

Mobile User Interaction Development for Low-Literacy Trends and Recurrent Design Problems: A Perspective from Designers in Developing Country

Elefelious G. Belay^{1(✉)}, D. Scott McCrickard²,
and Solomon A. Besufekad³

¹ IT PhD Program, Addis Ababa University, Addis Ababa, Ethiopia
elefelious@bdu.edu.et

² Center for HCI and Department of Computer Science,
Virginia Tech, Blacksburg, VA, USA
mccricks@cs.vt.edu

³ Center for IT Research and Innovation, IT PhD Program,
AAU, Addis Ababa, Ethiopia
solomon.atnafu@aau.edu.et

Abstract. This paper identifies factors important in low-literacy mobile user interaction design and development. It explains the limitations and recurrent design problems from developing countries, focusing on Ethiopia as a primary case study, with special consideration for the designer perspective. This exploratory research effort examines the match and mismatch in usability design guidelines for mobile interaction in developing countries. It also identifies the design and usability factors that affect mobile service (m-service) delivery in developing countries: context gaps, designer gaps, and technology gaps. Further, the paper examines the designer perception towards design guidance requirement and application. In so doing, it seeks to provide input for design guidance development in a generic way such that mobile user interface designer understanding will be enhanced and m-service delivery in developing countries will be more usable.

Keywords: Mobile user interaction · Low-Literacy · Recurrent design problems

1 Introduction

According to a report of the International Telecommunication Union, by the end of 2015, the mobile cellular subscription was projected to reach 91.8 and 73.5 per 100 inhabitants of developing countries and of Africa, respectively [1]. The numbers have been growing fast each year. The number of mobile subscriptions, deployment of extensive mobile infrastructure, and prevalence of low-cost mobile devices reflect great promise toward addressing the gaps in delivering different social (such as health care and agriculture) and economic (such as financial and banking) services. Despite the

overwhelming number of mobile users (mobile subscribers) their mobile service adoption (use pattern) has received little consideration within the many efforts of researchers addressing technology impact in developing society [2]. It is thus essential to examine these ever-growing resources and focus on better service adoption and diffusion of mobile services to meet the promise.

In general, designing mobile solutions for developing countries has unique challenges: power, device capability, privacy/security, and uncertain network communication are only a few [3–5]. Beyond these technological inefficiencies there are also limitations in terms of computing experience (most users have never used computing devices) and literacy. In most developing countries about half of the society is illiterate [3] (including for the country considered in this paper, Ethiopia [6]). Other factors like language and social value differences are additional challenges that hinder good provision of m-services in the region.

While a large percentage of users whose primary platform for accessing information and communication is the mobile phone, the previously mentioned challenges and limitations affect mobile user interface design. For instance power and device capability are related to the size and type of interface (multimedia application require a better device capability, including more power and space consumption). Thus, exploring mobile user interface usability that helps overcome these challenges is paramount and is an important element for mobile services adoption and diffusion.

In an effort to address these challenges, one of the suggested solutions is to document and codify the design knowledge of human-mobile interaction for mobile devices in developing nations [7]. This is part of work to lay down a foundation for building mobile user interface design knowledge for low-literacy. Other researches pointed out instead of redeploying technologies for developing countries that are meant to industrialized countries, human-computer interaction methods should focus on designing technologies that addresses the local contexts [3, 5].

The work reported here represents one component of the effort to support mobile user interface designer for low-literacy: providing concrete design guidance. We believe that good design guidance facilitates communication with the designer and can have great impact on mobile interface design for low-literacy. Since it is rare to find applications (and application designers) centered on rich experience and well-founded knowledge, extracting design guidance for this user group is difficult. Hence, it is essential that the development of effective design guidance should be supported by analysis of the context of use and user and also the local designer practices [8].

To capture knowledge of the current practices and recurrent design problem, we developed interview guides and interviewed a number of local designers in two stages. The first was informal interviews which were not recorded to get a sense of general design practices for mobile software developers in Ethiopia. The second phase is formal semi-structured interview to learn about specific, common design practices that should be shared across the community. The interviews of the designers focused on their design experience and recurrent design problems in designing mobile user interfaces for low-literacy situations.

