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Reviewing mHealth in developing countries: A stakeholder perspective

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Abstract

Infrastructural deficiencies, limited access to medicare, and shortage of health care workers are just a few of the barriers to health care in developing countries. As a consequence, the burden of disease and its impact on the livelihoods and the economic productivity of people are staggering. mHealth has been extolled as one possible solution to overcoming these challenges, yet discussion of mHealth systems is often limited to specific tasks and user groups. To address this, we adopt a stakeholder perspective and analyze existing research on the mHealth process in developing countries. Specifically, we focus on three key stakeholder groups, i.e. healthcare workers, patients, and system developers. We perform an in-depth analysis of 60 peer-reviewed studies to determine the extent to which different mHealth stakeholder interactions are researched, and to identify high-level themes emerging within these interactions. This analysis illustrates two key gaps in existing mHealth research. First, while interactions involving healthcare workers and/or patients have received significant attention, relatively little research has looked at the role of patient-to-patient interactions. Second, the interactions between system developers and the other stakeholder groups are strikingly under-represented. We conclude by calling for more mHealth research that explicitly addresses these stakeholder interactions.

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Keywords: Mobile Technology; mHealth; Developing Countries; Stakeholder

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1. Introduction

The uptake of mobile technology in developing countries has been remarkable [1,2]. This development has led governments, non-governmental organisations, and practitioners to exploit its potential to extend developmental activities to the poor rural communities who are mostly in the developing countries. Many factors are known to hinder health care delivery in developing countries, including infrastructural deficiencies [3,4] and limited access to medicare and health care workers [5]. Mobile technologies have been touted as a 'silver bullet' to address these issues by improving the management of health services, supply chains, and communication [6]. Strategies based around the use of such mobile technologies are collectively referred to as mobile health (mHealth)[6,7]. mHealth describes the utilisation of wireless technologies to transmit and enable various health data contents and services which are easily accessible through mobile devices such as mobile phones, smartphones and other mobile devices[8,9]. Consequently, a role has been identified for mHealth in developing countries across a range of contexts, for example as an incremental extension of ongoing eHealth developments in urban areas [10,11]. The advantages of mHealth are brought into focus in rural areas where there is little or no conventional healthcare infrastructure available[10,12]. In these areas, mobile devices have the potential to be rapidly deployed as a means of improving health interventions [7,13], preventing communicable diseases [10,14] and improving the health literacy of patients and of health care workers [10,15]. The relatively nascent nature of this phenomenon has resulted in limited meta-analysis of these studies, meaning it is difficult to determine areas of convergence and oversight [16,17]. The objective of this study is to identify and synthesise existing research, to better understand the interaction of the mHealth stakeholders across the mHealth process. This paper is organised as follows: Section 2 presents the methodology for the sampling/review process; Section 3 presents the findings; Section 4 discusses the contributions, implications, and limitations of the study.

2. Method

2.1. Gathering Literature

Literature was gathered from leading academic databases, namely the AIS Electronic Library (AISel); Science Direct & Web Science; JSTOR; Academic Search Complete & Scopus; OCLC FirstSearch; and Google Scholar. Search adopted a subjective, hermeneutics-based, and dialogical approach to the identification of relevant results[18], based on an evolving set of search terms. First, a set of synonymous terms for mHealth was used, e.g. "mHealth", "m-Health", "mHealth Care", "mHealthcare", "Mobile Health Care", and "Mobile Healthcare". A brute force search of papers within each of the databases mentioned returned a large number of papers (N>1 million), hence search terms were instead used in conjunction with context-related terms, specifically "in developing countries"; "in low and middle income countries"; "in low resource settings"; "in poor countries"; and "least developed countries" (e.g. "mobile health care in developing countries"). Papers were retrieved for each combination until the depth of search ceased to provide relevant results. This process reduced the initial set of 192 papers to 60 papers. Once the sample of literature was collected, a set of exclusion criteria was applied as part of title and abstract review. First, literature predating 2010 was excluded. This was done because the rapidly evolving capabilities of mobile devices could have made it misleading to compare studies of mHealth systems from before this period, so compromising the internal consistency of the sample. Second, only literature written in the English Language was included. Third, studies not using mobile devices specifically for health-related activities were excluded. Fourth, only peer-reviewed research was considered from journals, conferences or workshops. Fifth, mHealth studies that focused on technologies that did not include the following were excluded: mobile phones, smartphones, and tablets. This was done because other studies have adopted different definitions of mHealth that include, for example, mobile clinics. Sixth, studies must be focused on developing countries.

