest observation report was simple.

As for the SMS version, the participants with a higher degree of mobile experience felt that it was a cumbersome process as they had problems remembering the crop and pest identification number. 30% of the participants made multiple entries because they entered the wrong crop and pest identification number. The participants felt that more attention is required when using the SMS version so that wrong entries can be avoided. The participants with a lower degree of mobile experience had difficulties entering the message in the format as the crop and pest identification number does not make sense to them. 60% of the participants made entries in the wrong format without making a second attempt as it was a cumbersome process to type the whole message again.

The participants preferred the Android application as it requires less effort. The participants enjoyed using the Android version despite of the network slowness. The images and icons create excitement to the participants and they felt as though they were in a game. The participants were aware that the android smartphone version of pest reporting will not hinder their daily farming activities. The participants were even willing to pay a monthly subscription of about USD 1 – USD 2. This was an interesting finding for us. In spite of having limited exposure, the participants know the benefits that the smartphone application could provide. The pictures in Figure 3 show the participants using both the smartphone and SMS version of the application.
Conclusion

To conclude, the participants took a shorter time to complete the task on the smartphone application as compared to the SMS version. This is because the smartphone application was equipped with the user acclimatized technique which includes the usage of crops grown and pest seen in their village (personalization of Content), images of crop and pest are in icons (Representation) and only one click is required during the crop selection and the pest selection screen (Structural Navigation). The participants preferred the smartphone application as it was more user-friendly and they felt that it would be helpful to them as making a pest observation report will alert their neighboring farmers of the condition in their farms. This will enable the neighboring farmers to take necessary precautions. The participants also indicated that they were satisfied with the way the application is designed in a user-friendly manner.

Implications

Theoretical Implications

This study provides several major theoretical implications. First, our study integrates the uniqueness of user-acclimatized interaction such as personalization of content, structural navigation and representation provided by mobile features affecting the usability of the application on a novice user. This research provides insights on how an application can be designed such that a novice user will be able to use it without much hassle.

Second, in addition to the integration of the unique user-acclimatized interaction techniques, our study also aims to distinguish between the different user-acclimatized interactions techniques and their impact on the usability of the application on novice user. The usability of the mobile phone includes task performance time, user’s perception of the design as well as the overall experience of mobile application usage.

Third, this research also aims to provide the insights on the contingency of mobile expertise level of a user on the relationship between user-acclimatized interaction and usability of the application on a novice user.

Practical Implications

The findings of this study also provide some practical guidelines for the acclimatization of mobile interface design. First, it provides the application designers with ideas in which information scents can be used on mobile applications. Information scents can be used in the form of an image which would help an individual to recall the information.

Second, it provides application developers with ideas to personalized information on mobile applications. Two aspect of personalization discussed in this paper are location personalization and time personalization in the technique of personalization of content. In the application, the crops shown are
crops that are grown in the village (location personalization) and these crops are seasonal which can be found only during that time. These are important aspect of a mobile phone due to its spatial and temporal nature.

Third, it provides application developers with the needs of the novice users that have to be addressed. Very often, application developers think of innovative ideas to design applications such that it is unique. However, this made it complicated for the novice users to use. For example developers might think that including more than one action on a screen saves the user the trouble from having to transit from one screen to another. However, they might not be aware that this will cause confusion in the novice users as they do not know which action needs to be performed first.

Limitations and Future Research

First, the approach we conducted is a one-off case study. Future studies need to be conducted over a longer period and monitor daily usage.

Second, the techniques proposed are only suitable for smartphones which is equipped with touch-screen capabilities. Feature phones however are popular in the developing countries. Hence, this study could be improved by including other techniques which could be applied on a feature phone where the screen is not equipped with touch-screen capabilities.

Third, we provided the participants with a step-by-step guide on how to use this application during the study. Hence, this could have affected the performance time as participants could just follow the instructions given and not being affected by the interaction techniques used.

Forth, the participants were required to perform tasks on two different types of phones, smartphone and feature phone. People may argue that the results can be influenced by the differences of the platforms, e.g. one is graphics and another is text-based. This limitation can be improved by conducting the experiment on the platforms equipped with similar representation characteristics in the future studies.

Furthermore, techniques such as changing the brightness of the screen when an individual is out in the sun may be useful due to the spatial and temporal nature of the mobile devices. With the increasing number of smartphone users, using these proposed user-acclimatization techniques will provide individuals with a more efficient mobile usage experience.

Acknowledgements

This research is supported by the National Research Foundation, Prime Minister’s Office, Singapore under its International Research Centres in Singapore Funding Initiative and administered by the Interactive Digital Media Programme Office.
REFERENCES


