A MOBILE HEALTH DESIGN PROCESS TO IMPROVE COMMUNITY HEALTH WORKERS' ENGAGEMENT WITH MOBILE HEALTH

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ABSTRACT

Despite the significance of user engagement for the efficacy of mobile health systems, many such interventions frequently do not include user-engaging attributes. This is because, users' needs and sociocultural contexts of users' groups are frequently not considered in detail during mHealth design, implementation, and operation stages. As users' activities are influenced by their sociocultural contexts, it is important to capture such sociocultural contexts during various stages of mobile health designs. The aim of this paper is to develop a framework that improves user engagement with designed mobile health technology. This framework is intended to be used by mobile health designers and developers and it facilitates specific consideration of any sociocultural context existing. Thirty semi-structured interviews were conducted with end users and mobile health designers to investigate factors that facilitate or hinder user engagement with mobile health technologies. The results of this research show that to understand why and how users engage, continue to engage, disengage, and re-engage with previous mobile health technologies during designs of mobile apps, capturing sociocultural contexts of users during designs of mobile health apps and involving end users in designs of mobile health apps all play significant roles in improving user engagement with mobile health. This research proposes a new sociocultural framework called the **De**sign Pro**c**ess Engagement E**n**hancement Sys**t**em (DECENT) that enables mobile health designers to incorporate users' values as well as the sociocultural contexts of end users into the design process of mobile systems. Global South was the setting in which DECENT is tested.

KEYWORDS

Design Science, User-Centered Designs, User Engagement, Sociocultural Filtration, Sociocultural Contexts, Mobile Health

1. INTRODUCTION

Engagement is a universal goal in the design of content (Doherty & Doherty 2018). However, a lack of engagement may result from an imbalance in the integration of appropriate content and feature that maintain user interest. (Hingle & Patrick 2016; Tang et al. 2015). An important, and often overlooked feature of engagement research is the fit between various conceptions of engagement and the design process (Doherty & Doherty 2018). The design of engaging experiences lies in the appraisal of user engagement. However, little attention has been paid to the integration of measures of engagement within a process of design (Doherty and Doherty 2018). Thus, the need for a better design process of mHealth to improve user engagement. Ikwunne et al. (2022) conducted a systematic review of the user engagement design process and discovered a lack of consideration for sociocultural contexts in the design of mHealth interventions. The systematic review recommended that such sociocultural contexts be considered and addressed systematically by identifying a design process for engaging users in mHealth interventions (Ikwunne et al. 2020). In this research, user engagement is defined as a context-dependent, individual-specific psychological state that emerges from two-way interaction with an object, such as an app (Brodie et al. 2013; Brodie et al. 2011; Hollebeek 2011). The effectiveness of mobile health (mHealth) initiatives thus depends to a large extent on user engagement (Bo¨hm 2020; Grady et al. 2018). However, despite the claimed significance of user engagement for the efficacy of mHealth systems, many such interventions frequently do not include user-engaging attributes (Machado et al. 2016), this led to the research question on the research: how can a design framework be developed to improve user engagement in mHealth technologies? The aim of this research is to develop a framework that supports mHealth designers or developers in creating mHealth technologies that engage their

users. This research question results have four specific research objectives: 1) Overview of user engagement and how it is being evaluated for mHealth. 2) review of existing design process frameworks for mHealth. 3) Design of DECENT, and 4) Refine and evaluate the DECENT framework to guide user engagement to improve the user engagement design process for mHealth.

In the globalized economy, for example, new products are frequently developed for international markets. Because user characteristics and needs differ significantly across regions (Omo 2002), product development for global markets requires organizations to design products with these differences in user characteristics and needs in mind. According to Shen et al. (2006, p.7), "Successful interface metaphors should be developed or adapted through cultural requirements by or regarding, representatives of the culture for which they are intended". Culture is defined as the similar patterns of thinking, feeling, and acting of people who belong to the same group but are different in these patterns from other groups (Hofstede 1991). This 'acting' is largely based on unwritten rules and habits passed down from generation to generation (De Angeli 2006).

