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A Review on Challenges in Implementing Mobile Phone Based Data Collection in Developing Countries

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Abstract. As mobile phones are impregnating developing countries, there has also been a surge on the research of using mobile phone as a tool in solving development problems in the areas such as livelihoods, poverty alleviation, health, education, the environment and disasters. The mobile phone research is being mainly focused on developing a suitable and viable technology for rural development. Collecting and reporting field based statistics using mobile phone is aimed at reducing time latencies between the reporting to and accessing from the database. The present review was mainly focused on socio-technological challenges of mobile phone based data collection in developing countries particularly in rural areas. Mobile phone based data collection can be successfully used by zeroing the challenges by employing the solutions suggested especially for developing countries.

Keywords. mobile phone based data collection, implementation, challenges, solutions, developing Countries

Introduction

In recent years, there has been tremendous growth in mobile phone usage in developing countries and there is a projection for strong growth in future as well. The Global Information and Communications Department indicate that the mobile phone subscribers are more in developing countries than the developed world.[1] As mobile phone penetration is increasing rapidly, there has been an increase on the research of mobile phone as a tool in solving development problems. For example, International Development Research Centre, Canada, has sponsored mobile phone research projects in 20 countries for developing a suitable technology in the areas such as livelihoods, poverty alleviation, health, education, the environment and disasters.[2] There has also been report on survey by mobile phone and it is being conducted across multiple countries including Uganda, India, Mexico, Ukraine and Iraq to understand the number of research on mobile phone data collection. The mobile phone based data collection research is mainly being focused on developing a suitable and viable technology for rural development.[3] Mobile phone based data collection systems typically have several components that communicate for data collection, transmission, storage and retrieval.[4]

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Traditionally, the field based data collection or survey is done using paper and pen method in developing countries. It is cumbersome for any statistician who wants to analyse the data. Furthermore huge cost and time is involved towards transportation of filled in forms as well as in consolidation of data sheets. The limitations in paper based method encouraged the development of electronic method of data collection.[5]

From the early 1990s, Personal Digital Assistants (PDA) based data collection has been used mainly in medical environment but, there are lot of issues associated with this such as cost, power outage, slow downloading in database format and accidental lost of data.[6] In view of affordability and flexibility of mobile phone, numbers of organizations and projects have successfully used mobile phones as a data collection tool in the place of paper based method in the areas like: reporting health statistics and advice, agricultural advisory, electronic monitoring, customer service and natural disaster management.[1, 3] Collecting and reporting field based statistics using mobile phone aimed at reducing time latencies between the reporting to and accessing from the database. As there are some limitations in the application of mobile based data collection, it is still in infancy and has not been widely used in the place of paper based system beyond the pilot stage.[7]

Therefore, the present review mainly focuses on the challenges of mobile phone based data collection in developing countries particularly in rural areas. The objective of this paper is to analyse the socio-technical challenges reported in mobile phone based data collection initiatives and find out the suitable solutions for future researchers. This paper includes the summary of the challenges with suitable solutions for future research. The solutions discussed in this paper would immensely come of aid to the researchers, development workers and policy makers for future course of action. This will give way- forward for a suitable avenue of research and deployment of viable mobile phone based data collection as a replacement to the paper and PDA based system in their respective areas. The research question of this paper is that what challenges have been reported in the published papers and what suitable solutions have been adopted/suggested to overcome the challenges? This paper organized as follows: first we describe the methodology, second we present challenges, third we discuss the solutions and last we conclude.

Methodology

We collected the publication by an initial generic search using words from any database field (i.e. words from titles, keywords and abstracts) after which all key words yielded relevant publications were listed. Some of the search terms used were: mobile phone based data collection and developing countries, implementation and developing countries, challenges and developing countries, solutions and developing countries, data collection and developing countries. Searches were performed for publication dates ranging from 2005 to 2011. The publications were excluded as were not related to mobile phone based data collection in developing countries. The relevant publications were arranged in a systematic manner and analyzed various socio-technical challenges. The review also came up with suitable solutions to overcome the challenges that were reported in the respective initiatives.

Challenges

There were various socio-technical challenges reported in the mobile phone based data collection studies conducted in developing countries. One of the main challenges was mobile network in the rural areas and it did not always work as expected in the several initiatives. For example, the text messages were sometimes delayed enroute or jammed. Electronic forms and Short Messaging Services (SMS) on mobile phone were too problematic for large-scale deployment and found errors on critical health data. In the implementation of mobile phone and Near Field Communication based patient presence alert system, it has been reported that HTTP over GPRS was unreliable and they have seen diagnosis messages hang or be dropped. The limitations of the mobile network may present the most definitive challenge to the feasibility of phone-based data collection.[8 - 12]