2 Related Work

Despite the significant progress of user interface design [9, 10], advances specific to low-literacy mobile user interface are not yet comprehensively addressed [9]. Most low-literacy users from developing regions (that have high illiteracy rate [6]) encountered difficulties in using the most basic features of both mobile and other computing interfaces (such as making phone call, clicks) are not intuitive to them [11]. In recent years, a number of efforts in designing interfaces considered the skill, knowledge and experience of this user group [12–15].

Most literatures in this progress agree mobile user interface design for low-literacy user group should be different from those of the literate one (which can be communicated through textual description) [12–14, 16]. Nonetheless, there are also claims that highlight the challenges of textual interface for literate novice users [15]. Most of these efforts are based on of ethnographic research [12, 15, 16, 20] and presented the usability barrier of low-literacy and provide suggestion of design ideas in the form of general design recommendations and also features that contributed towards the successful low-literacy design.

Many researchers have made contributions in the area of interface design for low-literacy. Huenerfauth [18] outlined design guidelines to design user interface for illiterate users. Medhi et al. [15] studied and identified mobile interface usability challenges of low-literacy and novice mobile users; the work also further suggested design advices suitable for this user group, which improve the identified usability barriers. Chaudry et al. [14] conduct usability evaluation of non-text based graphical widgets focused on low-literacy user group, and based on the result of the evaluation some design recommendations are provided. Medhi et al. [12] suggested and tested text-free user interface design for low-literacy user to access employment information. Parikh et al. [19] presented the key user interface design features that are important for low-literacy user and success of managing financial institution in rural India. Gitau et al. [16] explored prospect and challenges of first-time mobile-only internet users who are low-literate and have no experience in other computing devices. Medhi et al. [15, 20] focused on evaluating and comparing non-literate and semi-literate users using three design artifacts.

In all, these contributions present usability challenges of low-literacy (such as visibility of functions, menu navigation, scroll bars, textual presentation) and provide design recommendation (regarding graphical representations, voice interfaces, avoiding textual input, minimizing navigation) [12, 14–16, 18–20]. Beyond contextual factors and generalizability of the research approach, most of these work share notions both in terms of usability challenges and design recommendations.

3 Methodology

Our goal in this paper is to gain a deeper understanding of the local mobile user interface designer practices, thoughts, and experiences. We also sought to get this information in the context of their actual situations, making interview and focused group discussion an attractive and fruitful methodology that provides a detailed account

of their practice and experience. The interview was made in two phases: one was informal and focused on general design practice and issues, and the other was formal semi-structured interviews with more detail. The mobile application developers (user interface designers) and companies were selected by consulting the Ministry of Communication and Information Technology, who has up-to-date information of the industry. This information shows there exist only few mobile application developer and companies in the country. As it is a qualitative research we have sought an adequate number of samples to better enlighten and understand the approaches under consideration.

All interviews were conducted by one interviewer; an interview took an average of fifty-five minutes (ranging from forty minutes to an hour and half). In an individual interview consisting of fourteen participants, eleven were male and three were female with an average age of twenty seven. Participants' educational background also ranges from information technology first degrees to PhDs (nine BSc., four MSc., one PhD). Their experience in mobile application development ranges from one year to six years of experience.

For the two group discussions, one had 6 (1 female, 5 males) and the other had 7 (2 females, 5 males) participants. The two discussions took a total of three hours and twenty minutes. Three of the participants in the group discussion have a Master's degree and all the rest have bachelor degree. Their experience in mobile application development also ranges from one to six years.

4 Findings and Discussions

Both the formal and informal interviews and the focus group discussions generally draw a large amount of qualitative data, on the different issues of the current mobile user interface design trend and the recurrent design problems. Moreover, it also unearths the experience and attitude towards the application of design guidance in their design. This paper summarizes the salient findings of the current mobile user interface design trends and their implication for how we can best support the design guidance development process and product that will help both the Ethiopian low-literate mobile user and designer.

Based on our research interest, the following four main themes emerged as results of the analysis: current mobile user interface design practice, classification of mobile users, recurrent design problems in low-literacy mobile user interface design, and source of design knowledge and its relevance.