2.2. Coding of sample literature

Previous research has suggested that healthcare delivery should be considered as a process [19,20]. The first commonly documented stage of this process is *prevention and education*, which allows interventions to be made before individuals become seriously ill[14,21]. The second stage is *data collection*, which allows healthcare workers a means of

understanding the needs of individuals and detecting issues quickly[22,23]. The third is *diagnosis*, wherein healthcare workers determine the cause of an individual's deterioration[24,25]. The fourth is *treatment*, as healthcare workers act to address the deterioration through various medicines, surgeries, etc. [24,26]. Each of these stages is thus mapped to the analysis of mHealth in this study, i.e. mPrevention/Education, represents the use of mobile health (mHealth) for preventive, advisory, counselling, and educational purposes; mData-Collection represents the use of mHealth applications to collect data that may inform other aspects of healthcare delivery; mDignosis represents the use of mHealth applications for the diagnosis of specific conditions, and; mTreatment represents the usage of mHealth systems to guide remedial healthcare interventions for specific patients. With the process conceptualized, the actors involved may then be considered. Considering the stakeholders of a system has been identified as integral to the design development and implementation of mHealth solutions[27,28]. This is true of most healthcare contexts, wherein different groups can possess varying perceptions, attitudes, skill-sets, and behaviors [29,30]. The first stakeholder group describes those involved in providing healthcare, i.e. the health care workers (HCWs) [31,32] (medical doctors, medical specialist, nurses, midwives, laboratory technicians and community health workers). The second group describes individuals receiving healthcare, i.e. patients (P) (including those who may benefit from preventative care). The third stakeholder group describes those individuals responsible for building the mHealth system, i.e. system developers (SD). Interaction flows for each of these stakeholder groups are considered between that group and the knowledge base (KB) enabled by the system, e.g. health care workers to knowledge base (HCWtoKB), between that group and other groups, e.g. SD to HCW (SDtoHCW), and within members of that group, e.g. health care workers to health care workers (HCWtoHCW). These interactions are illustrated in Fig. 1.

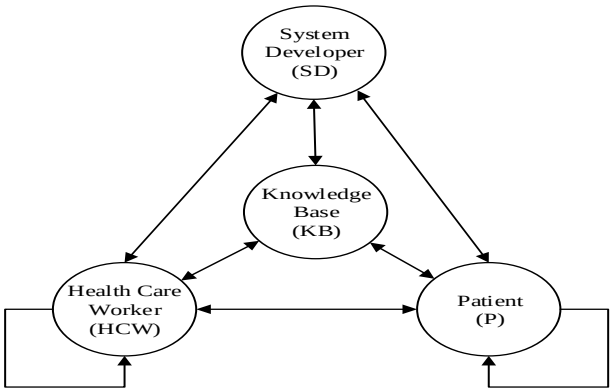


Fig. 1. A Stakeholder view of mHealth

3. Results

3.1. Health Care Worker Perspective

Table 1 - Focus of papers at each stage of mHealth process for health care workers' interaction

Stakeholder Interaction	mPrevention/Education	mData-Collection	mDiagnosis	mTreatment
HCW-HCW	26	28	22	23
HCW-P	41	45	34	35
HCW-KB	43	46	32	33
HCW-SD	5	5	5	3

3.1.1. Interactions between Health Care Workers and Health Care Workers

The interactions between HCWs were studied extensively across all four stages of the mHealth process. Among the literature addressing mPrevention/Education, most discussion centered upon the difficulties of providing training to scarce HCWs, who often struggle to make time for workshops due to real-world pressures and the practical demands of resource-poor settings [11,33]. This presents an important challenge, as contact with healthcare workers is necessary to reduce the sense of isolation experienced by rural doctors in developing countries[11,34]. Discussion around mData-Collection, and mTreatment frequently combined the two, focusing on the potential for distant experts to make use of remote specialization and resources to transfer their findings and diagnosis back to HCWs in the developing countries via SMS or email to inform Patient treatment [34,35].

3.1.2. Interactions between Health Care Workers and Patients

The interactions between HCWs and Patients were extensively studied across all four stages of mHealth. This range of studies demonstrated numerous benefits to health delivery when mHealth systems were introduced. In terms of data-Collection, there is evidence equipping HCWs with mobile data collection tools improves Patients' data collection time when compared to paper-based practices e.g. [23,24]. This enables more efficient data reporting[12,36], and subsequently a reduction in reporting/submission time[36,37]. These data can then be stored in shared reserves, e.g. a national repository [38,39] to be used by other health officials in diagnosing the Patients ailments or monitoring the state of the Patient from anywhere in the world [40,41].