According to Honold (1999), the approach to learning how to use a new mobile phone, for example, may vary depending on national culture. For example, German users prefer a user manual, whereas Italians prefer "learning by doing." Furthermore, while the salesperson is an important source of information for Chinese users, for Indian users, the entire family is involved in the knowledge acquisition process. Honold's (1999) research shows that culture influences patterns of user-product interaction and engagement, implying that designers should account for these differences in knowledge acquisition approaches. However, determining the nature of this impact may be difficult in the absence of a deeper understanding of how users actually "engage" with technologies (Sonderegger & Sauer, 2013). This emphasizes the importance of providing a framework for assessing users' sociocultural contexts for user engagement designs.

To take such sociocultural contexts into account, this research proposes to develop a new mHealth design framework to improve user engagement in mHealth. This design process will be called Design Process Engagement Enhancement System (DECENT).

This research follows a Design Science (DS) methodology approach which is defined as "a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence." (Hevner 2010). Therefore, a DS approach is used to develop DECENT as an artifact, to ensure that it addresses the needs of developers aiming for more user-engaging mHealth.

The remaining part of the paper is structured as follows. Section II discusses related works, while Section III discusses the methodology applied in this paper, which includes data collection, design science approaches for DECENT design, and the data analysis method. Section IV presents results and discussions on factors that facilitate or hinder mHealth engagement. Section V provides a description of DECENT framework and participants involvement refinement of DECENT. Section VI discusses DECENT evaluation by end-users and mHealth designers. Section VII presents the conclusion of the research.

2. LITERATURE REVIEW

The research objectives: 1) analyze an overview of user engagement, and how it is being evaluated for mHealth and 2) extensively review the literature assessing existing design process frameworks for mHealth are achieved in this section as follows:

2.1 Design and Evaluation of User Engagement with mHealth

Even though developing and measuring user engagement with health is a generally recognized goal of interactive system development across many disciplines, there is little guidance available to show designers' efforts to make things engaging (Ikwunne et al. 2022). To assist in creating and evaluating future mHealth interventions, Ikwunne et al. (2022) conducted a review to determine which design process enhances user engagement with mHealth. The review discovered that 1) a rigorous design process for user engagement with mHealth is essential, which incorporates users' sociocultural contexts into the design of mHealth interventions. 2) mHealth designs should clearly incorporate user or human-centered design methodologies, and users should be involved from the start to understand their needs and throughout the mHealth design process. Lalmas

& O'Brien (2014) demonstrated that, while designing for engagement is essential, it cannot be accomplished correctly without understanding how to define and measure user engagement.

Several studies have stressed the importance of understanding user engagement theories with mHealth interventions and analyses of their measurement to build effective interventions that suit users' requirements (Ikwunne et al. 2022; Ikwunne et al. 2022; Yardley et al. 2016; King et al. 2014). Perski et al. (2017) used two notions to measure engagement: subjective and objective measurements. Self-report surveys and qualitative techniques are among the subjective measures. Studies have used self-report questionnaires to assess participation in digital games and digital behaviour change interventions (DBCIs) (Martey et al. 2014; Fang & Zhang 2013). Qualitative methods, such as interviews or think-aloud exercises, have been utilized to acquire a deeper understanding of the nature of users' participation in digital games and DBCIs (Bossen et al. 2013). In the behavioural science literature, objective measures, such as mechanized tracking of use patterns, such as the number of logins, time spent online, and the degree and type of content used during the intervention period, are more commonly used than subjective measures (Morrison & Doherty 2014), whereas in the computer science and HCI literature, psychosocial measures, such as eye tracking, are more commonly used (Jennett et al. 2008).