4.1 Current Mobile User Interface Design Practice

The interviews and group discussions demonstrated that mobile user interface design is considered part and parcel of the implementation process, not as independent process to pursue. No particular emphasis is given for designing the user interface early in the development and also later in the testing stage. Only one participant mentioned a different practice than the others, his experience is described as:

'I usually try to sketch the user interface on the paper before I start the implementation process.' [Participant 3]

The result of the analysis also revealed user interface design is neither a component of the process nor obtain reasonable attention in development of mobile application. Designers tend to focus more on the internal implementation aspects of the system. However, participants from one mobile device manufacturer affiliated application development company mentioned that they only develop for a target device and test the completed application, no special focus is given for the interface.

'Mobile Application development is not widely practiced as you know. Thus for the application we develop we only focus on the functionality of the apps rather than the interface.' [Participant 6]

'Our mobile application are tested by both internal and external users and we don't have a special interface evaluation test rather we run test on the final application.' [Participant 8]

Participants consistently expressed the current mobile user interface design trend follows traditional application development processes. It is also neglecting people who have issues as a result of various technical (such as bandwidth limitation, unreliable connection) and economic (such as device capability, cost of connection) reasons. Even most typical applications of m-services are based on short message and Unstructured Supplementary Service Data (USSD) that is practically of no use to low-literacy user group.

'Most of the application we developed are not focused on certain user group and did not give a special attention neither for low-literacy nor rural users unless and otherwise a specific application are requested by a certain organization.' [Participant 10]

'Many mobile applications such as bank application uses USSD which is pretty much difficult for low-literate user group.' [Participant 3]

Participants felt that the available choice of mobile infrastructure and communication technologies are limited and pose a big challenge in application development. For example, participants argued that a result of communication bandwidth could potentially be a problem for not designing either audio or multimedia applications for the low-literate user group.

'Most low-literacy mobile users are living in rural area where there is inadequate infrastructure, such as 2G mobile network and it is very difficult to design a multimedia interface having this technology.' [Participant 5]

All participants somehow highlighted the challenges of designing for diverse mobile devices that have various features, type and size (screen size), capability (internal/hardware capability of the device), input methods (touch, keypad). In line with this, they also highlighted the need for local language (such as Amharic soft keypad) input mechanism standardization.

'There is no hard keyboard for Amharic language but there are various soft keyboard which are diverse and difficult to use that require common standard.' [Participant 12]

4.2 Classification of Mobile Users

According to the UNESCO report literacy rate in Ethiopia among the population aged 15 years and older (which is considered as adult) is 49.1 percent - nearly half of the population [6]. And more than 80 percent of the population of Ethiopia lives in rural area with low resource setting.

Low-literacy in most mobile interaction design research is defined only from the educational perspective [12, 14, 18]. Our research considers education as one parameter and claims other parameters (such as computing literacy, technology exposure, level of assistance required) to be considered for mobile user classification. Based on this we characterize users in three groups (m-illiterate, m-semi-literate, m-literate) [11]; the former two are also considered as part of the low-literacy mobile user group. How each of the additional parameters influence and impact the mobile interaction design has been assessed in this research.

While participants agreed on the concept of classifying mobile user groups, they were also initially thinking the conventional definition of literacy/illiteracy. After we presented the definition they also reflect their ideas towards additional parameters.

‘Even people who has moderate education such as high school and haven’t use any computing device are always encounter in using even the most common functionalities of the mobile.’ [Participant 2]

Participants also argued people who have moderate experience have to be considered differently in user interface design.

The designers also strongly argued that people who have moderate experience have to be considered differently in user interface design; however one participant reflected his view which is a bit different from the others – he argued that the difference between m-semi-literate and m-literate is a matter of experience and did not require a different design for this user group:

‘It only requires training to use a mobile phone but not required a different design to accommodate their needs’. [Participant 5]

In all, the result of the analysis highlighted that the different parameters we identified can prove useful for the classification of mobile user groups, and each characteristic along with the user group lead to informed discussion. The refined version of the result is shown in Table 1.

