User Requirements Gathering in mHealth: Perspective from Ghanaian End Users

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Abstract. Understanding user requirements is a fundamental part of information systems design and is key to the success of interactive systems. Factors such as ease of use, cross-cultural interface design are crucial to building usable products that will gain high acceptance among users. Developing a utilizable mobile health application involves applying human-centered design methodologies. However, mHealth applications face usability challenges in terms of their usefulness due to lack of end user inclusion during the design process. In order to investigate usability impact on the end user, this paper examines the challenges and findings from Ghanaian migrant communities in the United States. This paper seeks to contribute to the requirement gathering process by highlighting the needs and noting the challenges in the collection of user requirement data needed to design and develop a targeted mHealth application. The results of gathered user requirements will contribute to informing the design of mobile health interventions tailored for Ghanaian migrants.

Keywords: Cross-cultural design · Usability · User requirements

1 Introduction

Developing a utilizable mobile health application involves human-centered design. ISO 9241-210:2010 defines Human-centered design as an approach to interactive systems developments that aims to make systems usable and useful [1]. This is achievable by focusing on the users, their needs and requirements, and by applying human factors, and usability knowledge and techniques. This paper examines the findings and challenges from a user requirement gathering among Ghanaian migrant communities in the United States.

Health Information Technology (HIT) is increasingly being used by healthcare providers to improve patient care and can possibly transform all facets of the healthcare industry by addressing existing challenges [2]. Health disparities have long been established within the United States, and Ghanaian migrants fall within the category of people described as underserved by the healthcare industry [2]. With the advance in technology, and increase in usage of smartphones and mobile devices, mobile health applications offer great potential in bridging the healthcare disparity gap. For mobile mHealth applications to become an instrumental social innovation of benefit to people from all walks of life, it is expedient to study the sociocultural heterogeneity of the user

base, and integrate this in mHealth services delivery, taking cognizance of user behavior and cultural preferences. To increase satisfaction and generate positive user experience, it is important to involve the end user in the initial stages of the development process. Barriers between product developers with technical backgrounds and end users need to be overcome. This is possible by gathering information on user contexts and user needs and translating them into user requirements for product development. The user requirements gathering process goes beyond user interfaces by focusing on end users and eliciting useful information on user needs necessary to inform product design. Information from user requirements gathering directly affects the process of developing usable systems.

Specifically, the aim of this paper is to gain insight from Ghanaian users on their perception of mHealth applications, understand their needs, know their objectives and motivations and also find out how Ghanaian users interact with mHealth technology.

2   Background of the Study

Overall, the literature review establishes that there are opportunities for mobile applications to address healthcare needs relative to prevention and living a healthy life style among migrants in developed countries. mHealth technology provides the platform for Ghanaian migrants to be empowered to manage their health and adopt healthy lifestyle behaviors [3, 4]. Although there are few examples of mHealth tools that are quite popular in the United States, the use of mHealth tools is variant from community to community and are usually dependent on simplicity of use [2].

To develop useful and usable applications it is necessary to comprehend user needs and contexts, and subsequently translate these into user requirements with a focus on users throughout the development process [5]. Analysis of user requirements have not typically been performed prior to the design of such mobile applications [6]. To acknowledge the potential of mHealth applications, there is a need to investigate how these applications are perceived by end users in the aspect of its perceived usefulness, preferences and as a cross-cultural interface design impact. The objective is to gather useful information and enhance the design of mobile health tools tailored for Ghanaian migrants through user requirement gathering conducted within the targeted end users [5, 6].

Empirical research studies have confirmed that there is potential to improve health services delivery among communities with disparities by use of mHealth technology applications [2]. As such, understanding what motivates users from different cultures is important for positioning brands in different markets [7]. Such implicit cultural values need to be considered when designing mobile applications intended to reach end users from all cultural backgrounds [8]. This paper focuses on the challenges of user requirement gathering from Ghanaian migrants as end users. Investigating the usability of mobile health technology among migrant communities will highlight behavioural patterns and provide useful data to improve the design and utilization of mobile health interventions.