3.1.3. Interactions between Health Care Workers and Knowledge Base

The interaction between HCWs and KB was also extensively studied across all four stages of mHealth. In terms of mPrevention/Education, studies suggest that gaining access to some established KB or health information repository can enhance or improve HCWs' knowledge even when residing in a resource-poor settings [34,42]. Studies demonstrated a willingness among HCWs to gather and transmit collected Patient data to national repositories or databases [26,31]. There is also evidence these HCWs are willing to refer to such centralized systems to guide their diagnoses and treatments at the point-of-care in developing countries [26,33].

3.1.4. Interactions between Health Care Workers and System Developers

The interaction between HCWs and SD was the least well-represented across all stages of the mHealth process. Ensuring continuous use of mHealth systems by health care workers is often a key determinant of their success [29,36]. Thus, collaborative design processes are undertaken between HCWs and the SDs to minimize adoption issues at various parts of the mHealth process [29,36]. This is illustrated in case studies of rural setting in developing countries, where feedback provided from HCWs to the SDs led to significant functional changes in applications[24,36]. Collaborative design and implementation processes with HCWs have also been used to ease tensions around the introduction of mHealth systems[36,39].

3.2. A Patient Perspective

Table 2 - Focus of papers at each stage of mHealth process for Patients' interactions

Stakeholder Interaction	mPrevention/ Education	mData-Collection	mDignosis	mTreatment
P-HCW	41	45	34	35
P-KB	22	21	15	17
P-SD	3	3	3	3
P-P	1	1	-	-

3.2.1. Interaction between Patient and Health Care Worker

The interaction between Patients and HCWs were commonly studied across all the four stages of mHealth process. In terms of mPrevention/Education, studies documented the opportunity afforded Patients to reach out whenever they had emotional problems or felt like talking to a HCW[21,43]. Such findings are part of a broader theme where mobile technology enables Patients to feel connected to remote HCWs [8,44], as part of which Patients' data can be collected and stored as personal health records. Such data are available to the individual to HCW responsible to the Patient in the future, allowing ongoing care to accumulate [33,44].

3.2.2. Interaction between Patients and the Knowledge Base

Interactions between Patients and the KB were less salient in discussions of the mHealth process, though still extensively researched. Discussions addressing mPrevention/Education described systems where Patients can send SMS questions to a KB, then receive automated SMS messages on their cell phones that provides information and reminders for their self-care [14,44]. Patients have also been equipped with wearable devices to keep track of parameters such as blood pressure, pulse rate, temperature, weight, blood glucose are stored as relevant data in the knowledge base [33,44].

3.2.3. Interaction between Patients and System Developer

Table 2 illustrates that interactions between Patients and SDs were not widely considered. Of the studies that explored this aspect of mHealth, the most popular subject matter was the potential for Patients to amass perceptions of poor quality of service, which is identified as an key threat for the spread of mHealth systems [29,31]. It is argued that five variables: i) satisfaction, ii) confirmation of expectations, iii) perceived usefulness, iv) perceived service quality and v) perceived trust determine Patients' continued intention to use an mHealth system [31].

3.2.4. Interaction between Patient and Patients

Only a single study in the sample explicitly addressed interactions between Patients. That study [43] focused upon mPrevention/Education and mData-Collection. In particular, observations from an initiative in Uganda found that Patients could be trained to care for other Patients to allow (1) greater health support for fellow Patients (2) greater opportunity for HCWs to attend to other high-priority responsibilities in their daily schedules. It is noted that this approach of Patient training leads to changes in information-seeking among the broader Patient population, who become more likely to turn to these peer health care workers (PHCWs) for care than to conventional HCWs [43].

3.3. A System Developer Perspective

Table 3 - Focus of papers at each stage of mHealth delivery for System Developers interactions

Stakeholder Interaction	mPrevention/Education	mData-Collection	mDignosis	mTreatment
SD-P	3	3	3	3
SD-HCW	5	5	5	3
HCW-KB	5	8	5	5

3.3.1. Interaction between System Developer and Patients

The interaction between SD and Patients were not broadly studied in the sampled literature. Exceptions to this included exploration of mData-Collection centered on the security of Patients' health information, where SDs enable personalized health monitoring that helps patients gain confidence around the security of their treatment [31,33]. Interactions at other stages of the mHealth process highlighted SDs' ability to detect usability issues amongst different

cadre of Patients, e.g. in how youths or elderly Patients interact with technology [31]. Several studies note that such difference must be considered in the design and developments of mHealth applications [31,45].