Table 1. Characteristics of different mobile users group

Characteristics	M-illiterate	M-semi-literate	M-literate
Education	No	Yes/No	Yes
Computing literacy	No	Rare/fair	Yes
Technology exposure	No	Rare/fair	Yes
Level of assistance required	Yes	Somehow	No

4.3 Recurrent Design Problems in Low-Literacy Mobile User Interface Design

There has been a good deal of discussion about the benefits of designing user interfaces for low-literacy groups, including research and results from the Microsoft India research group [12, 17, 20]. This research is part of an ongoing effort to provide plausible design guidance for designers of low-literacy mobile user groups. In our interviews and focus group discussion, we explore the recurrent design problems that are important for designing mobile user interface for low-literacy user groups in the Ethiopian situations.

Generally, the results of the research led us to propose the recurrent design problems specific to low-literacy mobile user interface design. Some of the recurrent design problems that emerged from the analysis of data are summarized and presented in Table 2. The general and specific recurrent design problems described by the designer are intended to supplement the design guidance development process and results. This analysis provides design insights by highlighting possible solutions.

Table 2. Identified low-literacy mobile user interface recurrent design problems

General problem	Specific problem	Description
- Language barrier	- Various local language (Localization) - No standard for local font and alphabet - Diverse presentation of alphabet in the keypad	- English is not local language (which most mobile applications are being implemented) - Font and alphabet are different and has no standard
- Limited device capability	- Limited memory/storage - Slow processing speed	- Most low-literate users have low-cost device with lower capacity
- Text-based application	- Unstructured Supplementary Service Data - Short message (Difficult for both input and output interaction)	- Difficult to read and write - Limited (fewer) description availability
- Menu hierarchy	- Difficulty in navigation - Tough to figure out (guiding)	- Not able to traverse simple hierarchies
- Mobile network connection	- Low quality connection - 2G mobile network capacity	- Bandwidth requirements for multimedia (for graphical representation)
- Error feedback	- Error response - Error correction mechanism	- Require ways to correct and communicate errors

4.4 Source of Design Knowledge and Its Relevance

In this section we have explored the designers' requirements for proven solution and their current source of design principle and guidance. Participants are not aware of the availability of any mobile design guidance. Most of the designers' inspiration comes from their intuition and web search. Few of the participants describe general design advice like is found in an android guidebook or web site.

Some did mention browsing the web to see how to implement design features. Some describe mixed approaches that tend to be incremental; design and implementation approaches together. No clear distinction between design and implementation seemed to emerge from discussions; e.g., *'I haven't used any design guidance in my design, what I usually did is browse a similar application when I started to implement.'* [Participant 6] Participants are not aware of design structures like interaction patterns. Some identified software design patterns but not interaction design patterns.

5 Conclusion

This paper presented the designer perspective toward mobile interaction design for low-literacy situations. We described current mobile user interface design trends and some resulting recurrent design problems that emerged from the analysis of local designers' perception. We envisage that these recurrent design problems are considered and will be leveraged in design structure development for mobile interaction design for low-literacy.

The paper also describes the feasible and essential parameters that help to characterize the mobile user group. Moreover the paper briefly presented how these local designers perceived and make use of design guidance and principle. We are hopeful that the results of this paper will provide initial insights to the development of effective and formal design guidance that is useful (and used) by designers.

Our future work will combine the results of these findings, analysis of the context of use and user with theoretical and practical rationale to propose design patterns for mobile low-literacy. More broadly, we plan to pursue ways to support designers in crafting mobile technologies to support health, agriculture, and business [11, 21, 22].

