

## Designing icon-based mobile applications for illiterate users in rural areas

With the mobile phone subscriber penetration rate continuing to rise in Africa, the development of suitable mobile phone applications is becoming an increasingly important field of interest. The GSMA estimates that half the population in Sub-Saharan Africa will subscribe to mobile services by 2025, which combined with the present mobile gender gap suggests that a significantly large portion of all households will have access to a mobile phone. Although the usage of smartphones is being adopted in the more urban areas, the International Data Corporation reports that during the first quarter of 2018 feature phones accounted for 60.8% of Africa's total mobile phone market. Especially in rural areas where people live *off the grid* and have no direct access to an electricity power supply, basic and feature phones will likely remain dominant due to their noticeably favorable power consumption.

To accommodate for users that possess a basic phone, ICT4D initiatives generally opt for voice or text based mobile phone applications. Looking towards the future, it is expected that the penetration rate of feature phones will continue to grow, especially with inventive projects such as the KaiOS smart feature phone<sup>1</sup>, which is an affordable device that provides low energy consumption while having access to popular mobile apps. In the scenario where (smart) feature phones replace basic phones as the standard mobile device for rural areas, improving the usability of applications by means of icons as visual aids can be beneficial. For example, a mobile phone based seeds marketplace system can become more intuitive by providing selectable icons of the desired seed types that a user wishes to trade, instead of having to enumerate the seed types solely by audio.

In order to effectively incorporate icons into mobile applications, various aspects related to the local context of the deployment destination have to be taken into consideration. The usability of icon-based mobile interfaces is a human computer interaction topic that has already been extensively researched by others. The benefit and value of icons in user interfaces has been acknowledged and demonstrated, for example by Mesfin et al [1] who design and develop a mobile money solution specifically for illiterate people, since the existing mobile money platforms at the time only provided text-based interfaces. Their icon-based mobile money application makes use of images of bills in the local currency, as well as portrait icons of other people for money transfer purposes. Another example that shows effective usage of icons in a mobile application is the work of Bhamidipaty and Deepak [2], in which they present an enhanced symbol-based design to improve the address book feature of mobile phones for semi-literate users. The proposed redesign of the address book involves attaching icons to the keypad buttons and the system itself interpreting combinations of these icons. In the new address book, any contact can be associated with a variable length of icons, providing users with easy access to their contacts by pressing one or multiple keypad buttons.

However, creating an icon-based application intended for users with limited technological and literacy skills also comes with its own set of difficulties. The work of Lalji and Good [3] about mobile phone interface designs for illiterate populations showcases the complexity of designing a suitable interface. Lalji and Good have performed extensive field research on how illiterate users interpret different prototype phone interfaces, and during their experiments they even encounter subtle issues that were unrelated to usability factors, such as a reluctance towards using touchscreens. Their work also highlights contextual issues related to the interpretation of icons, for instance, participants understood the 'house' icon as a village hut and mistook musical notes for birds.

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<sup>1</sup> <https://www.kaiostech.com>

Another challenge to overcome in designing icon-based applications is the misinterpretation of icons that suffer from a 'western' bias, which is partially caused by the current (computer) icons usually being based on common office metaphors [4]. The paper of Heukelman and Obono [4] proposes an alternative to the office metaphors for African users that are unfamiliar with the office environment. In their experiments, they evaluate to what extent the participants are able to associate African cultural objects with specific computer actions. As an example, an African basket could be associated with saving work for a longer period of time, whereas a talking drum could represent sending a message. The main finding of the research is that the 'African village metaphor' experiences more support than regular office metaphors, especially among older African users.