2.1   User Requirements

A requirement is a statement that defines what a system should do. According to Withall, the requirements specify the flaws of a system and outlines the steps needed to solve the problem [9]. Withall further explains that a requirement is a single measurable objective that must be satisfied by a system. In other words, they must be precise and unambiguous. A challenge in the past has been how to present requirements in a way that is understandable to both technical system designers or developers and formal and informal users. User needs and contexts need to be translated into user requirements in a structured way for product designers but must be understandable by users as they must verify them [10].

Rombach divides the more formal description of requirements into two, technical requirements and user requirements [11]. Technical requirements outline how a product will be implemented to meet user requirements. User requirements on the other hand are from the user perspective and describe the functions, constraints and other features that must be provided to satisfy user needs [11, 12]. Gathering user needs is a necessary step to develop a usable product. There is a need for real data on users and their needs. Use cases can still be used on a regular basis to determine users' way of task execution. However, these implicit assumptions risk the mutual understanding between users and designers [5].

The requirements gathering process is encumbered with several challenges including users and designers thinking along the same lines and reflecting current system and processes, rather than being innovative, and users being unsure or not knowing what they want from a future system [1].

Measuring user requirement will position Ghanaian users to drive the design of systems that are tailored for them. To that effect, incorporating behavioral and cultural preferences with emphasis on user satisfaction, ease of use, and accessibility, will advance the use of mHealth applications within the Ghanaian migrant communities. User interface designers will also benefit as they design for the global market with cognition of the specific requirements of ethnic minorities.

2.2   User Centered Design

In our homes, offices and on our phones, we find ourselves inundated with systems and applications that are redundant because we find them difficult to understand, navigate or operate. These can range from the high-tech photocopier in the office to the newest healthcare application on your phone. Computer-based systems need to be designed with an understanding of the users they are intended for. User centered design (UCD) is a design approach that is aimed at increasing the usability of systems by active involvement of users at all phases of the design process. According to Johnson et al., the use of fundamental principles of good design at the start and throughout the design life cycle results in systems that are easy to learn, increase user productivity and satisfaction, increase user acceptance, decrease user errors, and decrease user training time [13]. User-centered design has become an important concept in the design of interactive

systems that is primarily concerned with the design of sociotechnical systems that focus on users, and the use of technologies by users in their daily routines [14].

Research has indicated that human resources and economic resources are wasted by numerous health care systems that are designed without consideration of user centered guidelines, resulting in dissatisfied users and abandoned systems [13]. Johnson et al., emphasizes that a major goal in the design of usable health care software should be to design systems that takes the characteristics of users and their environments into account and matches user capabilities.

Health information technology is a very promising area that is facing expectation challenges due to design flaws that are unable to meet user requirements [15]. Despite the continued proliferation and popularity of mHealth applications, evidence shows that more than 95% have not been tested [16]. There is limited research on the effectiveness and little support for understanding how best to design mHealth applications [17]. mHealth applications also fail to live up to their expectations due to lack of end-user feedback in the design process [18]. Growing research highlights the above shortfalls and emphasizes the need for further research to ensure that mHealth technologies are appropriately designed based on a user-centered approach [17, 19–21].

2.3   User Interface (UI)

An interface is the part of a system through which a user interacts with a system. Head describe an interface as the visible piece of a system that a user sees, hears or touches [22]. Whether you get in your car and drive from one point to another, switch on the vacuum cleaner, operate a treadmill, browse on your computer or use an application on your phone, you get the task done by interacting with the systems interface. A good interface effectively communicates with users on how to get tasks done. Inadequately designed interfaces on the other hand, are difficult to navigate and often leave users frustrated. Irrespective of how trivial, incidental or artful the design might be, good design interfaces are reliable and effective intermediaries that are based on solid design principles that enhance use [22].