References

1. International Telecommunication Union. ICT Facts and Figures (2015). Internet: <http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2015.pdf>
2. Donner, J.: Research approaches to mobile use in the developing world: a review of the literature. *Inf. Soc.* **24**(3), 140–159 (2008)
3. Brewer, E., Demmer, M., Ho, M., Honicky, R.J., Pal, J., Surana, S.: The challenges of technology research for developing regions. *IEEE Pervasive Comput.* **2**, 15–23 (2006)
4. Wyche, S.P., Murphy, L.L.: Dead China-make phones off the grid: investigating and designing for mobile phone use in rural Africa. In: *Proceedings of the Designing Interactive Systems Conference*, pp. 186–195 (2012)

5. Brewer, E., Demmer, M., Du, B., Ho, M., Kam, M., Nedeveschi, S., Pal, J., Patra, R., Surana, S., Fall, K.: The case for technology in developing regions. *Computer* **38**(6), 25–38 (2005)
6. UNESCO: Adult and Youth Literacy, 1990–2015 Analysis of data for 41 selected countries (2012)
7. Ho, M.R., Smyth, T.N., Kam, M., Dearden, A.: Human-computer interaction for development: the past, present, and future. *Inf. Technol. Int. Dev.* **5**(4), 1 (2009)
8. Kunert, T.: *User-Centered Interaction Design Patterns for Interactive Digital Television Applications*. Springer Science & Business Media, Heidelberg (2009)
9. Shneiderman, B.: *Designing the user interface*, Pearson Education India, Gurgaon (2003)
10. Tidwell, J.: *Designing Interfaces*. O'Reilly Media, Inc., Sebastopol (2010)
11. Belay, E.G., McCrickard, D.S.: Comparing literature claims and user claims for mobile user interface design: a case study. In: *Proceedings of the IEEE Conference on Collaboration Technologies and Systems (CTS 2015)*, pp. 418–425, Atlanta, GA (2015)
12. Medhi, I., Sager A., Toyama, K.: Text-free user interfaces for illiterate and semi-literate users. In: *International Conference on Information and Communication Technologies and Development, ICTD 2006*. IEEE (2006)
13. Ghosh, K., Parikh, T.S., Chavan, A.L.: Design considerations for a financial management system for rural, semi-literate users. In: *CHI 2003 Extended Abstracts on Human Factors in Computing Systems*. ACM (2003)
14. Chaudry, B.M., Connelly, K.H., Siek, K.A., Welch, J.L.: Mobile interface design for low-literacy populations. In: *Proceedings of the 2nd ACM SIGHIT International Health Informatics Symposium*, pp. 91–100 (2012)
15. Medhi, I., Patnaik, S., Brunskill, E., Gautama, S.N., Thies, W., Toyama, K.: Designing mobile interfaces for novice and low-literacy users. *ACM Trans. Comput.-Hum. Interact. (TOCHI)* **18**(1), 2 (2011)
16. Gitau, S., Marsden, G., Donner, J.: After access—challenges facing mobile-only Internet users in the developing world. In: Fitzpatrick, G., Hudson, S. (eds.) *Proceedings of the 28th International Conference on Human Factors in Computing Systems (CHI 2010)*, pp. 2603–2606. ACM, New York (2010). doi:[10.1145/1753326.1753720](https://doi.org/10.1145/1753326.1753720)
17. Medhi, I., Kuriyan R.: Text-free UI: prospects and challenges for ICT access. In: *Proceedings of the 9th International Conference on Social Implications of Computers in Developing Countries*, Sao Paulo, Brazil (2007)
18. Huenerfauth, M.P.: *Design approaches for developing user-interfaces accessible to illiterate users*. University College Dublin, Ireland (2002)
19. Parikh, T., Ghosh, K., Chavan, A.: Design studies for a financial management system for micro-credit groups in rural India. In: *ACM Conference on Universal Usability*, pp. 15–22. ACM Press, New York (2003)
20. Medhi, I., Gautama, S.N., Toyama, K.: A comparison of mobile money-transfer UIs for non-literate and semi-literate users. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 1741–1750 (2009)
21. Blackman, K.C.A., Zoellner, J., Kadir, A., Dockery, B., Johnson, S.B., Almeida, F.A., McCrickard, D.S., Hill, J.L., You, W., Estabrooks, P.: Examining the feasibility of smartphone game applications for physical activity promotion in middle school students. *Games Health J.* **4**(5), 409–419 (2015)
22. Seyam, M., McCrickard, D.S.: Collaborating on mobile app design through pair programming: a practice-oriented approach, overview, and expert review. In: *Proceedings of the IEEE Conference on Collaboration Technologies and Systems*, pp. 124–131 (2015)