Solutions to Challenges in Using Mobile Technology for Data Collection in Research Settings

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Abstract: Data collection is one of the important components of public health systems and research settings. The application of mobile technology to perform various tasks has increased in the recent past. This increase in usefulness has come at the expense of the usability of these devices in some contexts. The rapidly growing use of mobile technologies has also created a demand for mobile-based data collection solutions to bridge the information gaps in the health research in the developing countries. Studies conducted on mobile usability models found that usability is usually measured in terms of three attributes; effectiveness, efficiency and satisfaction. The three attributes are very important in ensuring accurate and timely data collection for public health systems. The rapid growing use of mobile technologies has also led to a demand for mobile-based as a mode of data collection. This study reviews the challenges that hinder the effective use of mobile technology such as internet network, infrastructure, installation and operation costs, and capacity of personnel and uptake of this new technology. This review will show the factors influencing the implementation of mobile technologies, particularly open source applications in research data collection and reporting systems for the developing world. It is important to look at the feasibility of mobile technologies, particularly open source technologies in improving the research data collection and reporting systems for the developing world. This review paper defines the challenges of deploying mobile technology in a remote environment and then discusses how to addresses these challenges to provide an adaptable systems.

Keywords: Data collection; Mobile technology; Health information systems; Open health and demographic surveillance

I. INTRODUCTION

Since 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 loss of data [1] Also due an emerging technology, many researchers have been devoted to conduct studies in various application areas (Pierre et al.) There has been tremendous growth of these systems in recent years; which has resulted in advancement of technologies all over the world. However few studies have been carried in the developing world on research settings and report data has also raised challenges of technological complexity in implementing systems. Health information systems (HIS) are the systems for collecting and processing health data from various sources. HIS have become a crucial component for strengthening the health systems in developing countries (Rashid and Lauren) [2]. This had led to shifting from paper based to mobile-based technology as means of processing health information in real time. Health researches nowadays deal with large amount of data, a situation that can lead to high risk of errors, and increase the cost of accessing and using the data. Mobile phone data collection has improved data quality, saved time in data collection and analysis, the software and hardware are user friendly, and there are cost savings. The high data quality is linked to features of the mobile data collection technology [3]. Even though the use of mobile technology seems to be effective as an enabling technology for resource limited settings in the developing world, there is still lack of shared standards in data collection methods and coordination between health care system levels. This can cause the gaps in reporting health data as it might lead to important data not to be reported, hence there is need for proper supervision [4]. In addition training and technical support is very critical for effective, accurate use and success of mobile data collection.

Decision makers, policy makers and health service providers need accurate and timely data in order to improve the quality of their services. The demand to health quality data is high needs a rapid data collection. The rapidly growing

use of mobile technologies has also created a demand for mobile-based data collection solutions to can be used to bridge the information gaps in the health research among the developing countries (Abouzahr et al.) [5]. Google Android platform is an example of open source software platform for mobile devices, which is composed of operating system and open libraries that are free of charge worldwide to be used by researchers and developers. Open source technology is the philosophy of developing and improving software through open and public forums by sharing the source code. The success of open source technologies was fuelled by the emergence of the internet which has then increased the demand of more collaboration between software developers [6,7]. The challenge of open source software is on keeping track of the software versions, because there are many developments going on at the same time. This causes open source software to be less competitive in software market compared to proprietary software. The electronic health record (EHR) is a digital record of a patient's health history that may be made up of records from many locations and/or sources, such as hospitals, providers, clinics, and public health agencies [8]. Health information technology (Health IT) may have the potential to improve the collection and exchange of self-reported data for example, in an individual's personal health record. It will take time to develop the infrastructure necessary to fully implement and support Health IT. In addition the systems changes can involve training a large number of staff many of whom may be off site and modifying practice in the management.