A usable interface is a vital element in the software development process. Users are diverse and as such interact with systems in different ways. Understanding users and their behavior is key to the development of usable interfaces [23]. System designers who understand users and think from the perspective of users, are able to translate their knowledge about users into developing systems with good interface design that support user interaction without difficulties [22]. Galtiz indicated that most applications in the market today appear to be generalized and unusable, but proper interface design incorporates a fusion of well-designed input and output mechanism that satisfy a user's needs, capabilities, and limitations in the most effective way [24].

2.4   Cultural Components in UI Development

Culture is an element that cannot be overlooked in the interface design process. Within one locality you may find users from different cultures. As user interface designers strive to develop more usable systems, there is a need to be cognizant of their own cultures and the culture of the intended users. Attention to their own cultural orientation

and knowledge of the preferred structures and processes of other cultures, positions interface designers to achieve more desirable localized and customized designs [25]. Only a limited number of published classical theories on culture are known in the interface design community. Hofstede explains culture to be essential patterns of thinking, feeling, and acting that are well established in individuals at childhood, and are evident in a person's choices of symbols, heroes/heroines, rituals and values [26]. Hofstede's work establishes 5 dimensions of culture that affect user interface design, namely: Power distance, Collectivism vs individualism, Femininity vs masculinity, Uncertainty avoidance, and Long vs short term orientation. Based on a user's culture they may exhibit several characteristic including being active or passive, expressive or less expressive, easy going and relaxed, or aggressive with strong emotions [26]. All these subtle or distinct cultural nuances largely influence a user's choice and affect what they expect or require from an interface. In order not to be culturally biased, it is expected that designers be cognizant of all these factors when designing user interfaces. According to Marcus, several questions remain unanswered about the consideration of cultural dimensions in user interface design [25]. Examples include: What cost effective tools are needed to support multicultural UI design? How can the success of multi-cultural UIs be measured so that templates can be developed for appropriate content delivery?

3   Methodology

A preliminary study was conducted to gather user requirements from Ghanaian end users. The study was developed using qualitative data collection techniques. The goal of this approach was to gather and better understand Ghanaian end user requirements. To this end a qualitative questionnaire was developed with open-ended questions, closed questions and Likert scales. The study was carried out over a 5-month period. A stratified random sampling approach was used in selecting participants comprising of migrants in one specific geographical location in Frederick, Maryland, U.S.A. Partic-ipants were chosen by recommendations and word of mouth. All participants agreed to be interviewed on a one-on-one basis at a convenient location of their choice. The purpose of the study was explained including the participants rights, and the right to terminate the participation at any time.

The facilities used for the interviews were Frederick community center and a local shopping mall. Each interview lasted 10–15 min. Data was collected from 30 Ghanaians comprising of 12 males and 18 females. All participants were interviewed face-to-face. The selected age groups that participated were within the ranges of age 30 to 55 and above. During each interview, the interviewer explained the purpose of the study to the participants and assured them of confidentiality. A questionnaire was given to the participants to follow after the interviewer's questions, which allowed for con-sistency of responses relevant for the study. Data was captured directly by marking or writing responses on the questionnaire for the different question types. The data obtained from the interview was cleaned, analyzed and relevant patterns recorded and then analyzed.

3.1 Data Collection Instrument

User requirements Gathering Questionnaire
   Circle Value:

1. Identify your age from the ranges listed below.

   18–29 30–35 36–40 41–45 46–50 51–55

2. Gender

   Male Female

3. What mobile device do you currently use?

a. iPhone
b. Android
c. Windows

4. How long have you owned/been using this mobile device?

a. 0–6 months
b. 6 months – 1 year
c. 1–3 years
d. Over 3 years

5. How would rate yourself about mobile technology usage?

a. Novice
b. Moderate
c. Advanced

6. How often do you use mobile applications?

a. 0–30 min per day
b. 1 h per day
c. More than 2 h per day
d. Other, ………………………………………

7. What mobile application(s) do you currently use regarding health?

   …………………………………………………………………………………

8. What specifically do you like most about the application that you use, in terms of functionality and features?

   Why? ……………………….………………………………………………..