There were occasional reports of data loss due to difficulty in saving the data and also due to misuse and breaking of device belonging to a male participant was reported in the mobile phone based interviews about sexual activity and contraceptive use on a day to day basis over a four week period.[13] Delay in server, no load or battery problems due to irregular voltage from the power source were also some of the constraints encountered.[8,12,14] Unexpected Hardware problem while charging phone and software problem in the first week of use and login problem that was taught in the training were observed.[15] The participants of the project were due to lack of proper training and were not advised to turn their phones off when battery power is very low rather than letting the phones die completely.[8]

In the real time bio-surveillance program the existing work load of health workers who were involved in data submission prevented submission of data on real time basis. The older age people were slow in operating mobile phone and the keypad operation was difficult for them. In some locations, data submission was not proactively taken-up because the health workers feared that by introducing a new technology their job performance can be monitored by the higher officials anytime. Data error and less experienced people in electronically data submission were some of the other challenges were observed.[16 - 19] In similar kind of this project, the health workers were needed to type in all the open ended response in the mobile phone incorporated with a smart algorithm, which might add a little cost and cause some inconvenience.[14] The field veterinarians who were involved in mobile phone based surveillance system specifically for animal populations faced mainly on technical aspects like data errors because the field veterinarians were less experience in electronically data submission .[20]

Changing the behavior of people and organizations, delivering of sensitive medical related information over mobile phone and collecting agricultural information for building a database and business model for information dissemination were some of the challenges. It was reported in a study a payment model has to be factored in for collecting agricultural information, which was one of the challenge encountered.[10] In a mobile phone based household survey, it has been reported that there is a possibility of data fabrication by the data collectors which posed the challenge. The mobile phones can be stolen or may cause research staff to be targeted if they use expensive mobile phones when conducting household surveys in high-crime areas.[21] Prepaid user had a

little restriction in usage as there was lack of clarity on re-charge of the connections and allowed usage.[11]

Political considerations, respondent privacy and data security were the other recurring challenges.[20] In one of the studies, it was suggested that mobile phone could be shared with their colleagues, but sharing of cell phone may impinge upon confidentiality efforts and perhaps contribute to participant's reluctance to report on sensitive topics and privacy while collecting data particularly from HIV positive patients.[13] Privacy was important for both clients and health workers. The HIV positive patients were not willing to publicly talk about it as it was necessary to maintain privacy.[15]

There was a difficulty in using key pad during phone call in Interactive Voice Response application which was used to collect feedback on water education training, when to speak, when to use the key pad. In the gender participation impact, women generally listened more quietly to the instructions and answered more slowly and clearly, whereas men tended to talk during instructions and more often spoke at the wrong time, did not know what question they were supposed to answer, or were difficult to understand.[7] In the comparative study of speech and dialed input voice interfaces for farmers, there was a difficulty in discomfort speaking single word command, talking to a computer was an unfamiliar idea, difficult in recovering from errors made by either the system or user, less educated users had more difficulty recovering from recognition errors and navigating command-driven menus and knowing when to provide input.[22]. In the subsequent year in the same IVR application that user found voice input more error prone due to the low accuracy of the speech recognizer in the noisy background environment.[23]

Solutions

The socio-technological challenges encountered during mobile phone based data collection can be tackled by solutions suggested/adopted in several initiatives especially for developing countries. As good network coverage is important for mobile phone based data collection in the field, it is suggested that feasibility of network coverage throughout the study area should be investigated prior to committing to the phone method. Researchers who find network shortcomings prevent from the original population of interest in the mobile phone based baseline survey. This can be overcome by adopting the sampling for the baseline survey from all area of interest, regardless of network coverage and then continue the phone survey in those villages with network availability.[8,11,24] As several mobile phone providers compete for last frontier market in the villages, it is necessary that mobile phone projects should be the correct alliance with a right mobile phone company.[25] With regard to mobile phone connectivity, it is suggested that post paid connection, which too has Closed User Group (CUG) facility, is the best option for consistent use as there was clarity on the limit of usage and bill payment and it seems to be cheaper call also.[11]

Lack of skill in operating mobile phone was identified as one of the challenges during the data collection process. For instance, the health workers who participated in patient health data digitization were slow in submitting the data and also in one of the projects, the user could not figure out how to log in the system. The user mistakenly

select deletion option, the application gets deleted and was removed from the memory permanently, required reinstallation. In such cases, the participants felt that all the data and reports have been lost. It is important at early stage to understand the problems associated with data submission. Therefore it is suggested that the users should be given more rigorous both in hardware and software training on the use of cell phones for data collection. As amount of training was varied to users to users, additional training should be conducted at regular intervals followed by weekly meeting to discuss the challenges they faced while using mobile phone. The training should include careful instructions on how to use the phone, starting with how to turn it on and off. Training manual should also be prepared well in advance prior to training and it should be given to the users so that it can be used to figure out the problem while they are in the field. Also, a more thorough and incremental incentivizing scheme needs to be worked out to further enhance participant compliance and commitment, and reduce device mishandling and data loss.[16, 23, 20, 18, 17, 15, 13, 8, 11]