1.1 The use of Mobile Technology
According to (Piette et al.) the use of mobile technology seems to be effective as an enabling technology for resource limited settings such as in the developing world. Kenya, an East African nation, has set standards of mobile phone use on the continent [7]. Being the fastest growing group of mobile technology users on the continent, 92% of Kenyans use their mobile phone to go online (Perry). The swift expansion of mobile phone technology in the developing world has created rapid development and deployment of a wide array of potential applications, including mobile banking, data collection, patient tracking, and behavioural interventions [8]. Despite the high coverage of mobile users, researchers still face some challenges in effective use of mobile phone as a data collection instrument (Kaplan et al.) It is important to consider constraints that can hinder researchers and users in implementing mobile technology in research settings. Systems changes can involve training a large number of staff many of whom may be off site and installation of the new systems that result to cost implications. The mobile market in the country has maintained an upward trend with an increase of 4.7 percent in the number of mobile subscriptions standing at 37.8 million up from 36.1 million subscriptions in year 2015 (Communications Authority of Kenya, 2015). Technology has allowed many organizations to monitor our performance, make decisions about our programs, and report on our progress cheaper, faster, and better. For example, a mobile data collection platform that uses ODK to complete a census and baseline survey for a deworming studies in Western Kenya. The solarMal project also conducted census and malaria study in Rusinga Island by using ODK Aggregate software integrated with OpenHDS (Open Health and Demographic Surveillance) data system. ODK aggregate is web application that provides interfaces to manage data collection forms and the collected data. OpenHDS is a software platform that is based on a centralized database used to collect a continuous demographics, socio economic and individual health data on Rusinga Island HDSS since 2012 to 2014. The application OpenHDS and ODK helped to improve the performance of monitoring data quality through structured surveys and logical error checks to reduce data errors that would be much more common in paper surveys. ODK aggregate data tables can be downloaded in useful formats for further analysis, and other data processing (Homan et al.) Despite the overall advantage of using mobile data collection over the traditional paper-based system, there are still some challenges involved [9].

1.2 Statement of the problem
Currently, organizations and projects are using mobile phone technology to collect information such as agriculture and crops information, weather updates, news and market prices, natural disaster information, census, opinion polls from the field, Mobile phone technology makes it possible to access information and interact with the databases. The development of this technology is based on a technology, which uses widely available mobile technology gadget. Despite an upward trend following increased demand for Internet services and reduced cost of Internet enabled mobile devices, there are still exist challenges in the operation costs, capacity of personnel and uptake of this new technology.

1.3 Objectives of the Study
The main objective of this study is to investigate and analyze the challenges associated with use mobile technology for data collection and provide possible solutions.

II. CHALLENGES IN THE APPLICATION OF MOBILE TECHNOLOGY

One of the main challenges is mobile network in the rural areas which at times do not work as expected in the several initiatives. For example, the text messages are sometimes delayed or jammed. Another challenge is lack of proper training to the project participants. For instance if the participants are not advised to turn their phones off when battery power is very low rather than letting the phones die completely and with keeping the battery charged. This can lead to data errors, missing data due to prevented submission of data on real time basis. There is also the challenge with behaviour of people and organizations in delivering of sensitive medical related information to the database over mobile. It has also been reported that in a mobile phone based household survey, there is a possibility of data fabrication by the data collectors which is also another challenge [9,10]. The mobile phones can also be stolen or may cause research staff to be targeted if they use expensive mobile phones when conducting household surveys in high-crime areas, hence this has become a data as well as individual security concern (Robertson) [11].

According to Trancen technology report 2011, though data connectivity is now prevalent, there are still many instances where cellular data service may not be available due to intermittent connectivity. While encryption is the obvious solution for secure transmissions on commercial networks, data security to and from mobile devices have the same problems. Another important challenge is respondent privacy and data security and this could contribute to participant's reluctance to report on sensitive information about them. This is because there is still the notion that mobile phone could be shared with their colleagues (Gultiano et al.) [12-14].

The initial costs of designing survey instruments delivered digitally may be considerably higher when constructing traditional paper-based questionnaires. In addition, new back-end technology infrastructure may need to be procured and hiring staff to put the system in place [15,16]. There exist several open source projects that seek to improve the data collection process but they still face so many challenges. Also previous work on mobile-based health data collection systems has focused on capturing remote data through SMS, which has limitation in capability of capturing data for instance one SMS can collect only maximum of 160 text characters. Furthermore, SMS based data collection systems required users to have knowledge of the SMS format, for example leaving space between data elements. Organizations still have some security challenges with cloud server storage [17]. Cloud computing is the kind of computing service that provides software data access and storage service that can be accessed everywhere regardless of physical location of the end user [1].

III. POSSIBLE SOLUTIONS

Mobile network problem in the rural areas can be solved by investigating the feasibility in order to determine areas with network availability and also to suggest areas with poor network for improvement. An alternative paper-based method of data collection can be used in areas without network while mobile phone can be used in areas with good network connectivity. In addition there is a possibility of designing a mobile data collection system that can be used offline and data submitted when network is available. This will lead to increased productivity since field workers are able to continue working even in areas where there is no network and submit data to a central server at their convenience. It also possible to create data collection forms even outside the office and upload to an android powered device to accommodate your data requirements for instance open data kit (ODK) is flexible in terms of offline application design. Hiring qualified staff who can subsequently conduct training to improve the participant's understanding of the technology or conducting additional training sessions at the request of the participant. The training should include aspect such as; using mobile phones in data collection, data submission, turning off the mobile device while not in use, data security and privacy. Every training session should be followed by testing knowledge of the participants to ensure that the investment in the technology offers a solution to effectively reduce errors and eliminate redundancy. Though the initial costs of implementing mobile data collection system is high, its overall cost and advantages outweighs traditional paper-based questionnaires. For a success, a decision should be made on the best tools or devices which are well suited for the specific data needs and/or data collection and sharing processes of the sponsoring group. In addition to purchasing mobile devices that keep battery longer, it is important to have solar backup chargers which can enable users to increase their productivity in the field. There is also reduced redundancy since field workers are able to collect and submit data to a central server which is accessible to people who may need it in a minute from anywhere (remotely) [4]. The new technology of mobile device have in built camera and GPS functionality that allows users to take photos and collect a GPS location to ensure the photograph was really collected