The understanding of user engagement and the evaluation of user-centered technologies are limited without a means of measuring engagement (O'Brien & Toms 2008). O'Brien & Toms (2008) brought together the threads of many research studies to identify the essential features of engaging experiences and to present a conceptual, process-based model of engagement based on Aesthetic, Flow, and Play theories, the conceptual paradigm, however, the model has not yet been tested and measured in a range of application domains, particularly in mHealth. The assessment of user involvement is crucial in the design of engaging experiences. On the other hand, understanding users and their interactions with technology prompted a shift toward the study of user experience (McCarthy 2004). However, little attention has been made to the integration of engagement measurements inside the process of mHealth design.

2.2 Design Framework for mHealth

The design process is referred to as the solution-based method used in developing mHealth interventions. Six frameworks were utilized in the literature: participatory design, user-centered design, double diamond, human-centered design, Hasso-Plattner Institute, and techno-centric approach (Ikwunne et al. 2022). The existing design framework, its descriptions, and key aspects of the frameworks are described in Table 1.

Table 1. Design frameworks and corresponding descriptions

Framework	Description	Key aspects
Participatory design (PD)	PD is a process that involves all stakeholders in the intervention design process to ensure that the interventions developed are usable and meet the needs of users (Bratteteig & Wagner 2016).	PD is an approach in which designers engage potential users to participate in all stages of the design process. (Bratteteig & Wagner 2016).
User Centered design (UCD)	UCD is the technique that focuses on putting users at the center of product design and development is known as UCD. Its primary goal is to improve the usability of interactive goods by the study of system use and the use of human factors and usability knowledge and methodologies (ISO 2010).	UCD is comprised of four steps: (1) understand and identify the needs of the users; (2) produce design solutions; (3) evaluate the design and (4) implement (ISO 2010).
Double Diamond (DD)	The Design Council developed the double diamond (DD) process is focused on the use of design thinking in business and innovation designs (Tschimmel 2012).	DD consists of four phases which are discovery, definition, development, and delivery (Tschimmel 2012). The DD procedure was utilized sparingly in the literature, with Nyatuka & de la Harpe (2019) examining its usage to improve healthcare delivery, particularly in low-resource settings.
Human-centered design (HCD)	The Innovation, Design Engineering Organization (IDEO) created the human-centered design (HCD) patterns. HCD was employed in the literature to construct a patient-centered e-health solution for	Hearing, producing, and delivering are the three steps of HCD (Das & Svanæs 2013).

	patients receiving weight reduction therapy (Das & Svanæs 2013) and different recommender system (Govoruhina & Nikiforova 2022; Mulrooney et al. 2006).	
Hasso-plattner Institute (HPI)	In the evaluated research, HPI was used to improve the testing of latent tuberculosis infection by health workers (Farao et al. 2020).	The HPI method is divided into six steps: "Understand", "Observe", "Point of View", "Ideate", "Prototype" and "Test" (Farao et al. 2020).
Techno-centric process	A "technocentric approach" unlike UCD is a design technique that emphasizes technological aspects to meet the system design needs.	The technocentric process is centered on "technology-push," in which designers first focus on technology before attempting to apply it (Carayannis et al. 2021).

Though the sociocultural contexts associated with user engagement have been established in the literature as important factors to consider when attempting to achieve user engagement with technology (mccurdie et al. 2012), little work has been done to develop a process (framework) for designing user engaging mHealth apps/technologies to guide mHealth designers and developers, particularly in under-resourced and underserved settings. There is no robust design approach for mHealth user engagement that incorporates users' socio-cultural contexts into mHealth intervention design. There are contributions about theory-based user-engaged mHealth therapies based on behavioural techniques (Ikwunne et al 2022). However, the research emphasizes the importance of developing a framework for incorporating processes that highlight end users' sociocultural backgrounds into the design of mHealth technology.