9. What specifically do you not like about the application that you use?

   Why? …………………………………………………………………………

10. Does the application help you to fulfil the health reason for which the application is intended?

   If yes, how…………………………………………………………………………
   If no, why? …………………………………………………………………………

11. As a Ghanaian, would you use an application that is specifically designed to address health issues for Ghanaians currently living in the USA?

   If yes, why? ……………………………………………………………………

   If no, why? ……………………………………………………………………

12. What specific features and functionalities would you expect the application to have to help you achieve your health goals?

   ……………………………………………………………………………

4   Results

Detailed analysis of the questionnaire revealed the following findings:

All participants had smartphones with 56.7% (17) having iPhones and the remaining 43.3% (13) having android phones. 56% of participants rated themselves as advanced mobile technology users, whiles 43.3 rated themselves as moderate mobile technology users. 80% (24) of participants already had mobile applications on their phones that they used to manage their health. Main features participants did not like about the applications they were currently using included its complexity (36.7%), lack of accuracy (13.3%), limited options (10%) and security concerns (10%). 66% of participants indicated that they would be interested in a mHealth application specifically designed for Ghanaians. 27% declined to answer. 7% said no, with the reason being security/trust issues. With regards to the question on what specific features and functionalities participants would need in an application designed to help them achieve their health goals, answers obtained have been grouped into functional and nonfunctional requirements and represented in the chart (Table 1) below.

Table 1. User needs categorized into functional and nonfunctional requirements.

Functional requirements	Percent (%)	CI* (95%)	Different from zero
Diet management /Ghanaian foods	20.5	6.05% to 34.95%	Yes
Fitness management	6.8	−2.21% to 15.81%	No
Health management	22.7	7.71% to 37.69%	Yes
General wellness information	27.3	7.71% to 37.69%	Yes
Voice command function	2.3	−3.06% to 7.66%	No
Nonfunctional requirements			
Privacy	2.3	−3.06% to 7.66%	No
Availability	4.5	−2.92% to 11.92%	No
Ease of Use	11.4	0.03% to 22.77%	Yes
Performance	2.3	−3.06% to 7.66%	No
Total	100		
*CI: Confidence interval			

5   Discussion

The results obtained indicated that 100% of participants used smart phones. This is promising in light of the potential benefits of smartphones. Smartphones are comparable to computers and they stand to potentially transform the face of the healthcare industry as they have the capacity to support eHealth applications and also afford all the benefits and uses of traditional computers with the added benefit of affordability and mobility. The impact of smartphones on medicine has been noted to be very significant [27]. Other factors that make smartphones an easy source for access to health information and communication is their widespread distribution, the relative cheapness, small size and homogeneity of products [28].

80% of participants had mHealth application on their phones, with the most popular apps being Apple health and Samsung health. With the advent of smartphones there has been an increase in the mobile phone applications. In 2010 there were more than 7000 smartphone applications dedicated to health, with estimates indicating 300 million applications downloaded in 2009, and 5 million downloaded in 2010 [28]. This high usage of applications among participants is very encouraging due to the fact that applications play an essential role in patient education, disease self-management, remote monitoring of patients, and collection of dietary data [29]. However, despite the large numbers of mobile phone ownership, the surge in electronic health advances, the high usage of health applications, and the promising prospects of mobile health technology within the healthcare industry, the lack of evidence of clinical effectiveness and lack of formal evaluation and review are key limitations that need to be addressed [29].