onsite. Generally an electronic form can capture unlimited amount of all data type including text, video, audio, barcodes and GPS data unlike SMS based data collection systems required users to have knowledge of the SMS format (Bexelius et al.). ODK was developed purposefully to bridge the information gaps in resource-constrained regions such as the developing world by taking advantage of mobile phones subscriptions growth in these regions. ODK has proved its capability but there still more that needs to be done to improve it the proposed prototype in Figure 1 below.
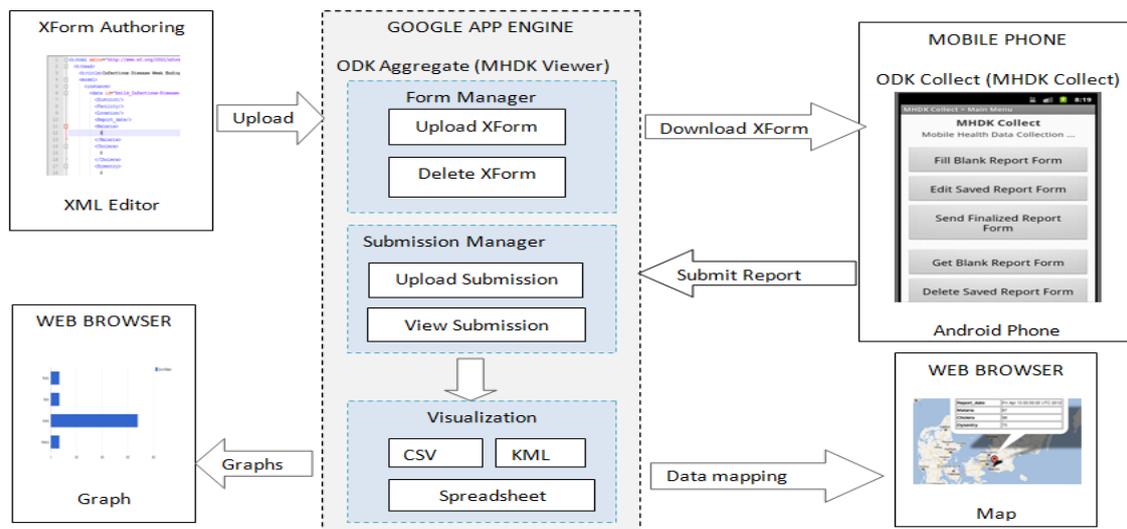

Figure 1: The main components of the proposed prototype.

IV.CONCLUSION AND RECOMMENDATIONS

This paper illustrates some of the challenges of mobile data collection in a remote research setting. For a successful implementation of mobile application, there is need to know how to mitigate these challenges. The Growth in mobile phone usage even in some of the poorest, most remote communities has allowed for new innovations such as mass dissemination of health research, verification of drug or vaccine authenticity. The compatibility between ODK and openHDS, which are free and open-source set of tools, can manage mobile data collection extremely well. This can be achieved by using ODK to convert paper questionnaires to e-forms and e-surveys and supporting offline data collection in areas without network. Despite the existing challenges, all mobile technologies are user-friendly and acceptable for collecting census information, interview consumers of various goods and services and poll potential voters. It has already been observed that the use of mobile phone for communication is prevalent in the developing world and that the current paper-based reporting systems are not practical and sustainable. Research organization should support and implement technology to improve the health data collection and reporting process. These research institutions should also partner with organization that deal with opens source software like ODK to improve on the scan technology that can used to implement both electronic health data and paper data collection which is applicable mostly in clinical trial research projects. It is also important to integrate most of these web based platform with Google earth so that data can be visualized through data mapping and simple graph features. This will allow for a quick spatial analysis of data that can be used to depict for an outbreak of a disease. Local server installation and configuration of the open source systems like ODK should be simplified for easy implementation by research organization who may be interested in using mobile application. Enabling data visualization and subsequently to provide alerts through mobile phone screen (mobile interface for data visualization) based on existing data in the server. This can be done through synchronization to mirror data that is exists in the server. Security to health data in the ubiquitous networks and other health data transmitted to networks and downloaded from the networks should be well secured. This is the only way research organization can have full trust in the use of cloud servers.

V. REFERENCES

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