3. METHODOLOGY

This research adopts design science research methodology (DSRM) which provides a process model for conducting Design Science research (Hevner 2010). The DSRM is divided into six phases below:

1. First we identified the problem and motivation of the study in the introduction.
2. Define Solution Objectives: DECENT's objective is to provide an mHealth design process (framework) that improves user engagement with the designed mHealth; the framework is intended to be used by mHealth designers and developers when developing mHealth apps/technologies, particularly underserved, under-resourced, and under-represented settings.
3. Design and development: Collecting and analysing data from semi-structured interviews to inform the DECENT framework.
4. Demonstration: Refining DECENT mHealth design to suit end-users' needs.
5. Evaluation**:** DSRM Phase 5 provides an evaluation of the DECENT framework.
6. Communication: Presentation of the research to an appropriate audience in human-computer interaction (HCI) and mHealth fields.

The methodology, including study design and data analysis, is described in the following sections.

3.1 Design Study

To collect data to understand what motivates users to engage in the ways they do and why they engage with mHealth technologies in their individual contexts, an established methodology employed in many HCI research by Jia et al. (2016) is followed as described below.

3.1.1 Research Context

To understand what motivates users to engage in the ways they do and why they engage with mHealth technologies in their individual contexts, we first examine the AIM Health Plus project, a mobile health initiative in Sierra Leone. Since the project's launch in 2017, an mHealth technology component has been a part of it. Sherbro Island and the Imperi neighbourhood are the geographic focus. For use by community health

workers (CHWs) during home visits, the AIM Health Plus project equips smartphones with a customized version of Dimagi's CommCare app. Despite the difficulties, the AIM Health Plus project has achieved significant strides in Sierra Leone, where 326 CHWs are using CommCare to deliver timed and targeted counseling (ttC) messages to induce healthy eating and behavior changes in moms of young children under two and pregnant women. The CHWs have also received appropriate training and guidance to ensure the app's long-term use. The app reminds CHWs of the appropriate times to visit households during pregnancy, early childhood, and adolescence.

3.1.2 Experimental Design

A snowballing technique was used to identify potential participants for this research. World Vision Ireland and Sierra Leone through their line managers contacted the participants and asked them to participate in the semi-structured interview process. Those who responded to the request were then sent the Participant Information Leaflet, which detailed the risks and benefits for the participant and provided more information on the study procedures. Within 7 days of receiving the information leaflet, the participant was contacted by the line manager to confirm that they were still interested in participating in the research. If the participant agreed to continue, he or she was asked to complete the consent process before the semi-structured began. Ethical approval was sorted prior to the collection of data.

A total of thirty (30) semi-structured key informant semi-structured interviews including end users, mobile health developers and designs, lasting between 30-90 minutes were conducted. The semi-structured interview questions focused on how participants engaged with their current or previous mHealth technology over time. The semi-structured interview questions were designed to determine which aspects of their mHealth technology they used and which they did not and what made users disengaged or re-engaged with mHealth apps. For semi-structured interviews involving community health workers (CHWs), semi-structured interviews were transcribed in audio in the local language (Mende). On the ground in Sierra Leone, a trained and experienced research assistant carried out the semi-structured interviews and transcribed and translated them. NVivo was used to code and analyze all of the semi-structured interviews

3.2 Data Analysis

The semi-structured interviews were analyzed using Braun and Clarke's (2021) six stages of thematic analysis via a deductive approach. The following is a summary of the thematic analysis phases:

1. Familiarization with data: In this first phase of the analysis, the lead researcher becomes acquainted with the data by reading the transcripts, notes, and audio tapes numerous times. The transcripts of the thirty semi-structured interviews and the reflection notes on each semi-structured interview were all imported into NVivo. NVivo can link different semi-structured interview data sources, allowing for faster retrieval and contextualization of each semi-structured interview. In addition, NVivo mind map tools were used to create a visual representation of concepts and connections linking the different concepts from the semi-structured interview data and research questions and linking them to other factors from the literature that act as facilitators and barriers of user engagement to gain a good understanding of the themes that will be identified from the semi-structured interview data.