Participants were very elaborate on what they needed in an application tailored for Ghanaian migrants. The list of functionalities needed include Diet management, health management, ease of use, fitness management, General wellness information, privacy, good performance and availability. The most significant of the needed functionalities, with high confidence intervals (Table 1), were general wellness information, health management, diet management, and ease of use. A noteworthy point is that when indicating their needs all participants specified the need for the functionalities to be delivered in the Ghanaian context where possible. For example, a diet management application in this context, should include the Ghanaian cuisine repertoire with its emphasis on starchy vegetables and legumes, and should also provide users with dietary information such as caloric contents for Ghanaian specific foods. Although general messages have been shown to have an impact on behavior change, evidence indicates that tailored messages stimulate greater cognitive ability in its audience [30]. In this respect making health, wellness, fitness and diet information relevant in context to the Ghanaian audience will be key in increasing uptake, acceptability and adoption within this group.

These findings are key foundational points that should inform the design when tailoring an application for Ghanaian migrants, however subsequent studies with larger data sets might be needed to substantiate the findings.

There were several challenges with this study. Identifying the features users would like in a tailored application was difficult as users had limited knowledge of specific

functionalities that can be tailored in an application. Other problems included, insufficient information, unclear statements, and contradicting requirements. As such, data collection incorporating a larger sample size might be needed to clarify or substantiate findings in this study. Gathering requirements from the older participants (51–55 years) was a challenge. The older participants did not use their smart phones to their full capacity. They indicated that they mainly used their phones for making calls and texting. However, they rated themselves as moderate and advanced users of mobile technology. Surprisingly, although these participants used smartphones and had a health application installed on their mobile phones, they were less likely to use an application for healthcare monitoring and relied on their healthcare practitioner for tracking their healthcare needs. One participant stated that "My health is a priority to me, however, I don't trust a machine to tell me what to do when it comes to improving my healthcare or giving me advice on steps to take, but if a trusted friend or colleague recommends it, I will be willing to give it a try." The willingness to accept a mobile health application if it is recommended by friends brings up the issue of trust. In other words, if an application has been tried and tested by someone a user can associate with, they are more likely to accept it. The challenge is how to interpret this perception into a workable solution for such users.

Inconsistencies in answers was another challenge. Some participants indicated they already had a mobile application but were interested in a mobile health application that was tailored to meet their needs. However, they refused to answer follow up questions on what they liked about the applications they currently had on their phones and what specific features and functionalities they needed in a mobile health application.

Some participants had limited knowledge about the features and functionalities of mobile health applications, or they were just unable to articulate the actual needs they wanted to address. They were interested in an application tailored to meet their needs and liked the fact that it would provide them the avenue to access information from a wearable gadget, or something that was already compatible with their phones. However, they were unable to clearly express their needs, and this resulted in unclear statements that presented a challenge for the researcher to code when analyzing the data.

Contradicting or conflicting requirements was another issue that was noticed. Participants wanted an easy to use, uncomplicated health application. However, they wanted the applications to have several functionalities and features, such as diet management fitness management and health and general wellbeing management all in one.

Another challenge was participants who were unwilling to accept new technology. These participants indicated that in their opinion physical doctors and hospitals were the right way to access healthcare information and did not think having a shortcut to monitor their health via smart phones would work for them. They were not interested in a healthcare application and answered NA (no answer) for most questions.

It is anticipated that embracing and engaging participants with all their varied perceptions in the requirement gathering process and making provision for feedback during the iterative design process of a system will build confidence and acceptability and promote a sense of ownership in users.

6   Conclusion

User requirement gathering is an important step needed to provide information for developing guidelines for iterative prototype design, necessary for developing acceptable applications for specific audiences. This paper makes a contribution to the field of cross-cultural usability studies by providing a preliminary understanding from a user perspective, the needs of Ghanaians in terms of content and features, of a tailored mHealth application. Measuring usability requirement augments the Ghanaian user to drive the design. To that effect, incorporating user requirements with emphasis on tailored information on general wellness, health management, and diet management, will go a long way to advance the use of mHealth applications within Ghanaian migrant communities. User interface designers will also benefit as they design for the global market with cognition of ethnic minorities. There is a need for further exploratory studies in migrant groups in mHealth technology and the potential to engage and empower all users to be in control of, and to manage their health.

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