The research of Medhi et al [5] presents two text-free user interfaces as part of a substantial research performed in Bangalore slum communities. The main goal of their research is to develop user interfaces such that even novice illiterate users require no intervention from others to use the applications. The paper introduces various crucial design principles relevant for illiterate users. For example, graphical cues may be interpreted differently based upon psychological, cultural or religious biases. In their experiments, there was confusion about the 'viewing order' of icons due to the participants expecting the icons to be viewed right to left, as this is common in their culture, whereas the intended viewing order was left to right. This obscurity was remedied by introducing an explicit arrow indicating the order. The conducted experiments once again reveal how easily visual aids can be misinterpreted, as users also tended to take some abstracted elements literally, which can result in confusion when nonrealistic colours are used to clarify images. Medhi et al also stress the importance of voice feedback for all functional units, as well as help instructions on all screens, which allow for the application to be used more autonomously.

Then there is still the aspect of illiteracy, whereas some research targets semi-literate users [2,5], in an ideal world, mobile applications are designed in such a way that provisions are made for illiterate users. In the work of Wiedenbeck [6], it is pointed out that icons are extensively used in human-machine communication interfaces, since icons can easily be recognised and remembered. However, Wiedenbeck also argues that icons are best understood when accompanied by textual descriptions. Clearly, textual descriptions will not benefit illiterate users, and while non-traditional literate users may still be able to correctly interpret icons displaying unfamiliar metaphors through accompanying text, illiterate users would be at a loss [3]. Hence, finding the most suitable icons and metaphors to represent the functionalities in an application is a non-trivial task that requires extensive evaluation. To accommodate for illiterate users while still effectively incorporating icons in mobile applications, Medhi et al [7] propose combining audio and visual representations, e.g. using voice annotations for icons. While voice annotation generally helped in the speed of comprehension, some of the participants were unable to fully process the bimodal input, and ended up focusing either on the graphic or the audio, but not both.

Regardless of the practical success of the mentioned research and experiments, two recurring topics regarding the design and development of the applications stand out: user-centered design, and collaboration with the local people. It is apparent that icons are a powerful method of communication and interaction, however appropriate usage of icons remains challenging. Icons and metaphors that are not adequately evaluated by the target audience may result in users becoming reluctant or demotivated to adopt an icon-based application. The research of Lalji and Good [3] highlights that multiple options and 'feature rich' phones excited the participants, however actually using the phones frustrated and confused them. Once again, this emphasizes the importance of user-centered design and the involvement of the users throughout the entire development process.

Understanding the local context of the target environment and users is a key component of the design phase of an application. The most effective way of obtaining adequate knowledge about the users along with their needs and expectations is simply by involving them throughout the entire development process. When icons are used as graphical cues in an application, contextual issues such as knowledge representation have to be accounted for. Due to cultural differences, the local users may misinterpret metaphors and may associate entirely different concepts with the displayed figures, as common icons and their meaning are not culturally set in stone. To ensure that the right information is being captured by a visual representation, the project has to involve interaction with the local users to retrieve information concerning the expected representation of knowledge.

A topic that has not yet been extensively covered in research concerned with using icons in mobile applications is the adaptation of users to new designs. Medhi et al [5] do point out the active fear and mistrust of personal computer technology that may be present with users. To clarify, imagine an icon-based farm assisting application. If a farmer is told to press an icon representing water on a device, which will water the crops on a farm, the farmer may not believe or trust that pressing the button will actually perform the desired task. To overcome the doubts of the users, the users should be involved in development process from an early stage, as their doubts will decrease over time when they experience the process. The most effective method of having users adapt to a new system is by slowly letting the users adapt by means of collaborative development.

To conclude, this research has showcased the potential and value of icon-based mobile phone applications, and has evaluated various researches to collect the most important design principles that have to be considered in order to incorporate icons in applications intended for illiterate users. Additionally, the provided examples emphasise why user-centered design, collaboration with the local people, and understanding the local context are crucial aspects for a successful incorporation of icons in applications, as well as for ICT4D projects in general. All in all, this work serves as a compact overview of the most important aspects to take into consideration when developing icon-based mobile applications, which can hopefully prevent future initiatives from running into complications.

## References

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