2. Systematic data coding: The second phase starts off the coding exploration. NVivo 12 is used to find words, sentences, and paragraphs that discuss a significant topic from the semi-structured interview data using the visual representation of concepts created in phase 1. Based on the meaning subject deduced from the semi-structured interview data, labels were assigned to these isolated words, phrases, and sentences. Until all semi-structured interview transcripts have been coded, each transcript is coded individually.

3. Generating initial themes from coded and collated data: In phase 3, themes were generated from the coded data. Initial themes are created from categories based on the preset themes during this step of the thematic analysis process (Maykut & Morehouse 2002). The authors began grouping the codes that had comparable meanings or were connected to one another once the transcripts had been coded. After clustering the codes, the authors assigned labels to the clusters based on the meaning that the codes shared. For instance, the theme categories "design engagement (process) awareness", "design engagement (process) goals", "design engagement process problem with stakeholder mapping", "negative experience with (not) involvement in design process", and "positive experience with design process" were grouped together under the theme "design process engagement".

4. Developing and reviewing themes: The fourth phase systematically reviewed the evolving thematic framework of nodes. During phase 4, some nodes were merged, while others were clustered together into related code categories. The ideas derived from the data were gradually developed (data reconstruction), and the flat-structured nodes evolved into a more complex hierarchical structure (tree nodes).

5. Refining, defining, and naming themes: In phase 5, the data was revisited, and its breadth and depth were examined (Richards 2020). The themes were connected, and the connections were explained (Ritchie & Spencer 2002). The responses of the participants are summarized in these data-topics-as-themes, but there is no central concept, no shared meaning, only a shared topic. In the initial theme generation described in phase four, for example, the theme "socio-technical facilitator" represents a data topic because it does not provide a shared meaning or a central concept. However, the theme was refined in this phase and renamed to "socio-technical facilitators of user engagement with mobile health technologies".

6. Writing report: The final phase is writing the report. The thematic analysis report was written in the next section (results and discussions) as a qualitative report since the aim of the analysis was to understand what motivates users to engage in the ways they do and why they engage with mHealth technologies in their individual contexts and takes a step further to develop a framework that incorporates the sociocultural contexts of users into the design, based on the user-centered design models and the results of the semi-structured interviews.

4. RESULTS AND DISCUSSIONS

This section provides results and discussions of the application Braun and Clarke's (2021) six stages of thematic analysis of the semi-structured interviews with 30 participants which produced six themes and twenty-three categories as shown in figure 1. However, only one category's findings from each of the six themes that are described below in detail.

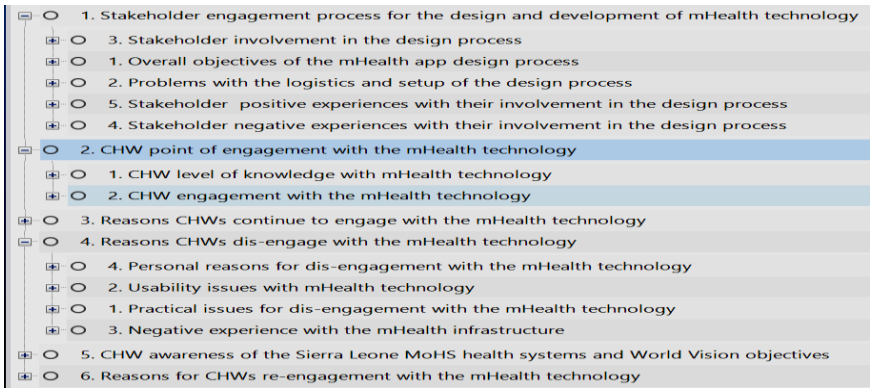

Figure 1. Results of thematic analysis of 30 semi-structured interviews

Theme 1 - Stakeholder engagement process design of the mHealth technology: The first theme is the stakeholder engagement process design of the mHealth technology. This first theme is subdivided into five categories: 1) overall objectives of the mHealth app design process, 2) problems with logistics and setup of the design process; 3) stakeholder involvement in the design process, 4) stakeholder negative experiences with their involvement in the design process and 5) stakeholder positive experiences with their involvement in the design process. The themes' meaning was explained through the categories. There are distinct attributes for each of the five categories. The codes inside each category's content and meaning served as the basis for defining the attributes of each category.