The health records submitted by users were found with erroneous data in terms of incorrect/incomplete words without editing the disease names, symptoms and signs. So, it is suggested that creating drop down menu and simplification of software application on mobile phone could be the suitable solution in order to avoid error rates.[16-17] The health workers had a fear in submitting data as their higher officials monitor their job performance through the system. The misunderstanding between the data collectors and their higher officials should be clarified at the earlier stage of the project to achieve the desired results of the project objectives. Data entry work has delayed as they are pre-occupied with their regular works. In view of this, additional human resources could be placed in collecting data instead of depending on the people who are already engaged in their regular work.[16-18]

In the HIV related project, health workers had given feedback to the project team to remove the clients name on the clients list on the application because it may create needless inconvenient for both clients and community health workers. In reality, many HIV positive people might not be interested to talk publicly about it. So, it is suggested that no personal information of the respondent needs to be collected in order to avoid the unnecessary consequences. It is also important to maintain privacy especially for sensitive issues like HIV patients. It is better if electronically storing patient health records are secured and the privacy must be protected to maintain the confidentiality of the respondents.[15,18]

Data fabrication by mobile phone data collector has been emerged out in a household survey conducted in South Africa. So, it is important to supervise the data collectors through web and use of a more expensive mobile phone with GPS capabilities. This can be a better solution for monitoring the data collectors in remote rural area.[21] Diagnosis would be stuck any time the cell phone fails to operate. So it is important that keeping track of the total number of instances of when the cell phone breaks down would help measure the robustness of the technology.[12] In Bangladesh based agricultural market information system (AMIS) project, it has been reported that finding someone willing to pay for the data collection process has been difficult. So, it is suggested that the Department of Agriculture Marketing in Bangladesh already has a web based information system which can be utilized for dissemination of information.[10]

A menu-based interactive voice response (IVR) system has emerged to be the most appropriate solution to the defined digital inclusion problem. This voice technology presents representations that are closest to the natural human language and do not require any level of literacy.[26] The experiences in IVR suggest that a number of more general design principles for IVR interfaces to be designed for similar populations in order to identify the voice successful rates among the men and women populations.[7] In general, it is advocated that appropriate use of speech recognition, when and if it matches the requirements of the task for example, in random-access tasks, when the space of potential responses is high (such as in a search interface). As there was more voice input error prone due to low accuracy of the speech recognizer and noisy background environments in interactive voice forum that was pilot tested with small farmers in rural India, the system should be developed an appropriate use of speech recognition and user generated voice content to navigate and search options.[23] In the mobile phone based data collection process, introducing a touch screen for digitizing data using mobile phone's camera for optical data capture can also be suitable tool in rural areas.[16] Battery problems due to irregular voltage from the power source could be solved by using solar chargers that could be the better solution for charging the mobile phone.[8,15]

Conclusions

This paper tried out to answer two research questions: "What challenges have been reported in the mobile phone based data collection?" and what solutions have been reported/suggested to overcome the challenges. This paper has identified various socio-technical challenges but some of the key challenges need to be given great attention while implementing the mobile phone based data collection particularly in rural areas:

- Network shortcomings
- Intensive software and hardware training for the users
- Weekly/regular meetings to discuss the challenges
- Collecting sensitive information especially from HIV patients and privacy of the patients
- Voice input error due to noisy background/environment

Regarding the second research question this paper has shown suitable solutions that can be applied in the future research on mobile phone based data collection particularly in developing countries. As mobile phone users are constantly increasing, the mobile based data collection can be expected to be more to replace the existing traditional paper based system in various sectors. The major contribution of this paper is to find out various socio-technological challenges with suitable solutions for future researchers. Mobile phone based data collection is a system and it should be best designed to balance between the issues during the implementation in the field. All the challenges and solutions analyzed in this paper must be taken into consideration for future research.

By considering all those challenges, mobile based data collection system needs to be tailored according to local condition. From the literatures, it was noted that speech recognition is likely to still be a useful technology. In addition to challenges, the plan

of financial sustainability should be prepared defining the roles of the various stakeholders (the NGO, donors, researchers and end-users) and establishing relationships with local Non Governmental Organizations, peoples and other stakeholders are very important and there should be a true partnership between the stakeholders in the design process.[27,23] In addition, political support has been the most important factor in the successful implementation and operation of the mobile phone based data collection.[20]

It is evident from the literature that the mobile phone is being successfully used for data collection in developing countries particularly in rural areas despite of several challenges. However, it has not been used widely in the place of paper based system beyond the pilot stage. It is recommended that the future researchers in developing countries can adopt the solutions discussed in this paper and make use of the mobile phone as a data collection device effectively in the real time scenario according to their local conditions.

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