3.3.2. Interaction between System Developer and Health Care Worker

The interactions between SDs and HCWs were also infrequently studied in the sampled literature. Studies highlighted SDs' need to understand the reality of the conditions under which HCWs in the developing countries operate, particularly when diagnosing and treating conditions[24,39]. Research also documented the implications when SDs fail to consult with the HCWs, whose collective buy-in is often essential for a system to gain traction [36].

3.3.3. Interaction between System Developer and Knowledge Base

As with other System Designer-related interactions, interactions between system designers and the KB were also studied infrequently in the sampled literature. Amongst the literature addressing mPrevention/Education, much of the discussion focused on the development of new technologies that continuously improve health outcomes and quality of life, or that will offer solutions to emerging problems in the future[46,47]. In the same vein, the concept of "grafting" is being recommended as a new perspective on information infrastructure, wherein new solutions must be 'grafted' onto existing resources and local interested parties [48].

4. Discussions and Conclusion

This review analysed research according to a stakeholder perspective that defined HCWs, patients, and SDs as key groups, as well as a stage-based perspective defining four key stages of the mHealth process, namely mPrevention/Education, mData-Collection, mDignosis and mTreatment. Initial sampling for the review identified 192 peer reviewed journals, conferences and workshops papers. This sample was reduced to 60 eligible studies based on exclusion criteria, these 60 papers were then coded along the stakeholder and stage-based perspective. This review has made five significant contributions to IS research.

First, a contribution is made in the form of the two dimensional lens used to analyse the literature. This lens provided a useful, reusable means of sense-making for the diverse body of research in this space, revealing several important high-level trends in the analysis and design of mHealth systems in developing countries. Among these trends was a triangulated meta-level investigation of the potential of mobile phones to transform health care delivery services in resource-poor settings [32,33], to address heterogeneous information needs in rural communities [29,39], to boost information penetration in areas where access to health information is limited [41,49], and to provide real time collaborative and adaptive interventions [22,50].

Second, a balanced focus of mHealth was observed across each of the stages of the mHealth process. Several of the sampled papers report findings from pilot studies in which the maturity and reach of system implementation was limited, meaning many issues of integration and scale may yet emerge. However, the fact that mHealth efforts represent a proportional breadth of activities means that the value of each stage can be observed and discussed. For example, in India mPrevention/Education interventions that targeted the metal health of teenage girls between the ages of 16-18 years from urban slums resulted in 62% of users feeling more supported [21]. The demonstrable success of these types of initiative paves the way for subsequent holistic endeavours in comparable contexts.

Third, analysis of the literature showed that interactions around HCWs are extensively researched. This makes sense, given these stakeholders are likely to be the most intensive, or direct users of mHealth systems. Thus, understanding these stakeholders is essential to understanding their mental model, cultural biases, and tacit expectations of a new system [51,52]. Given mHealth systems will involve significant new practices for these HCWs e.g.[12,53], it is important for scholars and designers to understand the existing practices users may already have in place [54,55].

Fourth, although the role of Patients is generally well-researched, there is a significant oversight in terms of the design and analysis of system-relevant Patient-to-Patient interactions. This is a significant shortcoming for the body of knowledge around mHealth, as peer-based observation, discussion, and referral plays an important role when introducing new systems [56,57]. The single paper that studied this stakeholder interaction [43] suggests this is no less

relevant for mHealth in developing countries, demonstrating that when Patients are trained to cater for other Patients it brings support to others through peer-based exchange of information and counselling.

Fifth, but perhaps most importantly, analysis of existing literature revealed a significant under-representation of research studying SDs' interactions with other stakeholders. Recent advances in system design have shown that the manner in which SDs interact with potential users is key to eliciting good requirements, spotting issues early, and allowing creative solutions to be presented for complex situated problems [58,59]. This under-representation may be limiting the effectiveness of mHealth initiatives by inadvertently creating design contexts where SDs have limited capacity to empathise with Patients and HCWs. Based on these findings, we call for future research that focuses specifically on 1) the interaction between SDs and other stakeholders and 2) the critical peer-based information exchange, referral, and knowledge sharing that happens between Patients. Addressing these gaps will be crucial to increasing cultural sensitivity and allowing mHealth systems to reach the poorest and most remote regions.

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