Category 1. Overall objectives of the mHealth app design process: This refers to the health or wellness goals that an individual can achieve while using mHealth technologies. According to CHWs, mHealth technologies were designed to help save the lives of pregnant women and children under the age of five. One interviewee's comment on health or wellness goals demonstrated this:

"The mHealth project was designed to stop maternal and child deaths, which is exactly what we need in this community". (P15)

This category offers resources for incorporating numerous stakeholders in mHealth projects that enhance healthcare delivery.

Theme 2 - CHW's point of engagement with the mHealth technology: The CHW's point of engagement with mHealth technology is the second theme. This is the point at which the CHWs began engaging with the mHealth technology. Participants talked about the start of interesting encounters. Two categories are used to categorize the theme: 1. CHW level of knowledge with mHealth technology; and 2. CHW engagement with the mHealth technology.

Category 1. CHW level of knowledge with mHealth technology**:** This speaks to CHWs' familiarity with the elements of technologies or applications that pique users' interest. An interviewee made the following observation regarding the CHW's use of technology to plan work:

"It also helps me organize my work". (P8)

Theme 3 - Reasons CHWs continue to engage with the mHealth technology: The third theme is the reasons why CHWs continue to use mHealth technology. After describing the point at which they became engaged, CHWs described what was happening and what they felt and thought while engaged, and what made them stay engaged with the mHealth, which formed this theme's six categories, shown in figure 1. CHWs' awareness (level of knowledge) of the mHealth technology to achieve its aims; 2. technological reasons CHWs continue engaging with mHealth technology; 3. social and cultural reasons CHWs continue to engage with mHealth technology; 4. aesthetic reasons for CHW continued engagement with the mHealth technology; 5. CHWs identification of ease of use of the mHealth technology; and 6. CHW positive experiences while using the mHealth technology.

Category 1. CHWs' awareness (level of knowledge) of the mHealth technology to achieve its aims:

This category refers to CHWs' level of understanding of what components of technologies or apps are doing to keep them engaged with mHealth technologies. According to CHWs, there were good impacts on their behaviour and work practice reconfiguration. This is consistent with the following comments from interviewees:

"The use of the CommCare apps impacted my work behaviour because I felt motivated to do more". (P10)

Theme 4 - Reasons CHWs dis-engage with the mHealth technology: The fourth theme focuses on the factors that cause CHWs to avoid using mobile health technologies. It investigates instances in which CHWs chose internally to quit using mHealth technology or in which elements of their external environment led them to stop using it. Four categories make up the fourth theme: 1. usability issues with mHealth technology, 2. practical issues for dis-engagement from the mHealth technology, 3. negative experience with the mHealth infrastructure; and personal reasons for dis-engagement from the mHealth technology.

Category 1. Usability issues with mHealth technology: This is a reference to usability flaws found with mHealth technology or app components that disengage users. One respondent raised the issue of how difficult it is to fix faults and mistakes:

"issue using the app is the area of overdue after registration of the client. If the CHW did not follow up on appointment time, the client would go overdue, and some found it difficult to rectify the issue even after visiting the person. The app administrators will be seen as overdue even though the necessary things have been done but the app failed to synchronise". (P9)

Theme 5 - CHW awareness of the Sierra Leone MoHS health systems and World Vision objectives: The fifth theme is the CHWs' knowledge of World Vision's goals and the Sierra Leone MoHS health systems. If CHWs are aware of their health systems even when they are not using mHealth technologies is explored. Without the aid of technologies or apps, this would assist in evaluating the health or wellness objectives that can be derived from CHWs. The fifth theme is divided into two categories: 1. CHW awareness of the manual health systems (before implementation of the mHealth technology), and 2. CHW issues with the manual health systems (before implementation of the mHealth technology).

Category 1. CHW awareness of the manual health systems (before implementation of the mHealth technology): This is in reference to the health or wellness objectives that CHWs can establish without them using mHealth tools or apps. To register households, one respondent noted that paper was necessary and was used instead of technology:

"Initially, we were using paper-based household registration prior to the mobile health technology known as the CommCare application". (P3)

Theme 6 - Reasons for CHWs re-engagement with the mHealth technology: The sixth theme focuses on the motivations for CHWs' re- engagement with mHealth technology. It investigated whether CHWs would use mHealth technology again. The six theme is divided into four categories: 1. CHWs practical problems with re-engagement with the mHealth technology, 2. what the CHW needs for re-engagement with the mHealth

technology, 3. CHW incentives for re-engagement with the mHealth technology, and 4. aesthetics for CHW re-engagement with the mHealth technology.

Category 1. CHWs practical problems with re-engagement with the mHealth technology: This is referring to challenges with re-engaging with the mHealth technology components in a practical sense. One participant in the semi-structured interview stated that the mHealth app does not have stories like those in the paper form:

"The phone they were given did not contain the pictures and stories found in the books. It's just blunt, direct messages". (P18)

5. DECENT PROTOTYPE

Based on the input from the user centered design models, and results from the semi-structured interviews, DECENT prototypes were developed and presented to the participants. The design sessions included participants (end users, mHealth designers) worked together to provide feedback on what they thought and what they understood about the various phases of the DECENT prototypes as well as how the components should be developed to capture their sociocultural contexts and values. This allowed the participants to explore their own ideas for something that might be useful for them. To consider their requirements and values, the participants refine the DECENT prototypes. Participants experimented with, redesigned, or critiqued DECENT prototypes using design tools like paper and sticky notes. Participants did, however, incorporate key concepts and reorganize some tools from the first DECENT prototypes' phase 1 (sociocultural filtration), including personas, capture and postcards, contextual inquiry, and self-built guides. The main difference between the two tools is that while the capture and postcard provide examples of user experiences in the engagement phases of user engagement with mHealth, communication delight provides the same examples with more visual appeal. Even though participants understood and interpreted the communication delight tool without feedback, they thought that once it was added, it would have an impact on it. Figure 2 depicts the DECENT framework, which is a process-oriented user-centered design process that incorporates users' sociocultural contexts into the mHealth design process.

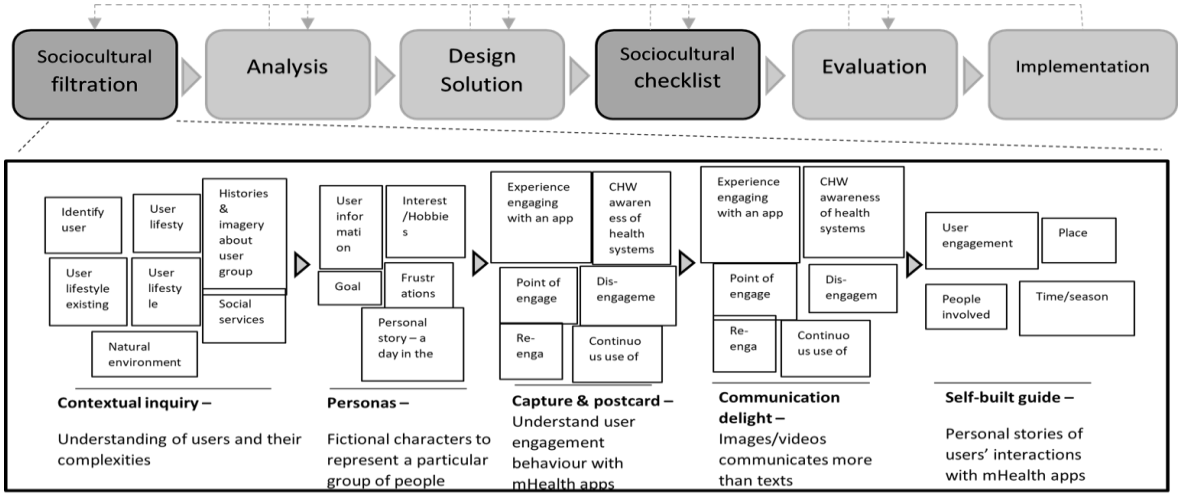

Figure 2. DECENT framework

It places an emphasis on aesthetic, sociocultural, and contextual values, as well as a critical knowledge of the role of design in sociocultural contexts. The DECENT framework is divided into six phases and is based on a user-centered approach. Phase 1: Social and cultural filtration: Many tool sets are employed in this step to understand users' sociocultural contexts. Phase 1 include contextual inquiry, personalities, capture cards and postcards, self-built guides, and communication delight. Other phases of DECENT framework are user needs analysis, design solution development, a socio-cultural checklist, evaluation, and implementation.

6. DECENT EVALUATION

In this paper, it is not possible to say whether the DECENT framework results in more user- engaging mobile health technology. Instead, the assessment procedures looked at DECENT's applicability, comprehension, ease of use, coherence, and engagement, as well as if the steps necessary for the DECENT design process led to mHealth technology that had higher user engagement. It was also established whether the DECENT design process can evaluate end-user requirements, sociocultural contexts and whether the results are engaging and usable. Three mHealth designers evaluated the improved DECENT prototypes at this stage; two of the three participated in the refining of DECENT framework. One of the three mHealth designers Did not participant. Based on what end users liked and disapproved of the DECENT framework was also assessed. Eight end users, comprising six CHWs and one CHW focus as well as a community child monitor (CCM), were also polled to determine whether they had a positive experience taking part in the DECENT design process and whether they thought it would encourage them to interact with the DECENT end-product.

1. Engaging mHealth: This refers to whether mHealth designers and end-users believe that DECENT are likely to result in more engaging mHealth. Participants who are end-users of the DECENT were asked if they thought DECENT would result in mHealth with better user engagement. The participants stated that they were aware that their input from the DECENT design sessions was used in creating the DECENT. As a result, they felt that the DECENT would result in mHealth with better user engagement because the end product would capture their values and reflect their needs.

"In fact, the steps followed in DECENT would produce an outcome that will be very user-friendly". (FG3)

"It will be very perfect, the steps taken were fine and any technology that comes out of it is very usable". (FG1)

2. Usability, effectiveness and other opinions of DECENT: To evaluate whether designer believe that the components of DECENT are likely to be useful and usable, practicable, understandable, easy to follow, coherent, and engaging, mHealth designers were asked to provide their opinions regarding whether DECENT is practical, understandable, easy to follow, coherent, and engaging. One of the mHealth designers (who did involve in the design of DECENT) provided this opinion:

"Yes, it is practical, understandable, etc because it is based on experience and practical's we have already experienced, which is why we recommended the changes. It is coherent and some will be able to use it to gather information". (FG1)

7. CONCLUSION

This paper provides overview of user engagement and how it is being evaluated for mHealth, and reviews existing design process frameworks for mHealth. We conducted 30 semi-structed interview with end-users and mHealth participants to investigate facilitators and barriers to user engagement with mHealth. We offered qualitative insights to explain what motivates users to engage in the ways they do and why they engage with mHealth technologies in their individual contexts and takes a step further to develop a framework that incorporates the sociocultural contexts of users into the design, based on the user-centered design models and the results of the semi-structured interviews. Our work advances user engagement designs with mHealth and HCI research by underpinning the importance of development framework that guides mHealth designers in creating mHealth apps that engages end-users. Future work will apply findings and DECENT framework from this work in developing an mHealth application for delivering health interventions which in turn will be evaluated by end-users. Further studies will also be conducted to determine if our findings would be applicable in other domains besides health.

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